Knowledge work productivity in an activity-based workplace: a comparative analysis

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Abstract

Purpose – The purpose of this paper was to extend the current knowledge on the impacts of activity-based workplaces (ABWs) on productivity in knowledge work. It offers more background information that is needed to properly evaluate ABWs' suitability for different organisations. In the results section, ABWs are compared to the cellular and open-plan office types.

Design/methodology/approach – This study was conducted using a survey method with 5,841 respondents. The data were collected between 2015 and 2019 from 32 public-sector organisations.

Findings – The findings of this paper reveal that ABWs offer clear advantages over the other office types but requires careful design and well-implemented solutions. The superiority between ABWs and cellular offices also depends on workers' profiles and needs and is not for everyone.

Practical implications – For practitioners, this paper offers valuable information to compare the three office types: ABW, cellular and open-plan. It also highlights the importance of careful planning and good implementation, which are both essential to making the ABW environment productive for employees. Finally, this paper clearly provides evidence that ABWs and open-plan offices differ in their facilities and productivity.

Originality/value – This paper included a unique and large sample with open variables, which are fairly rare in ABW-related papers. It also provides evidence that ABWs, when implemented correctly, seem to be an excellent option for some work profiles.

Keywords Performance, Productivity, Knowledge work, Office, Activity based workplace, Flexible work

Paper type Research paper

1. Introduction

The activity-based workplace (ABW) and the discussion of its impacts on productivity have been major topics in facilities management for the past decade. However, the empirical evidence on the productivity impacts of the office type changes has been somewhat unclear since both positive and negative results have been obtained (De Been and Beijer, 2014; Ruostela *et al.*, 2015; Leesman, 2017). The purpose of this paper was to dig deeper into the background behind the ABW, summarise the results of previous studies and, finally, offer

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new insights into how knowledge workers perceive productivity in ABWs compared to cellular and open-plan offices.

In the literature, the ABW has been described using several terms, for example, *new ways of working* , *a multi-use office*, *A-FO* and *a flexi office*. However, since 2016, *ABW* has been the most commonly used term (Marzban *et al.*, 2022). The idea behind the ABW involves giving knowledge workers more responsibility to determine how their work is done while managers focus on results; thus, the knowledge worker has more autonomy and the flexibility to choose how, when and where results are obtained (Van der Voordt, 2004; Van Meel, 2011). ABWs answer this need by givi ng employees opportunities to choose the most suitable facilities for their tasks. They have become topical over the past 15 years, while the level of information and communications technology has reached high levels at many organisations since most workers have mobile tools that easily facilitate access to their organisation's information systems, regardless of their locations (Ruostela *et al.*, 2015; Van der Voordt, 2004). ABWs are also an interesting option for organisations from a financial perspective in that it allows them to decrease offices' square metres. When planning an ABW, understanding that it entails not just facilities is important; a successful ABW process requires good IT support and changes to management and the organisation's culture. Facilities alone do not change; the whole approach to work changes. The scale of such changes and the new approaches to work that the ABW requires have made organisations desire empirical evidence about work productivity before they implement these changes.

Previous articles have provided a good understanding of the ABW concept, how to run the ABW process, what to consider and which results to expect. However, far fewer articles have provided widely accepted information about the ABW's impacts or benefits. Productivity- and performance-related measures are especially missing from the previous papers, which makes evaluating the ABW's success difficult. Many researchers (e.g. Engelen *et al.*, 2018) have highlighted that the ABW-related literature requires more studies to evaluate and identify for whom, where and how the ABW concept succeeds. Engelen *et al.* (2018) also concluded that some studies have obtained positive results, while others have obtained negative results. Many studies have also suggested that the ABW works for some knowledge workers but not all of them. People who work in ABW environments without being very "active" by switching desks regularly also seem fairly common. This inaction causes one of the most common comments on the ABW: "it is just an open-plan office". This perspective is due to the ABW change process's two critical points that may cause project failure and unsatisfied workers. The first is the planning of this change, which asks, "Are the nature of the work and the work profiles understood correctly, and does the plan include the proper number of different types of zones or spaces?" The second point concerns implementation, asking, "Are the knowledge workers using the ABW facilities as they are meant to be used?"

