

Article

Routines, Rigidity and Real Estate: Organisational Innovations in the Workplace

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Abstract: Finding ways to reduce the environmental impact of the existing building stock is an important element in climate change mitigation. This article examines environmentally focused organisational innovations in the corporate real estate industry. Organisational innovations are often overlooked as they cause considerable disruption to the daily routines of employees. In this article, the focal organisational innovation is the adoption of activity-based working. The study aims to uncover the barriers to activity-based working and to compare it to similar best practice strategies that aim to reduce cost and environmental impact. A case study office building has been analysed to examine the efficiency of the workplace arrangement strategy and the impact of this strategy on the building's energy consumption. The results of the case study coupled with evidence from the global real estate industry suggest that activity-based working can deliver substantial benefits for the employer organisations and the employees. However, despite this it has not reached high levels of adoption on a global scale. This failure to achieve high levels of adoption is evidence of routine rigidity. This article highlights the importance of building occupancy in the future discussion on environmental impact reduction in the corporate real estate industry.

Keywords: organisational innovation; routine rigidity; activity-based working; corporate real estate management; space efficiency

1. Introduction

The building sector has a substantial environmental impact and it should be a priority area for governments aiming to reduce global greenhouse gas emissions. It has been shown that the building sector consumes approximately 39% of the total energy consumption and emits approximately 35% of the total CO₂ emissions in Europe [1]. Strict emissions targets have been set by the European commission and the current plan is to reduce greenhouse gas emissions by at least 80% by 2050, compared to 1990, with the intention of keeping climate change below two degrees Celsius [2]. The current EU guidance on how to reduce the environmental impact of buildings during their operational life takes a very technocentric approach [3]. The focus is on minimising the amount of energy consumption through energy efficiency improvements and increasing the amount of renewable energy generated on-site.

This technocentrism is driven by an engineering approach to tackle the environmental impact of buildings. It requires considerable investment in new equipment and the installation of equipment. It is essentially a process innovation and is similar to upgrading old industrial machinery with more efficient equipment. One of the big benefits is that it does not adversely affect the daily life of the users in the building [4]. The improvements can be made with the minimum amount of impact on the building users and without compromising their levels of satisfaction. The building continues to perform as before with the same amount of illuminance from the light fittings, the same amount of

fresh air, the building is still heated and cooled to the same temperature, and the view from the window does not change. For example, a technocentric approach to reducing environmental impact could be to install solar panels on the roof of a building. In contrast to this, a behavior change campaign that encourages the building users to turn off the lights when they leave the room and thus impacts the daily life of the users.

An alternative to the technocentric approach is to look at changes that could be made at an organisational level rather than at a process level. This involves a behavioural approach rather than an engineering approach. Organisational innovations have the benefit of employing simple solutions and thus they entail very low investment. However, they are often rejected in the corporate real estate industry as they introduce considerable disruption to the routines of the building users which often leads to increased levels of user dissatisfaction. This avoidance of the risk related to changes on an organisational level is not uncommon and scholars have shown that the barriers to organisational innovations are stronger inhibitors of environmental innovation than product, process, or technological barriers [5]. In this article the focal organisational innovation is the adoption of activity-based working.

These barriers to organisational change can be referred to as organisational inertia and they can be split into two categories which are resource rigidity and routine rigidity. The former is the failure to change the organisation's resource allocations and the latter is the failure to change the organisational processes. The technocentric approach to reducing environmental impact in the corporate real estate industry and the investments needed for this approach suggests that that resource rigidity is not a significant problem. However, the lack of widespread adoption of a behavioural approach to complement the technocentric approach suggests that there is evidence of routine rigidity.

Routine rigidity is a new but relevant area in the literature on innovation and its strength lies in its ability to explain why some rational innovations continue to be ignored. To date, it has only been referenced in environmental sustainability literature with regard to sustainable procurement policies [6]. To close this gap, this article collects detailed empirical evidence from the corporate real estate industry with the aim of shedding further light on the relationship between routine rigidity and environmentally focused organisational innovations. To add to the understanding of these topics, this article asks the following question: how does routine rigidity inhibit environmentally focused organisational innovations in the corporate real estate industry?

The following section presents the article's theoretical framework and the next section addresses the method used to analyse the empirical data. The fourth section analyses the results and the fifth section discusses the relevance of these results. The final section provides a conclusion, addresses the limitations of the current study and offers recommendations for future research.

