Environmental assessment platform for cities racing to net zero

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Abstract. The UK was the first major economy to pass a Climate Change Act in 2008, which was revised in 2019 to achieve net zero emissions by 2050. In 2019, Southampton City Council (SCC) declared a climate emergency setting ambitious targets for the city to become carbon neutral under the banner Green City Charter (GCC), which was signed by 70 city-based organisations. There is, however, no specific methodology to quantify progress towards the targets. Here we present the outcomes from developing the GCC Tracker in collaboration with local authorities and stakeholders. The approach is based on the Analytical Hierarchy Process, with expertise agreed weights to measure the success or otherwise of carbon environmental commitments. The outcome is the Green City Tracker encompassing an assessment matrix that provides ratings and quantifies annual progress for achieving committed targets. The Tracker was applied to 10 institutions and the results show their ratings as a function of each sub-criteria and as an overarching rating. The approach highlighted the importance of generating a universally applicable and time/resource efficient processes in order to incentivise organisation participation. The Tracker was widely accepted by regional local authorities with a plan to widely adapt it to other cities declared targets.

1. Introduction
In 2008 the UK was the first major economy to pass the Climate Change Act committing the Government to 80% reduction in emissions by 2050, which was augmented in 2019 to net zero by the same date [1]. The UK Committee on Climate Change (CCC) was created under the Act to report on annual progress and provide projections called carbon budgets which are on a 5-year basis. In its July 2019 progress report the CCC stated that current policy actions were “well short of those required for the net-zero target” [2] and the UK was not even on track to meet its early, less challenging, 80% target. Although the UK’s energy sector has undergone considerable emission reductions through expansion in renewable energy electrical power supply other sectors (transportation, businesses and residential) are largely unchanged [3]. The total cost of reaching net zero is considerable and CCC estimated this to be in the range of £50-£70bn per year. It is recognised that achieving net zero carbon has vast benefits, including improved air quality, enhancing natural environment, health, productivity and reduced hospital admissions [4].

In the UK, 74% of cities and local authorities (local governments) have declared a climate emergency with some setting quantifiable targets for their cities by a certain date [5]. In June 2019, the City of Southampton lead by its City Council (SCC) announced ambitious targets under the Green City Charter (GCC) banner enshrined within the Green City Plan [6]. The Charter was created in consultation and partnership with residents, local businesses and organisations to assist Southampton City in its transition towards zero carbon making the City cleaner, greener and healthier for its citizens. The GCC has five main components: (i) sustainable energy and carbon reduction, (ii) delivering clean air and quality of life, (iii) natural environment, (iv) resource, waste and water management and (v) sustainable travel. In
addition to the City Council, the GCC was signed by more than 70 entities in the City, including institutions, businesses and charities. In spite of these sustainability driven aspirations, there were no specific principles to measure the success or otherwise of declared commitments (charter), nor a methodology to quantify progress and the required fundamental changes to achieve the agreed targets.

While there is an agreed consensus on climate change and the measures required to reduce emissions [7] there is no societal consensus on the required measures governments and local authorities should implement to achieve net zero [8]. Sustainability assessment (SA) and reporting (SR) are considered an essential element in achieving sustainable development [9]. Published studies show the importance of implementing the two assessment processes in helping to guide cities/organisations towards net zero pathways and commit to their corporate social responsibilities [10].

A number of methodologies and tools have been developed to assess and report on organisations’ sustainability performance [11, 12]. These focus on alternate dimensions of sustainability and scales be it at the city, organisation or building levels, with reporting classified into (a) frameworks, e.g. Greenhouse Gas (GHG) Protocol, (b) standards including ISO 14001:2004 environmental management systems and (c) ratings and indices such as the LEED (Leadership in Energy and Environmental Design) rating system.

This wide array of sustainability assessment and reporting tools provide organisations the opportunity to select those that best suit their required level of data or focus of assessment, be that to inform stakeholders or optimise operations [13]. However, to meet their sustainability targets, cities and organisations within will require locally-relevant indicators [14]. Therefore this work aims to develop a robust sustainability assessment tool to quantifying the status and progress of the City of Southampton and its GCC signatories in achieving the committed targets based on the agreed five pillars of the GCC. Furthermore, in the UK organisations that exceed at least two of the following: £36m annual turnover, £18m balance sheet total and 250 employees, are required to report publicly on their UK energy use and carbon emissions. Within the City of Southampton many entities fall under these categories.

There are a number of established methods for estimating carbon emissions, such as the most widely used GHG Protocol method [15]. In this work we adopt such a protocol within an assessment platform having a locally (but generally widely applicable) appropriate rating system with additional foci on educating and encouraging organisations to invest in sustainability to complement their required or set out targets. In essence, this paper depicts the approach undertaken to establish an assessment and progress tracking tools (GC Tracker) and its application at the City organisation level. The following sections document: the research and assessment methodology designed to create the GC Tracker based on the announced 5 pillars mentioned earlier, the results from the initial application of the Tracker, a discussion on the implications of implementing the said tracker and its tools and the scope for future work and adaptability of utilising the tracker in other cities.