The purpose of this paper was to examine the ABW's complexity from critical perspectives, comparing it to cellular and open-plan settings. The study's main research question was:

RQ1. How does an ABW compare to cellular and open-plan offices in terms of productivity?

Further, this question was further examined in relation to different work profiles and levels of satisfaction with current implementations.

The current work's structure follows the typical structure for research papers by first presenting the study's theoretical background, including the current knowledge about the

productivity of knowledge work in an ABW and highlighting some issues which sometimes make evaluating the implementation difficult. The methodology section describes how the study was implemented and the data analysed via clustering and variance analysis. In the results section, the paper provides new information about the productivity of knowledge work in different office types. The discussion section then shows that the results may confirm many previous studies' results, and more importantly, it presents more data to evaluate the results in detail. Finally, the conclusions and limitations of this paper are discussed along with future research directions.

2. Theoretical background

2.1 Productivity in an activity-based workplace

Productivity in knowledge work has long been a complex challenge addressed by numerous researchers (Ramirez and Nembhard, 2004; Koopmans *et al.*, 2011). Bosch-Sijtsema *et al.* (2009) found that knowledge work productivity is not standard. It may differ largely depending on the task, on contextual factors and on the knowledge worker's individual capabilities. Ramirez and Nembhard (2004) conducted a literature review on knowledge work productivity, identifying over 20 different methodological approaches to measuring productivity in knowledge work. Common themes Ramirez and Nembhard found from these productivity measures are, for example, work efficiency, quality of work, results and achieving goals. Drucker (1999) dissected knowledge work productivity into two aspects: "doing the right things and doing things right". The latter, "doing things right", centres on resource utilisation and the work process, emphasising the need to optimise processes and achieve outcomes with minimal resources. Improving the work environment is a good example of trying to do things right and ABW philosophy enables knowledge workers to find the best ways for them.

One of the factors affecting the productivity of knowledge workers are the facilities and the office layout setting. Studies have been conducted on cellular offices and open-plan offices, but fewer studies have examined the ABW and their results are not very clear. For the cellular and open-plan offices the effects to productivity are well known, but where the ABW setting sits in this comparison has remained unclear. ABW-related research articles can be divided into two categories. The first category is statistical papers with large data sets from several organisations. The second is case studies, typically from one organisation, examining the process of changing from a cellular or open-plan office to an ABW. Also, two comprehensive and recent literature reviews have been published (Engelen *et al.*, 2018; Marzban *et al.*, 2022). Overall, most of the research articles have examined the knowledge work productivity and other variables of the ABW without actual comparisons to other office types. As Marzban *et al.* (2022) states, productivity and work performance are perhaps the most debatable aspects of the ABW discussion.

There are several reasons why productivity and work performance remain the most debatable aspects of the ABW discussion. One key issue is the lack of research articles published yet, and it should be noted especially that a problem in many ABW-related articles is their incomplete critical information for making the judgement about the results. Typical issues with such missing information include what kinds of workers are present and especially what kinds of work tasks they attend to, the design process and workers' satisfaction with it, a description of how facilities are used, the time elapsed since a change to an ABW and the previous office type, the organisation and office size and – one of the most important questions – how the results are measured. Without all this information, evaluating the ABW is difficult, yet almost all this information is missing from the current

literature. Nonetheless, the previous literature contains some information about work productivity in an ABW.

How do previous studies compare the ABW to cellular offices in the productivity of knowledge work? Two comprehensive literature reviews were conducted to find the answer to this question, and both concluded that the answer remained unclear or that it depends on from situation to situation. Engelen *et al.* (2018) concluded that some studies have yielded positive results while other studies have obtained negative results. Marzban *et al.* (2022) obtained similar results in their literature review. The included studies were inclined to be either more positive (i.e. concerning interior design) or negative (i.e. concerning indoor environmental quality, productivity, distraction and privacy) in relation to various attributes of an ABW. The studies did not fully agree on any single effect of ABW environments on occupants. The comparison between ABW and open-plan offices has received less debate. For example, Divett (2020) discovered that workers in an ABW setting reported higher levels of satisfaction and productivity compared to those in an open-plan office. This difference was due to improved interaction and decision-making processes. While leaders recognised an improvement in team productivity, no significant improvement in their own productivity has occurred. Candido *et al.* (2019) also found that ABW workspaces yielded significantly higher satisfaction results concerning perceived productivity and health than open-plan offices.