2. Theoretical Framework

2.1. Organisational Innovations

Organisational innovations can be described as being ambitious whereas incremental innovation is merely doing the same things as before, but more efficiently [7,8]. Incremental innovation has also been defined by previous scholars as the minor improvements or simple adjustments in existing products, services, or processes by an approach that reinforces, modifies, or extends current environmental knowledge [9]. One of the consequences of incremental innovation is that it reinforces the existing processes, normative standards, and capabilities of established organisations. This is in stark contrast to the new questions that are asked and the new skills that are required by more ambitious innovation strategies [7]. Reconfiguring established organisational processes is a difficult and challenging task as it disrupts routines and requires a change in behaviour of the firm's employees. As a consequence, the reconfiguration must be carried out on an organisational level and not only in one isolated part of the organisation. This is why organisational innovations are more complex than incremental innovations which improve the existing situation or process innovations which can be as simple as upgrading an item of production equipment. A simple way of distinguishing between process and

organisational innovation is to define process innovation as being related to equipment and specific techniques or procedures, while organisational innovation can be defined as being related to people and the organisation of work [10]. This is supported by the research of Rogers [11] who argues that the reconfiguration of organisational processes is a measure of how innovative the whole firm is. It is not just the actions of a few people and thus should be characterised as organisational innovation.

Inertia theory first came to prominence when scholars began to describe the adaptability of organisations in changing market conditions [12]. Structural inertia is concerned with the factors that limit the ability to adapt and it is made up of internal structural arrangements and the constraints of the economic environment. Organisational innovation is inhibited by the internal structural arrangements which is also referred to as organisational inertia and this includes sunk costs, the internal political landscape, the availability of information, and the organisation's historical path.

When firms seek to change their established organisational processes they are forced to determine which operating procedures are fit for the purpose and which procedures, to paraphrase Hannan and Freeman [13], are precedents that have become normative standards. In other words, some operational processes have been retained simply because they worked in the past. Overcoming organisational inertia requires the development of new organizational capabilities and this a challenging task as capabilities are expensive to adjust and difficult to create in the first place [14,15]. Organizational capabilities consist of routines which are highly patterned, repetitious, and have been created over an extended duration. They require tacit knowledge and specific understanding of each objective and this is why they cannot easily be bought and must instead be built inside the organisation [16]. It is also the reason why breaking these patterns and discarding the familiar routines in favour of a new process is difficult. This is in line with the literature on innovation as changes to employee routines have been shown to be more disruptive than other types of innovative strategies such as process improvements. In the past when these kinds of organisational barriers have been studied in depth, it has been claimed that they are stronger inhibitors of environmental innovation than product, process, or technological barriers [5].

Incumbent failure is extremely common and incumbent inertia is described as the inability of organisations to respond to significant fluctuations in their economic environment [17,18]. Gilbert [19] examined the struggle of incumbent firms in the face of discontinuous change and categorised the sluggishness of their response into two distinct categories. These categories are resource rigidity and routine rigidity, where resource rigidity is the failure to change the organisation's resource allocations and routine rigidity is the failure to change the organisational processes. Therefore, if a firm is seeking to renew organisational processes then they must be aware of routine rigidity and how to overcome this.

2.2. Corporate Real Estate

The core purpose of this article is to examine if routine rigidity inhibits environmentally focused organisational innovations in the corporate real estate industry. In order to do this we will focus on how the field of corporate real estate management has responded to the relatively recent trend of new-ways-of-working which has dramatically changed the daily routines of building users in offices. One of the primary aims of new-ways-of-working, such as activity-based working, is to make workplaces more space efficient. The focus on space efficiency can deliver considerable cost and environmental benefits for an organisation, however, there is also a clear impact on the daily routines of the organisations employees.

This article focuses primarily on office buildings and the occupancy rate is used as a measure of how successfully an organisation has implemented activity-based working and thus overcome routine rigidity. This metric for successful implementation of activity-based working is limited, however it does directly correlate with one of the main drivers for activity-based working, which is space optimization, and it also matches the scope of this article. Office buildings are the largest commercial building sector in terms of floor space and energy use in most countries and the occupancy rate of

a building is a measure of the occupancy of a building compared to its capacity [20]. The occupancy rate tells us if the spaces in a building are used efficiently by the building users or if the building is often empty, and it has been widely noted that office buildings are only partially occupied during their opening hours. It is important to note that the occupancy rate is rarely considered when implementing energy reduction strategies even though it has a substantial influence on energy consumption in office buildings.