2. Methodology
As indicated earlier, the GCC was announced, but had no specific indictors to measure the success or otherwise of the commitments. The approach undertaken was to establish an assessment and progress tracking tools (GC Tracker) on the Analytic Hierarchy Process (AHP) methodology [16]. Developing a sustainability assessment tool will include the processing of the selected number of criteria and their sub-criteria, some of which will inevitably be conflicting. This complex multi-criteria decision making problem lends itself well to the established AHP approach [17, 18]. The method involves experts, stakeholders and/or scholars within the field assessing and weighting the criteria to generate a weighted score through pairwise comparison based on the experience and knowledge of the appraisers [19]. This produces an agreed consensus on the criteria weighting helping mitigate one of the recorded issues of criteria, in particular environmental criteria, having an amplified importance [20]. The pairwise comparison method is conducted by comparing pairs in each criteria and sub-criteria group, where the most important criteria/sub-criteria are selected and then assigned a score from an Importance Index (I) Scale (Table 1) to determine the relative importance between the two compared criteria.
In order to fulfil the AHP process, 15 experts agreed to take part in an online survey to produce the Performance Tracker Matrix based on the pre-determined five criteria (GCC pillars) and thirteen sub-criteria (Table 2). The experts, who have experience across all five criteria, compared pairs in each criteria and sub-criteria group assigning each a score from the Importance Index. The pairwise comparison procedure calculated the final weights by building two square matrices, the pairwise comparison matrix and the normalised matrix [17]. The pairwise comparison matrix has an equal number of rows and columns, equal to the number of criteria and is built through using the combined average Importance Index scores from the participating experts. The normalised matrix is then generated by dividing each matrix element by its column magnitude with the weight of each criterion equal to the average of its row in the normalised matrix, as an example see [17].

The final part of the pairwise comparison was to verify the experts’ input, which are deemed accurate if the Consistency Ratio (CR) is less or equal to 0.1, through the equation CR = CI / RI. RI is the Random Consistency Index and CI is the Consistency Index, where CI = (λ\text{max} - n) / (n - 1), with n being the number of criteria and λ\text{max} is the Principal Eigenvalue, which is equal to the products of the criteria sum total of each column of the pairwise matrix and the determined criterion weight value [18]. The experts’ input was found to be accurate with CRs of less than 0.1 producing the agreed consensus of relative weights for the 5 criteria as shown in Table 2.

| Main Criteria                | Weight | Sub-criteria                                      | Weight |
|------------------------------|--------|--------------------------------------------------|--------|
| Sustainable Energy and Carbon| 35%    | Carbon reduction planning & delivery             | 20%    |
| Reduction                    |        | Energy efficiency measures                       | 40%    |
| Delivering Clean Air & Quality of Life | 21%    | Reduction in fossil fuel consumption | 40%    |
| Natural Environment          | 12%    | Incentive and disincentive schemes            | 41%    |
| Resource, Waste & Water Management | 12%    | Low emission vehicles                           | 44%    |
| Sustainable Travel           | 19%    | Support & management of green infrastructure    | 50%    |
|                              |        | Establishing green infrastructure               | 50%    |
|                              |        | Waste policies                                  | 39%    |
|                              |        | Procurement policies                           | 28%    |
|                              |        | Monitoring water consumption                    | 33%    |
|                              |        | Sustainable travel to work                      | 60%    |
|                              |        | Sustainable business travel                     | 40%    |

A number of sustainability indicators with their own relative scores were developed within each sub-criterion. These items were developed through a review of existing assessment tools and methods followed by a rigorous consultation process with academic, local authority and stakeholder experts. These experts had to consider applicability, accessibility, comprehensiveness, timescale and comparability for all types and sizes of organisations [21] [22]. Additionally, assessment tools are often criticised for requiring a vast level of data and time from those being assessed [11], a matter which is often overlooked during the development process [23]. In order to mitigate this and create a robust yet user friendly tool, the list of indicators was capped at 39 items (Figure 1). To reduce the data filling...
burden further, the questions within these incorporate qualitative and quantitative data capture with, where possible, binary yes or no responses. These 39 items incorporate input-oriented and output-oriented operational measures (e.g. consumption of raw materials and emissions/pollutants) alongside strategic environmental attitudes and management (e.g. carbon management plan and publishing strategy). Where applicable items and sub-criteria were linked to existing policies/regulations, such as UK ultra-low emission vehicle standards and the UK public procurement policy. Also a reduced list of 30 items, maintaining all 13 sub-criteria, was developed in order to consider those that do not own/control their own premises. The final matrix score is estimated using the relative weights of the five criteria, which in turn were scored from the relative weights of the sub-criteria which are a sum of the sub-criteria item scores.