Productivity of ABW and other office types has been studied only in a few studies with large data set. De Been and Beijer (2014) published a popular study with many citations. The aim of this research was to determine whether the type of office environment influenced satisfaction with this environment and productivity support. Those authors studied this question with a survey administered to 11,799 employees at 26 organisations. As a result, they found that people evaluated the ABW's productivity support less positively than that of individual and shared-room offices. Also, the level of satisfaction with communication was evaluated evenly between the ABW and individual and shared-room offices. However, little additional data was provided – for example, regarding the nature of work, workplace design or how facilities were used. The other well-cited comparative study with a large data set was conducted by Leesman (2017) who summarised that, at the macro-level, ABW does not seem very good option, but the benefits are revealed at the micro-level. However, the results of the Leesman report, it should be noted that 71% of the people in the ABW environment were not using it as intended (not switching). In addition to this issue, Leesman (2017) is not peer-reviewed journal article and did not reveal how the productivity was measured. Better background information and more positive results of ABW are found from case studies, which typically focus more on the micro-level and describe carefully planned implementations.

2.2 The impact of the work profiles and use

Marzban *et al.* (2022) found in their literature review that most of the ABW's negative effects were related to misusing the facilities, such as noise levels and other distractions when workers tried to focus. On the positive side, Marzban *et al.* (2022) concluded that the ABW is seen as positive when facilities are used as intended. For example, Haynes *et al.* (2019) found that switching locations during the day positively influenced satisfaction with an ABW and conversely, less mobile and location-fixed workers experienced a negative impact on their productivity. This finding was mainly due to location-fixed workers' experiencing more noise and interruptions when they wanted to concentrate. Instead, more collaborative tasks led to improved creativity and interaction from the workplace provision. However, as

Leesman (2017) found, 71% of respondents in an ABW environment had anchored themselves at a single desk, which they called a catastrophe.

Hoendervanger *et al.* (2016) conducted a study to identify whether switching behaviour was related to satisfaction with ABW environments and which factors might explain the switching workstations factor. The study used data from 3,189 respondents at seven organisations. The authors found that workers who switched several times a day were significantly more satisfied with the ABW, mainly workers with mobile work profiles. However, most workers were not satisfied with the ABW, yet neither did they use it as intended by changing desks frequently. Hoendervanger *et al.* concluded that, in their sample, the ABW worked only for a small minority of workers. Their paper did not at all explain the organisations' ABW projects, which left what happened and whether any factors could explain the results an open question. For example, it was unclear whether the employees refrained from switching because they did not need to, because they did not want to or because switching was impossible, as Hoendervanger *et al.* (2018) pointed out, due to personal preferences. Palvalin *et al.* (2017) highlighted that self-management also played a significant role when using the facilities correctly, such as through switching.

Personal characteristics affect how the ABW is seen (Hoendervanger *et al.*, 2018). Wadu Mesthrige and Chiang (2019) also observed that extroversion was somewhat positively correlated with work productivity, while introversion lacked any significant correlations with work productivity in an ABW environment. They also concluded that, overall, younger workers had more open and positive feelings about an ABW setup generally. Arundell *et al.* (2018) suggested that ABW employees associated ABWs with greater opportunities for movement and collaboration but had mixed views on its productivity impact.

2.3 The impacts of activity-based workplaces' design and implementation

Babapour (2019) suggested that, from an organisational perspective, a significant role in ABW success is how the change was planned, designed and implemented using ABW rules, policies and concepts. Marzban *et al.* (2022) concluded that the shortcomings of ABW environments are more related to how this approach to working is implemented and how occupants use it, rather than the concept itself. For example, Ruotsela *et al.* (2015) found that the ABW setting type could be effective for SME-sized consulting organisations. Their paper also showed that the optimal ABW setting could not be reached by an initial implementation since new adjustments were required to find an optimal solution. Meanwhile, Brunia *et al.* (2016) compared two successful cases with two less successful cases, and they identified several characteristics of a good ABW setting. In successful cases, the implementations included the proper number of desks for different types of tasks and the spaces' acoustics were well- designed. A commonality between the two different types of cases was also top managers' commitment to the ABW, especially during preparation and implementation (Brunia *et al.*, 2016).