There is a wide range of average occupancy rates for office buildings and evidence has shown a range from 30 to 70% occupied [21,22]. The British Council for Offices (BCO) provides benchmarking services on this data in the UK and they have stated in 2013 that occupancy levels were typically between 60 and 70% [23]. If we take the BCO's conservative estimate of occupancy, then it means that on average 30–40% of the desks are empty during working hours. In addition, there is a wide variation between occupation densities, from 7 m² of floor area per person to as much as 20 m² per person for private offices [24,25]. According to the British Council for Offices, the mean occupation density is 10.9 m² per person [23]. Outside of office buildings, university buildings also have very low occupancy rates due to building users spreading their time over many different buildings and the working day being spread over a longer time period than a typical office building. Studies have found university occupancy rates to be less than 40% during office hours [26,27].

Utilisation patterns determine the amount of floor area that an organisation needs and thus they have a strong influence on the environmental impact and the costs associated with a corporate real estate portfolio. The operating costs for corporate real estate are proportional to the net floor area and thus optimising floor area has a positive impact on running costs. For example, a report on the office sector in Helsinki, which is the location of this article's case study building, calculated the average annual cost per annum of each office desk to be €9225 [28]. The report also notes that Helsinki has only the 15th most expensive occupancy costs in the world and thus the cost per workstation is even higher in a number of other cities. Occupancy patterns also have a substantial influence on the environmental impact of the entire global building stock. If office buildings are on average 30–40% empty during working hours then energy is being consumed by the unused area even if it is empty. It is being heated in winter, cooled in summer, and ventilated and background lit all year round. Also, the embodied carbon emissions of the materials used to construct the building are not being optimised if a large portion of the building is consistently unused. As a consequence, desk-sharing has even been cited as a good example of the circular economy in the built environment [29]. Underutilised buildings can even contribute to urban sprawl and an example of this is the construction of new buildings on the edge of cities while many spaces that are already constructed remain unused.

2.3. Activity-Based Working

In the last 10 to 15 years, the real estate industry has responded to the inefficiency of low occupancy in offices by questioning the policy of providing a desk for each employee. New ways of working have emerged which centre on the concept of activity-based working (also referred to as desk-sharing, flexi-desk, hot desking, or non-territorial working) which enables the employees to choose the space which is best suited for the task at hand [24,30]. Activity-based working implies that there are no assigned workstations and that desks are shared amongst the employees. It also recognises that there are many different working styles needed throughout a typical working day and seeks to accommodate these both inside and outside the office. Employees might want to occupy a quiet space when they need to concentrate or occupy a space in an open office for other tasks. An array of alternative spaces are also needed to facilitate various forms of group work. The application of activity-based working typically includes the installation of a totally new fitout in the office areas. However, it must be noted that the application of activity-based working that is observed in this article is less extensive than this. In the observed case study, the fitout has been refined rather than redesigned in order to reduce fitout costs and although some of the furniture was renewed, the layout was only changed to a minor degree.

The movement towards desk-sharing and remote working had a dramatic impact on the daily routines in the organisations where it was implemented. It changed the most deeply rooted routine of getting up in the morning, arriving at your place of work, and sitting at your own desk. The employees were offered a choice of where they would work each day and when they chose to work in the office they were offered a choice of what kind of space they would like to occupy. It is an example of organisational processes being renewed and thus routine rigidity being overcome. It is remarkable that such a strong routine could be overcome when the most commonly discussed driver of this change is the cost savings from reducing the amount of unused space [21,22,30–34]. However, the change has not just been driven by optimising space and there are many reasons for the move to activity-based working.

One reason is that organisations themselves are evolving which means that employees have greater control over their daily tasks and no longer need to be micro-managed by supervisors. As a result, their tasks can be completed outside the workplace [21,35]. Another factor is that changes in technology have also contributed to employees being able to complete their daily tasks and communicate with colleagues from outside the office through methods such as email, mobile phones, and video conferencing [31,34,35]. Activity-based workspaces have also been designed in order to stimulate communication and collaboration. This is a continuation of the trend towards open offices which were introduced to replace single person office rooms [31]. Lastly, it has been reported that many companies have moved towards activity-based workspaces to attract younger employees, to reduce environmental impact, and in the belief that an attractive office environment improves the well-being of its users [22,35].

