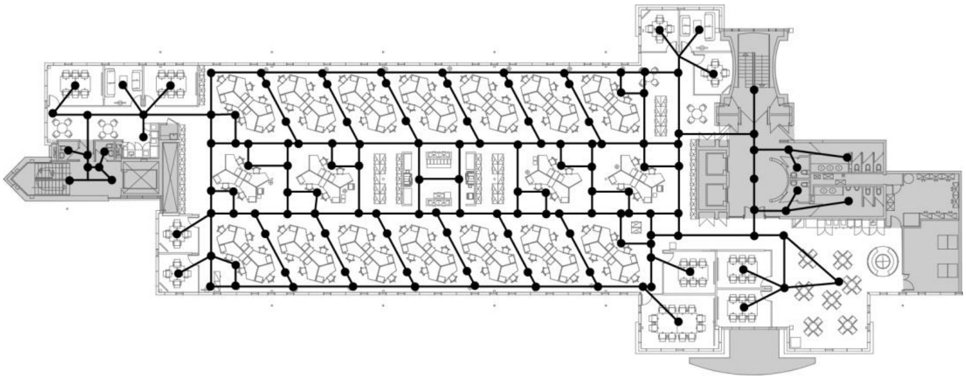
Supplementary File 1

Definition and Calculation of Selected Spatial Metrics for the Active Buildings study

In order to measure the spatial properties of office buildings by a standard method, two-dimensional 'Spatial Graphs' were produced, using drawings of floorplan where lines are drawn, representing the possible circulation routes between individual workstations and key office destinations such as kitchens/coffee points, shared printers/copiers, meeting rooms, lifts, stairs and WCs (**Figure S1**).

Figure S1. Example of a 'Spatial Graph'



A floorplan of a case study building, with generated Spatial Graph shown in black. The graph represents all circulation routes taking account of barriers to movement such as walls and furniture. The solid black lines represent the routes that connect the workstations and destinations. The 'vertices' or 'nodes' of the graph shown as black dots are the workstations, the key office destinations, and the intersections between lines. 'Edges' are segments between each black dot.

From the Spatial Graph, four metric categories were calculated to represent:

1. Distance from each workstation to key office destinations
2. Distance from each workstation to all workstations on the floor
3. Visibility of other workstations (sitting or standing)
4. Workstation 'closeness' minimising angles or turns.

Further details of the four types of metrics are provided below.

1. Distance from each workstation to key office destinations

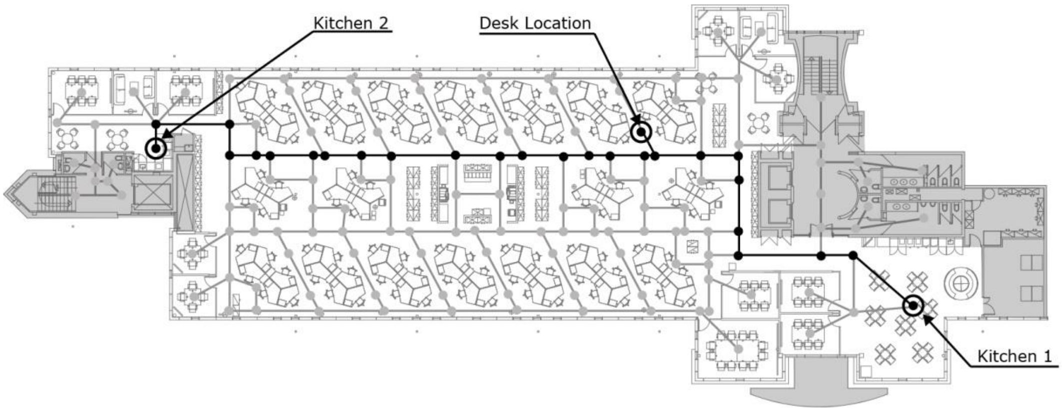
Using the Spatial Graph, distances from each workstation to key office destinations are calculated by considering the shortest path, measured in terms of either: the least length in metres (D_m); or fewest edges -i.e. segments on the Spatial Graph – (D_e)

