CONCLUDE
Informed Decision Making

Case Study

How to do more with less, by making better use of space

Solving a riddle that has not been effectively solved before…
…How do we increase the capacity of our acute hospitals and achieve improved clinical services and outcomes, but do so as space, resource and energy efficiently as possible?

These are the typical questions asked at the very early requirements stage for new or refurbished healthcare facilities. This case study explains how The Conclude Consultancy helped to answer these challenging questions.

Headline benefit: For a typical hospital in Sweden every 1.0 square metre of space saved translates into 200 -250 kWh energy saving. In the United Kingdom the expected saving translates into 400-450 kWh.

Business benefits achieved:

1. The Occupancy Analytics ™ method saved 6,000 m^2 forecast use of space in a 36,000m^2 hospital, whilst supporting the same patient throughput as the larger hospital that was originally planned.
2. 6,000 m^2 of space translated into 1,750,000 kWh per annum saving in energy (29% of total forecast energy consumption). At 0.16 kg CO_2 per kWh this is equivalent to saving 0.28 tonnes of CO_2 emissions per annum. This equates to 7% of per capita emissions (4.6 metric tons of CO_2) in Sweden
3. 21% difference in forecast energy consumption between conventional engineering practice and the use of Occupancy Analytics ™. This arises because the new method replaces the typical assumptions made by many engineers in the forecasting of energy performance.
4. Scaleable strategy applicable to all hospitals – see case study for 90,000m^2 hospital in the UK.

6,000m^2 of potential space savings were identified to evaluate the impact of The Conclude Consultancy (TCC) Occupancy Analytics™ method on the planning of a new hospital in Gothenburg, Sweden. Using the data from this analysis, TCC was then requested to advise on the impact of these space savings on the forecast energy performance for the hospital.

The client wished to use this knowledge to inform the low energy strategy for all of the new hospitals to be developed in the region. TCC reasoned that the smaller the hospital for the same patient throughput as a larger hospital, the better the energy efficiency – but the question to be answered was by how much?

Working with the client's energy consultants (AF Consult) TCC created a template of occupancy profile data that could be processed directly into the energy modelling simulation used by the consultants. This data replaced the occupancy profiles typically used in the simulation software.

The business challenge for TCC

To provide quantitative data to demonstrate the business benefits of a smaller more space efficient hospital.

The data output from the TCC Occupancy Analytics™ simulation needed to be compatible with energy simulation software used by the

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client's energy consultants. Working with the developers of the software, TCC and AF Consult developed an occupancy profile template. The data was then imported directly into the simulation.

Our methodology

TCC's methods are based on analysing the optimal utilisation of clinical space using their Occupancy Analytics™ method. Data from the analysis is then imported into proprietary energy modelling software. TCC has used Riuska™ and IDA ICE™. See: http://www.granlund.fi/en/software/riuska/), (http://equa.se/en/).

The occupancy profile data from TCC includes the following data sets:

1. Statistical distribution of occupancy (patient types, staff types and support staff types) at hourly intervals throughout each day.
2. Statistical analysis for 90 and 10 percentile distributions as well as Mean values.
3. Equipment utilisation profiles.
4. Elevator demand profiles.

Learning outcomes for the client

What were the key learning outcomes for the client?

a) The method removes substantial occupancy related assumptions from engineering analysis. These assumptions, which are embedded in computational analysis within the software, cause substantial error to arise in forecast energy consumption.

b) These inaccuracies lead to the 'Performance Gap', which is the difference between forecast energy consumption and energy consumption In-use. (For example, see: *de Wilde P (2014), The Gap Between Predicted and Measured Energy Performance of Buildings: A Framework for Investigation. Automation in Construction, Volume 41 (40-49)*).

The analysis addresses one of the fundamental challenges for contemporary energy forecasting, which has been the subject of much academic research, and that is how to reliably predict occupancy patterns and then to use these patterns for the forecasting of energy demand In-use.

Conventional practice in the forecasting of energy consumption is often very unreliable and the inaccuracies in forecasting can amount to a factor of about 2.5-3.0. In our analysis on this project we found a 21% error in the forecast based solely on the TCC analysis of In-use. This error would lead to an understatement of future energy performance and as such when measured In-use the resulting energy performance would therefore be substantially higher.

Our analysis also found that equipment energy loads are typically much lower than is often predicted by engineers. This arises because the profiles typically used in energy modelling simulation assume that equipment is running for substantial periods of the working day, and without any variation of use. It identifies that the variances in use can be substantial. In this case the energy consumption is overstated and this leads to significant over-estimation of cooling loads (more equipment use = greater heat gains that need to be offset by increased cooling), leading to larger more expensive cooling plant infrastructure. Conversely, it also means that forecast heating demand would be much lower, when the opposite would be the case during In-use. But by using the TCC Occupancy Analytics™

methods it would eradicate these errors and lead to significantly improved decision -making concerning the capital expenditure budgets for HVAC plant infrastructure.

How would TCC methods lead to improved-decision making for a project leadership team?

Decision: *What would be a challenging energy target that we could rely upon?*

Answer: To achieve a target of less than 200 kWh/m^2 for example (which would be a step in the right direction to low energy performance), would require a clear understanding of In-use operations, modelled with the associated energy impact. The basis of the decision must be documented in operational policies agreed with the clinical leadership teams. If this were not to be done, then In-use electrical energy consumption could not be effectively managed.

Decision: *What actions should we be taking to achieve a target significantly less than 200 kWh/m^2?*

Answer: Definitely avoid 'best practice' based approaches using generic standards. Space is the major driving factor behind energy consumption, so the need is to make the hospital as small as possible, without compromising operational performance.

Decision: *We need to be certain that we have not over-sized engineering plant infrastructure, because these costs can amount to between 40%-50% of the overall construction budget. How can we have confidence that we have not done so?*

Answer: Firstly avoid the substantial assumptions that are most often made in engineering design. Establish energy demand profiles based on analysis of In-use to ensure an accurate basis of design.

Secondly, the need is to understand the primary drivers of energy consumption and develop policies with the clinical leadership team to minimise the impact of these drivers. Document agreed strategies and policies within Operational Policy documents.

Decision: *How is this strategy applicable to much larger hospitals – what savings should we expect to plan for?*

Answer: TCC were appointed to review the planning and basis of design for a 90,000m^2 acute hospital redevelopment providing regional services in the county of Sussex in the UK.

Using their Occupancy Analytics™ methods, TCC were asked to identify space saving opportunities in the design and planning for Outpatient services. Of the 229 outpatient patient rooms, TCC identified that 38% of these would not be required using new clinical service delivery processes.

Amounting to nearly 4,000m^2 gross floor area of space savings, the Trust sought to plan for increased capacity clinical activity rather than reduce the size of the hospital.

Energy analysis for the whole scheme demonstrated that through a combination of 'right-sizing' space and HVAC plant infrastructure (using Occupancy Analytics™ data), overall plant sizing could be reduced by an average of 24%, and energy consumption reduced to between 100 – 150 kWh/m^2 (22-33% reduction). The client's specialist advisors independently validated these results.