Activity-based working has been around for more than two decades and it is important to consider how successful it has been in that time. The feedback has been largely positive and the end results have shown that it is possible to provide high quality indoor workspace environments at high occupation densities [30,35,36]. The original expectations that prompted to change towards activity based working have been met and there are also benefits derived from the flexibility of the working location and the impact of this on work-life balance [21]. In addition, it has been claimed that moving to a new working style can accelerate cultural and organisational change and can renew corporate culture. It has also been reported that employees looked more favourably on the change when they are actively involved in the planning of the new workspace [35]. However, there are some elements of activity based working that have received negative feedback and sufficient attention should be given to limit their impact. The literature has warned that increased remote working can negatively impact communication between colleagues and that the best place to bring people together and to communicate is at the workplace [21]. The importance of a well-designed space reservation system for activity-based offices was also stressed [33]. All in all, the feedback has been positive but when improvements have been suggested they have been related to the lack of privacy, inadequate spaces to support work that requires concentration, insufficient storage space, difficulties in locating colleagues, wasting employee time through the repeated process of setting up and shutting down a workstation, and the limited ability of personalising a workstation [30,31].

3. Materials and Methods

3.1. Occupancy Patterns

A case study research design has been selected as the adoption and implementation of an industry trend involves processes, activities, and events [37]. The study also involves complex events and behaviour, occurring within a real-life context which makes it relevant to the case study approach [38]. A typical modern office building was examined to determine if routine rigidity has inhibited the implementation of strategies that have clear cost and environmental benefits. The focal strategy was the adoption of activity-based working that had recently been implemented in the case study building. The study aimed to determine how successfully it had been implemented and what impact it had upon cost savings and environmental impact reduction.

To do this, empirical data on occupancy patterns were collected by installing two video cameras in an office building in Helsinki, Finland. The video cameras were chosen as they were compatible with a commercial people counting software which is typically used in retail buildings to monitor the number of visitors over a period of time. The studied area was a portion of the third floor of a three floor office building. Its floor area was approximately 650 m² and it mainly comprised of a large open office area, three meeting rooms, a small kitchenette, and a break area. This area was chosen as it was the only part of the building that had less than three entrance and exit routes and this greatly simplified the installation and the analysis of the camera data. Figure 1a shows a camera installed in the ceiling of the case study building and Figure 1b shows an image from the people counting software which displays a real-time view from one of the cameras and the most recent results from that camera.

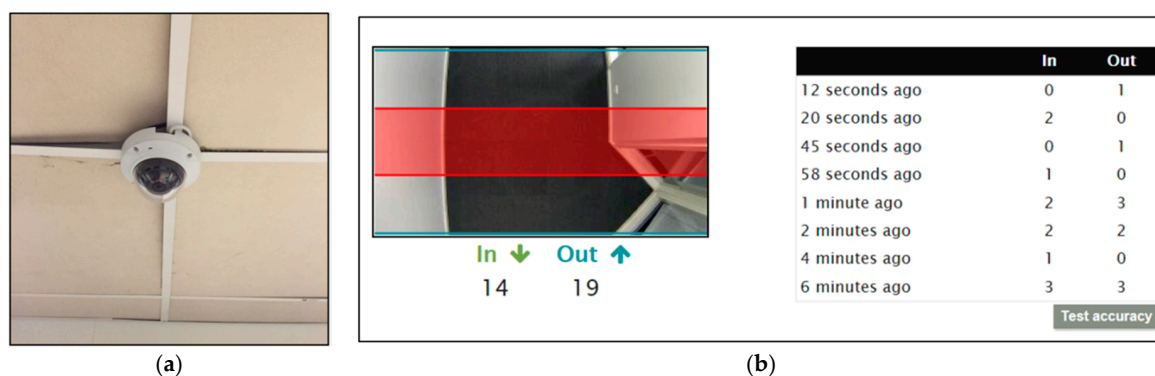


Figure 1. (a) An installed camera in the case study building; (b) An image from the people counting software.

The study was carried out for the whole month of May 2016. May was suitable from an energy consumption point of view as it falls outside the hottest and coldest periods of the year. May was also suitable from an occupancy point of view as it was not affected by the Finnish summer holiday period which generally occurs from June to August. The cameras were installed in the ceiling and pointed straight down so that the faces of the people passing beneath them could not be seen. This meant that privacy was less of an issue when compared to other security camera systems which are pointed directly at people as they approach. This is an important point as it has been claimed by previous researchers that privacy is the main factor that prevents vision based occupancy monitoring from being widely implemented [36].