The findings of a study conducted by Haapakangas *et al.* (2018) highlighted the factors most strongly associated with work productivity and well-being in activity-based offices. According to their results, satisfaction with privacy, communication and the physical environment (PE) emerged as the most influential factors. On the other hand, satisfaction with personalisation had less significance, while satisfaction with storage, IT functions and cleaning exhibited weaker associations. Their study also revealed that actively using different workspaces was positively linked to higher productivity and well-being. However, the time spent searching for a workspace negatively influenced both outcomes. These findings suggest that prioritising efforts to enhance privacy and communication while facilitating the easy switching between workspaces is crucial to fostering optimal work

productivity and well-being in activity-based offices. Marzban *et al.* (2022) pointed in their review article that many studies reported difficulties in finding a preferred workstation. Gerdenitsch *et al.* (2017) observed a significant interaction effect through which workspace satisfaction and team interaction improved better among participants who reported a higher perceived fit between needs and supplies. Lusa *et al.* (2019) found that workers' satisfaction with their workspaces correlated positively with their future work ability.

2.4 Summary of the theoretical background and the research gap

A conclusion of this theoretical background is that there are different types of knowledge workers who require different types of office designs. The knowledge workers who naturally switch between tasks and locations from time to time are those who could benefit ABW settings. As the authors have stated in the previous literature, the ABW does not fit all knowledge workers. However, as Engelen *et al.* (2018) and Brunia *et al.* (2016), for example, have highlighted, most of the problems in ABW settings have resulted from poor planning or the misuse of facilities. Nonetheless, the previous literature has been unable to explicitly present the kinds of situations in which the ABW performs better than the cellular office type or how user satisfaction influences productivity.

The research gap in the ABW centres on the lack of a definitive and consistent understanding of the impact of ABW on work productivity compared to other office configurations like cellular and open-plan offices. Although some comprehensive literature reviews, exemplified by Engelen *et al.* (2018) and Marzban *et al.* (2022), have sought to address this issue, they both concluded that the answer remains ambiguous and context-dependent. This ongoing debate primarily results from the limited number of research articles dedicated to ABW and the persisting issue of incomplete critical information required for making informed judgements in a large-scale studies. The absence of essential information, including the nature of work tasks, the design processes, the patterns of facility usage and, significantly, the methods used for measuring productivity, hinders the formation of a consensus in the existing literature.

3. Methodology

The current study's research was conducted in Finland between 2015 and 2019 with 32 organisations and 5,841 valid responses. These organisations varied in size from small to medium, while the number of responses from a single organisation ranged from 20 to 277. The respondents were from public organisations and publicly owned corporations from around the country. The respondents' backgrounds were not specifically asked about, but the participants represented typical office workers in the public sector. The research data were collected using an online survey that had been created and validated by Palvalin *et al.* (2015) and Palvalin (2017). Palvalin *et al.* (2015) have created the survey in collaboration of several researchers with few iterations based on the test rounds. The survey tool was presented to the organisations that were planning to do some work environment changes in near future, which increased their motivation to use and respond to the survey.

The data were collected for the organisations' own use in pre- and post-analyses of their changes in work environments, but the respondents were also aware that the data would be used for scientific purposes as well. The respondents answered the survey items on a five-point Likert scale [*disagree(1)–agree(5)*]. In this study, seven items from the *physical work environment* variables and seven items from *productivity* variables were analysed to answer the research questions. Additionally, the respondents were asked to answer a question about which of five locations they spent their work time in with 10% interval: *1 = at the office*, *2 = at home*, *3 = in other places* (e.g. with a client or a partner), *4 = in vehicles* or *5 = in*

public places. The questionnaire was sent to the participants by email, and they typically had about two weeks' time to respond. The response rates varied from 33% to 89%. The data used in this study were not collected purely for research purpose, so they were limited, for example, concerning the knowledge workers' backgrounds, the kinds of actual office settings they were using and, in an ABW, how many times a day they switched locations within their offices. All the respondents needed to work in one of the following three office settings to be included in this study:

(1) an ABW;

(2) a cellular office or; and

(3) an open-plan office.