The example below is for kitchens:

1.1 Distance to the Nearest Kitchen (metres or edges) $D_mC^{kitchen}$ or $D_eC^{kitchen}$

1.2 Average Distance to all kitchens on the floor (metres or edges): $D_mA^{kitchen}$ or $D_eA^{kitchen}$ (see **Figure S2**)

Figure S2. Example of a spatial graph with subgraph showing shortest routes



The spatial graph with the sub-graph (in black) of the shortest routes between a participant's desk location and all the kitchens on the floor, in this case, 2 kitchens. By averaging the two distances, the following can be calculated: 'Average Distance to All the kitchens on the floor (metres or edges)': $D_mA^{kitchen}$ or $D_eA^{kitchen}$.

Once the above metrics have been computed for each type of destination, two further composite metrics are calculated for each workstation. For these metrics, distances to male or female WCs were assigned depending on participant sex.

1.3 Average Distance to All Nearest Destinations on the floor (meters or edges):

$$Av\text{-}D_mC^{all} = \text{Average}\ [D_mC^{kitchen} + D_mC^{printer} + D_mC^{lift} + D_mC^{stairs} + D_mC^{WC} + D_mC^{meeting\text{-}room}]$$

$$Av\text{-}D_eC^{all} = \text{Average}\ [D_eC^{kitchen} + D_eC^{printer} + D_eC^{lift} + D_eC^{stairs} + D_eC^{WC} + D_eC^{meeting\text{-}room}]$$

1.4 Average Distance to All Destinations on the floor (meters or edges)

$$Av\text{-}D_mA^{all} = \text{Average}\ [D_mA^{kitchen} + D_mA^{printer} + D_mA^{lift} + D_mA^{stairs} + D_mA^{WC} + D_mA^{meeting\text{-}room}]$$

$$Av\text{-}D_eA^{all} = \text{Average}\ [D_eA^{kitchen} + D_eA^{printer} + D_eA^{lift} + D_eA^{stairs} + D_eA^{WC} + D_eA^{meeting\text{-}room}]$$

2. Distance from each workstation to all workstations on the floor:

This metric is calculated to represent the 'proximity' of all other workstations (i.e. co-workers) on the floor, measured as the average of the distances from each workstation to all other workstation on the same floor (this metric is also calculated in meters or edges).

Average Distance to All Workstations on the floor (metres or edges): $D_mA^{workstation}$ or $D_eA^{workstation}$

3. Visibility of other workstations

Two metrics regarding visibility of other workstations were calculated:

3.1 Visibility of Co-workers, Standing

3.2 Visibility of Co-workers, Sitting

These count respectively how many workstation (i.e. co-workers) are potentially visible within a 360 degrees visual field from the participant's workstation when the participant is either standing or sitting, after taking account of visual barriers such as solid walls and partitions.

4. Workstation 'Closeness Centrality'

'Closeness Centrality' was calculated to capture how 'close' a workstation is to all other nodes on the Spatial Graph, considering the shortest distance in terms of: number of turns, or angular deviation. Closeness is devised to capture aspects of the 'connectivity' and 'integration' metrics in Duncan et al. [17], and to minimise changes in directions, as mentioned in Sailer and McCulloh [22]. In particular, the inverse normalised Closeness Centrality was used ('normalised' via the number of 'nodes', N, on the Graph).

In particular, given two points x and y on a Spatial Graph with N number of nodes, such that:

$dT(x, y)$ and $dA(x, y)$

are respectively the length of the shortest distance between x and y, measured in either least number of turns, or angular deviation, then

4.1 Normalised Closeness Centrality (Turns) of a workstation x:

$CCN(x)_T = (N-1) / \sum_y dT(x, y)$

a. Normalised Closeness Centrality (Angular) of a workstation x:

$CCN(x)_A = (N-1) / \sum_y dA(x, y)$

Note in this case a 'turn' was an angular deviation of more than 30 degrees.