The purpose of the software is to count the number of people passing in real-time and also to calculate their direction of travel. The output file of each camera reports the number of people that travel in each direction for each 15 min interval. The data from the cameras was then combined to calculate the number of people that occupied the case study area for each 15 min interval of the month in question. This means that the occupancy rate of the case study area can be measured in real time. The case study building is open for 16 h each day from 06:00 to 22:00 and the counting software was reset to zero at midnight every night. One simple way of detecting error within the results of the counting software was to view the occupancy after 22:00. If the software reported that there was someone still occupying the studied area after 22:00 then it had failed to correctly detect all of the people that had left the studied area during the day. Similarly, if the combined count was negative after 22:00 then it had failed to correctly detect all of the people that had entered the studied area during the day.

3.2. Energy Consumption

In order to understand the full implication of the occupancy rate on energy consumption, a 3-dimensional dynamic energy simulation was made for the building. Once the dynamic energy

simulation was configured, it was then manipulated to calculate the energy consumption of three different versions of the case study office area. Each of the three versions of the case study office space had a different floor area which related to a different workplace arrangement strategy. The energy simulation is described in more detail in Appendix A.

4. Results

The results of the study were analysed to provide insight on our research question through two measures: (a) the efficiency of the workplace arrangement strategy and (b) the impact of the workplace arrangement strategy on the building's energy consumption.

4.1. Space Efficiency

In total, 66 employees were assigned to work in the area that was studied and 54 desks were provided for these employees. This means that the desk sharing workplace arrangement strategy of the open office area can assumed to be 18% smaller than if a desk had been provided for each employee. As can be seen in Figure 2 below, the occupancy data for the month of May showed that the peak number of employees that were present in the open office at any one time was 44. This means the desk sharing workplace arrangement strategy could be 33% smaller than if a desk had been provided for each employee and that occupancy data suggests that the space is oversized by approximately 15%.

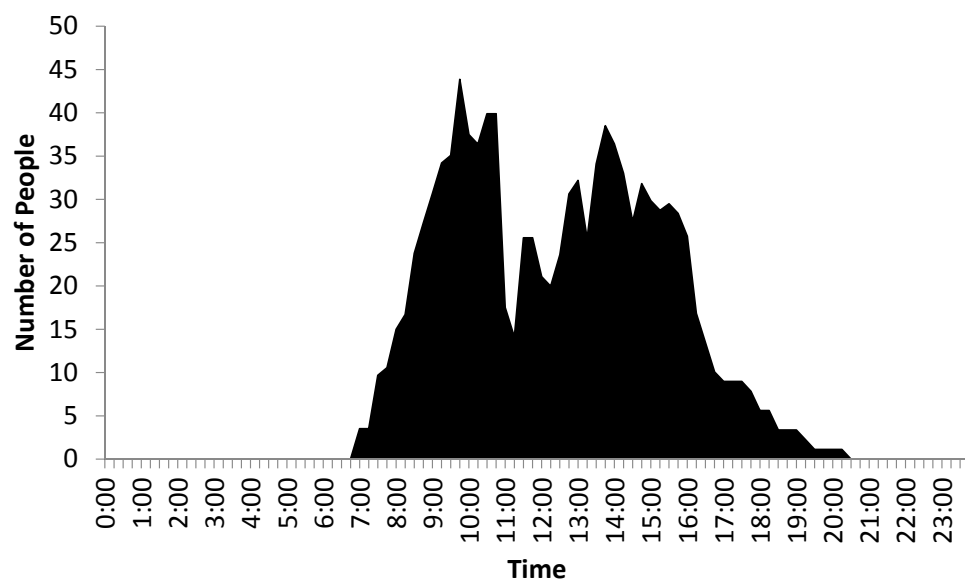


Figure 2. Occupancy of the case study office area for the peak day.

4.2. Energy Consumption

A dynamic energy simulation was used to compare the energy consumption implications of optimising the number of desks in open office areas. In the observed case the open office area is the studied area minus the area of the three meeting rooms, the small kitchenette, and the break area. In all, the energy consumption of three alternative open office floor areas were simulated. The first office area was 644 m² and represented the traditional office scenario where each member of the staff was allocated a desk. The second office area to be simulated was 527 m² and this represented the desk allocation of 54 desks for 66 employees that was observed in the case study area. The final simulated office area of 429 m² represented the optimised scenario where the number of desks matched the measured peak occupancy of the open office area which was 44 people. The energy consumption of all three areas can be seen in Table 1 below.

Table 1. The energy simulation results for the open office area.