Performance Tracker templates, and accompanying guidelines have been produced for the assessment which provide a full breakdown and explanation on the scoring of the 39 individual sub-criteria, stipulating the scores, intent and requirements. All documents have been graphically reproduced (e.g. Figure 1) to help communicate the process with participating organisations. GC signatories are able to register their interest on the Tracker webpages [24] whereby they receive an individual video consultation to explain the assessment process and are given the GC Templates with which to complete the assessment. Upon receipt of the set of completed templates a follow up video consultation will be arranged where a researcher will explain the score and provide guidance on the next steps.

3. Results and Discussion
Ten city-based institutions have been assessed during October 2020 to February 2021 and in the following section we provide an example of the assessment conducted with Southampton City Council and the University of Southampton.

Southampton City Council was assessed, and the results are given in Figure 2. SCC was found to have an overall score of satisfactory (Figure 2 (a)), scoring highly in the Environment (natural environment) criteria with a score of outstanding (97%) and a score of satisfactory in all other criteria (Figure 2 (b)). For example, to estimate the score of the Sustainable Energy & Carbon Reduction criteria, the carbon reduction planning sub-criteria has three indicators which were estimated from the scores of the: carbon management plan (CMP), delivery team and publishing strategy. The CMP is a documented strategy and set of actions to help an organisation meet their carbon reduction objectives. As shown in

![Figure 1. GC Tracker weighted criteria and sub-criteria (see [24] for a full size image).]
Figure 2 (c), SCC scored 5 out of 5 as they have an up-to-date CMP, with yearly reports and have established a target date and plan to become a carbon neutral entity. They score full marks for the delivery team sub-criteria as they employ multiple staff dedicated to planning and delivering on the CMP across a variety of teams which are dedicated to planning and deliver. Then finally for the publishing strategy they were able to provide evidence that they make sustainable aspirations/efforts publicly available and that they have multiple schemes to embed a sustainable work culture. Looking at the overall score for the Sustainable Energy & Carbon Reduction criterion (Figure 2 (c)), the assessment identified key areas for improvement including the insulation and building fabric of their building stock and their carbon emissions and energy provisions from renewables.

In contrast the University of Southampton (UoS) has an overall score of 61% (satisfactory), slightly less than that of SCC shown in Figure 2 (a). As per Figure 3, UoS had good scores in the Sustainable Travel (88%) and Environment (83%) criteria. The Energy and Waste criteria were both satisfactory (64% and 65% respectively) while Clean Air was found to have scope for improvement scoring only 31% with low scores in the majority of sub-criteria (Figure 3).

The above two examples provide an indication of the flexibility and wider applicability of the Tracker. Other GC signatories have taken part in the assessment process with different predictions of scores given by the Tracker. Furthermore, some have selected to have their outcome confidential, which allowable under the Tracker. Any issue regrading scores is addressed through consultations and the annual reviewer of signatories to be undertaken by the Council.

4. Conclusions and Future Work

As can be seen from the above results the developed tracker was deemed to be appropriate to allow assessment of GC signatories according to the 5 criteria. The approach is informative and provides guidance to pathways of improvement under the specified criteria and sub-criteria. The feedback was excellent as the Tracker is burdensome yet flexible and robust to provide a score and depiction where action will be required to achieve a better score in the next annual assessment cycle. Clearly there is a sensitivity around publishing the results which will need addressing.

The Tracker and its processes were widely accepted by the City of Southampton and is now part of Southampton City Council’s Green City work programme with additional assessments planned with willing GC signatories. Areas for enhancement were identified across the five pillars (criteria), as was the case for the other signatories who wished for their scores to remain confidential. As indicated earlier,
the assessment process was able to identify key issues for each participating organisation and provide targets and instructions for the next year with annual assessments planned to document organisations progress and assess their revised strategies. We are engaging with other interested local authorities and while they have different sustainability pillars to achieve their required targets, they are somehow similar with scope for a reordering of criteria and sub criteria to suit each local authority’s sustainability agenda while maintaining the robust AHP methodology.

Work on developing the methodology began before the full impact of the COVID-19 pandemic, however one must take note of the significant effect this has, and will have, on proposed sustainable measures. With many organisations having had to operate with significant restrictions, add to this the likely prospect of a global recession and they will likely find it harder to justify investing time and money into low carbon pathways regardless of the long-term economic logic [25]. The use of tailored indicators to support the regional sustainability pillars with publicised stakeholder involvement can aid sustainable development. A locally relevant time/resource efficient assessment platform has been shown through this initial trial to support local authorities and organisations with the capacity to be used as a vehicle to support their sustainability credentials.

Acknowledgements

This work is a part of the activities of the Energy and Climate Change Division at the University of Southampton (www.energy.soton.ac.uk). This work is also in partnership with Southampton City Council, Winchester City Council and the Department of Electrical and Computer Engineering at the King Abdulaziz University, Saudi Arabia. The work is supported by an EPSRC Impact Acceleration Account (IAA), with partial support by the Ministry of Education in Saudi Arabia through project number 714, coordinated through the Deanship for Research and Innovation, KAU.

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