Simulation	Number of Employees	Number of Desks		Area		Annual Energy Consumption	
	#	#	(%)	(m ²)	(%)	(MWh)	%
Traditional	66	66	100	644	100	85.6	100
Observed	66	54	82	527	82	73.2	86
Optimised	66	44	67	429	67	59.6	70

The results show that optimising the size of the occupied area has a substantial impact on energy consumption. The current policy of providing 54 desks for 66 people has reduced the energy consumption of the case study area by 14% compared to the calculated energy consumption of the traditional one desk per person strategy. This is impressive by itself, however, our calculations show that the energy consumption could be reduced by a further 16% if the number of desks were to match the measured peak occupancy.

5. Discussion

The results suggest that the newly implemented workplace arrangement strategy was conservative in its approach. The organisation could have reduced the number of desks to 44 but instead chose to provide 54 desks which achieves only 64% of the potential space reduction. It has been noted that organisations should provide an excess number of desks as there is a threshold where users will refuse to look for a desk if a spare desk is difficult to find. This has been compared to queuing systems where the customer refuses to join the queue if the queue is perceived as being too long [32]. It has also been noted that extra desks allows the company to grow in size without changes to the space and that the number of excess desks can be reduced if there is a well-designed space reservation system. However, even with this information, providing 22% extra desks still seems disproportionately too many. The case study office area had recently changed from providing a desk for each employee to adopting activity-based working. The new workplace arrangement strategy has not fully adopted activity-based working as the fitout has been refined rather than redesigned in order to reduce fitout costs. This change was made to increase space efficiency and although some of the furniture was renewed, the layout was only changed to a minor degree. It is also important to note that other parts of the building were not enlarged to accommodate additional employees. The number of car parking spaces remained the same as did the number of toilets and the size of the restaurant. This suggests that the original building design was adequately sized to accommodate a high population density and that a portion of the space saving would not be lost to accommodate extra building users.

Activity-based working is clearly a rational strategy from the point of view of the organisation through cost savings, increased collaboration, and a renewed corporate culture. It also makes sense from the point of view of the employee through increased flexibility and the positive impact of this on work-life balance. A global survey on change in the workplace has recently been compiled by Cushman and Wakefield, who are an authority on this subject, and it includes statistics on the adoption of activity-based working in three territories [39]. These global territories are Europe Middle East, and Africa (EMEA), Asia Pacific (APAC), and North America (NA), and the results of the survey showed that low adoption was evident in 45% of EMEA workplaces, 71% of APAC workplaces, and 75% of NA workplaces. In this article, low adoption is defined as workplaces where less than 30% of the desks are assigned to desk-sharing. The results of the survey also showed that high adoption was evident in 39% of EMEA workplaces, 16% of APAC workplaces, and 12% of NA workplaces. High adoption is defined in this article as workplaces where more than 70% of the desks are assigned to desk-sharing. This is in line with the 2013 study by the BCO which states that UK office buildings are still only 60–70% occupied [23]. These results suggest that, despite the clear benefits for the

stakeholders involved, the adoption of activity-based working has not been as pervasive as could be expected.

The second part of our study analysed the reduction in energy consumption that could be brought about by using less space per person. The amount of energy reduction that was calculated is a direct result of having less floor area to maintain and the purpose of this calculation is to demonstrate the potential energy savings that could be achieved if activity-based working was widely adopted. Adoption to a high degree would mean that workplaces would occupy less space in the built environment and this would reduce the need to construct new workplaces and surplus workplaces could be used for other purposes. This would have a substantial impact on global energy consumption as office buildings are the largest commercial building sector in terms of floor space and energy use in most countries [20]. The results show that by only providing 54 desks for 66 employees, the energy consumption of the office space was reduced by 14%. They also show that if only 44 desks had been provided for the 66 employees then consumption of the office space would have been reduced by 30%. These are considerable savings and it is important to note the other characteristics of this organisational innovation. The innovation is not driven by technology although it is facilitated by technology advancements that enable employees to complete their daily tasks and communicate with colleagues from outside the office and thus the benefit of adopting such simple solutions is that they require very low investment. The change also results in cost savings from reductions in space rental payments. These innovations should always be considered when office buildings are aiming to reduce costs and environmental impact and they will play a large part in delivering the net-zero energy buildings (NZEB) of the future. Upon analysis of these calculations, it is surprising that activity-based working is so infrequently suggested as a means of reducing the environmental impact in the corporate real estate industry.

This article argues that the failure of activity-based working to achieve higher levels of adoption in the global corporate real estate industry despite the clear benefits to the organisations and their employees is evidence of routine rigidity. This is compounded by the fact that environmental guidelines, which are more important now than ever before, continue to focus on technocentric solutions despite the substantial impact that can be achieved through behavioural approaches such as space optimisation. The rigidity is related to the failure to change organizational processes and not the failure to make resource investments. There could be other inertial forces within the real estate industry that are causing the rigidity and these cannot be overcome by the technocentric solutions related to energy efficiency improvements and renewable energy. These additional inertial forces could be related to (a) the cost of changes to the building design; (b) the cost of a new fitout; (c) the waste and loss of embodied energy related to changes to the building design and a new fitout and (d) systemic factors such as the duration of lease agreements. This article is primarily concerned with desk sharing and increasing space efficiency. The implementation of the innovation does not need a new fit out or changes to the design of the building. The case study building did not make these changes and it was not impeded by lease agreements. It involves the purging of space that is not necessary and better use of the space that is necessary. The additional inertial forces outlined above are closer to the resource rigidity than routine rigidity as they can be quantified in terms of financial cost. Whereas organisational innovations, which are related to people and the organisation of work, have a much stronger inertia. This stronger inertia is to be expected as the daily routines of the employees are highly patterned, repetitious, and have become familiar over an extended duration. This is the reason why breaking these patterns and discarding the routines in favour of a new and unknown process is difficult and this is consistent with the literature on the renewal of organisational processes [5,14–16].

6. Conclusions

Environmentally focused innovations are concerned with reducing environmental impact and in achieving environmentally focused sustainability targets. They are essential to climate change mitigation as they aim to conserve the consumption of resources and to reduce the generation of

pollution and waste. The characteristics of the environmentally focused organisational innovations are a valuable study area as they can deliver substantial reductions in environmental impact without relying on considerable investment.

Routine rigidity is a new but relevant area in the literature and its strength lies in its ability to explain why some rational innovations are not implemented. To date, it has only been referenced in the literature on environmentally focused innovations with regard to sustainable procurement policies. To close this gap, this article collects empirical evidence that sheds further light on the relationship between these two concepts. The focal innovation is the adoption of activity-based working and the empirical data enables the environmental impact reduction to be calculated.

The relevance of building occupancy in the discussion on cost and environmental impact reduction in the corporate real estate industry is highlighted in this article. The low cost and high impact nature of the focal innovations should make them attractive to organisations and the impact on daily routines should be managed to make them more appealing to the employees. From this evidence, it is expected that activity-based working will play a large part in delivering the net-zero energy buildings (NZEB) of the future. Activity-based working is part of a wider trend that concentrates on resource efficiency of our existing assets in the built environment and has the potential to reduce urban sprawl and promote more compact urban environments where citizens are encouraged to walk and cycle rather than use their own car. This would in turn have a positive impact on civic health through increased exercise and on the environmental impact through reduced transportation emissions. Underutilised buildings can even contribute to urban sprawl and an example of this is the construction of new buildings on the edge of cities while many spaces that are already constructed remain unused.

The research design of this article demonstrates one empirical methodology for examining routine rigidity in the corporate real estate industry, however, the approach has limitations. The results of the case study have been analysed from a normative point of view and the argued influence of routine rigidity on the organizational innovations should be verified with additional sources. There are three further avenues of research that would complement the findings of this article. First, a qualitative study that focuses on organisational inertia and activity-based working would provide further background on the assumption that organisations reject activity-based working due to its impact on the daily routines of their employees. This study could research the decision making process surrounding the adoption of activity-based working and consider the impact of the cost of changes to the building design and a new fitout, the waste and loss of embodied energy related to this, and systemic factors such as the duration of lease agreements. Second, activity-based working introduces a new problem to the real estate industry and this is related to how many desks should be provided. Determining the size of the office space or the number of desk is no longer just as easy as counting the number of employees. Thus, the occupancy patterns become important information due to the intimate relationship between activity, space, and cost. Providing too many workspaces incurs a cost penalty due to unused space and providing too little space fails to meet the expectations of the employees and disrupts comfort and productivity. Further study is required on the method of measuring occupancy patterns in order to optimise the use of buildings. Thirdly, this article opens the discussion on how the optimisation of building occupancy patterns can substantially reduce the environmental impact of buildings. It has taken inspiration from recent space-as-a-service trends such as coworking and sharing economy platforms for commercial spaces such as Eventup, Splacer, Venuetastic, Venuu, and Flextila. However, in order to introduce this concept, the article has taken a simplistic view of space rental as an ownership mechanism in the real estate industry. Further research is required to understand the overall environmental impact of space optimisation on the existing buildings that will no longer be needed if space efficiency becomes a focus of the industry.

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Conflicts of Interest: The author declares no conflict of interest.

Appendix A

A full dynamic energy simulation of the case study building was created using the programme IES Virtual Environment. The simulation used the actual geometries and properties of the building such as window sizes, u-values, and lighting loads, and calculated the total energy consumption for every hour in an average year. The simulated energy consumption was then validated with the actual energy consumption data that had been collected by energy meters over the previous year. The model may be seen below in Figure A1. Figure A1 also shows the case study area which is highlighted in blue. This model of the case study area was then concentrated upon and it was used to simulate the energy consumption of the three versions of the case study office space that related to a different workplace arrangement strategy. The three geometrical versions of the case study office area can be seen below in Figure A2. The real-life (observed) case study area with an area of 527 m² can be seen first in Figure A2a. This area was then manipulated to represent the two other versions. It was important here to replicate the ratio of the floor area to the external wall area of the real-life case study area, as this has the most impact on energy consumption.

Energy consumption in the building can be split into heating, cooling, lighting, and electricity to power equipment. In the simulation, the lighting was primarily related to the floor area as the lighting was assumed to be fully on in the case study area when it was occupied, thus, the lighting energy is proportional to the total floor area. The optimized scenario had more people per unit area. Therefore, it had a higher hot water heating load, higher ventilation heating load, higher ventilation cooling, and higher equipment electricity load when compared to the energy consumption per square meter of the other scenarios. The heating load was lower in the optimized scenario due to heat gain from the extra people and the fact that the geometries of all three scenarios aimed to have a similar portion of external wall area to internal wall area. As a result, the percentage of the energy consumption of the optimised scenario when compared to the traditional scenario (70%) was similar but slightly higher than the percentage of floor area of the optimised scenario when compared to the traditional scenario (67%).

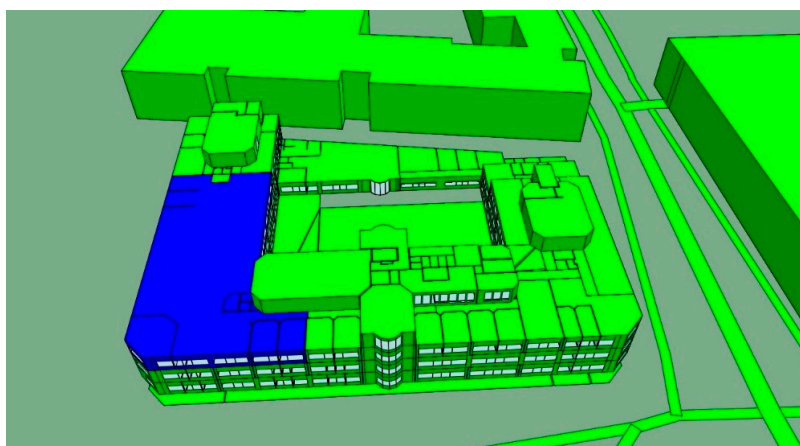


Figure A1. The three dimensional simulation model for the case study building.

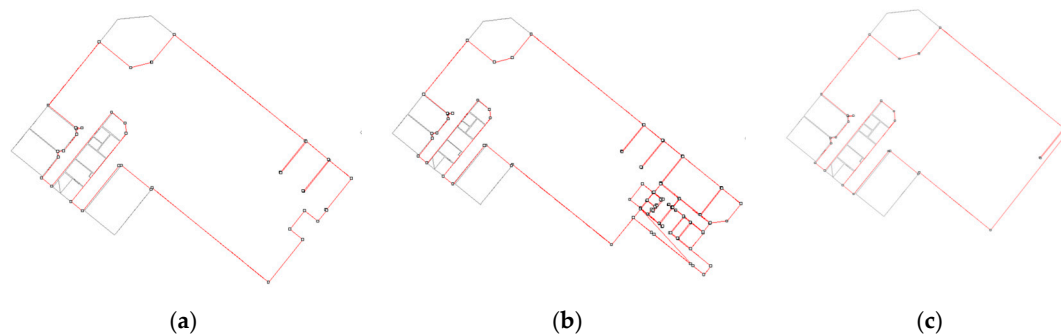


Figure A2. The geometry of the three different workplace arrangement strategies as modeled in the energy simulation. (a) The 527 m² observed version; (b) 644 m² traditional version; (c) the 429 m² optimised version.

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