The study's data analysis started with screening. The responses were analysed to whether each respondent had answered the majority of the questions and expressed sufficient deviation in their responses. The next step in the analysis was using *K*-means clustering with SPSS Statistics (standard settings) to divide the respondents into groups based on their work locations. The workers needed to work in their offices at least 30% of the time for their data to be included in this step so that they had enough experience working at their offices. The data used for this clustering concerned the amount of work done:

- in the office;
- at home;
- in other workplaces;
- on transportation; and
- in public places.

Several options were evaluated in the clustering analysis, but ultimately, three clusters seemed to form the most recognisable groups. The first group comprised the respondents who almost always worked at the office ($n = 3{,}401$). The second group comprised the respondents who worked at the office, but also from home ($n = 849$). Finally, the third group comprised the respondents who worked at the office, but also from other locations ($n = 1{,}194$). The results of the clustering analysis were used to identify how much mobility outside an organisation was included in a workday. ANOVA was performed using a nonparametric, independent-sample Kruskall–Wallis test (standard settings, all pairwise).

4. Results

4.1 Comparing the results for activity-based workplaces, cellular offices and open-plan offices

An overview of the results seemed to indicate a clear difference between the three office types (Table 1). For almost all the items, a difference between the three types was clear, with cellular offices having the highest scores, followed by ABWs and then open-plan offices. While this tendency applied especially to the items concerning the PE, there were three exceptions to this order. For item PE4, ergonomics was perceived to be worse in ABWs than in open-plan offices. This result was expected since, in ABWs, multiple workers use the same desks and chairs, so the settings might not always be adjusted correctly for each user. In the productivity items P1 and P7, the means were the same for both cellular offices and ABWs. Both items were related to work efficiency, one on the individual level and the other on the team level. The differences in other productivity-related items were also small between cellular and activity-based workspaces, while a larger gap was observed between activity-based and open-plan offices. A significant difference was observed between the PE

Table 1.
Means and ANOVA of the results from respondents in activity-based workplaces, cellular offices and open-plan offices

Item *n*	Cellular (one person) 2,849	Open-plan 1,200	ABW 1,792	Total 5,841	ANOVA *p*-value
1PE There is a space available for tasks that require concentration and peace at our workplace when needed	4.53	3.25	3.88	4.07	0.000
2PE There are enough rooms at my workplace for formal and informal meetings	3.79	2.81	3.32	3.45	0.000
3PE The facilities at my workplace enable spontaneous interaction between workers	4.02	3.62	3.92	3.91	0.000
4PE The ergonomic arrangements of the workstations at my workplace are in order	4.13	3.69	3.62	3.88	0.000
5PE There are generally no disruptive factors in my work environment (like sounds or movements)	3.79	2.26	2.65	3.12	0.000
6PE There is a place in which I can discuss or talk on the phone about matters which I do not want others to hear	4.33	3.49	3.83	4.01	0.000
7PE The facilities at my workplace are conducive to efficient working	4.42	3.09	3.39	3.83	0.000
1P I achieve satisfactory results in relation to my goals	4.11	4.02	4.11	4.09	0.004
2P I can take care of my work tasks fluently	4.09	3.95	4.04	4.05	0.000
3P I can use my working time for matters which are right for the goals	3.75	3.59	3.68	3.70	0.000
4P I have sufficient skills to accomplish my tasks efficiently	4.26	4.19	4.23	4.24	0.020
5P I can fulfil clients' expectations	4.06	3.99	4.05	4.04	0.024
6P The results of my work are of high quality	4.21	4.08	4.16	4.17	0.000
7P The group(s) of which I am a member work efficiently as an entity	3.68	3.56	3.68	3.65	0.001

Source: Author

items (about 0.5–1.0 points) compared to the productivity-related items overall (about 0.01–0.2 points). This finding might be explained by the fact that many other elements in the work environment would also have influenced perceived productivity, some of which could be even more important than the type of office layout.

Another surprising finding concerned PE3, spontaneous interaction, in which cellular offices has the highest score 4.02 (though, theoretically, this lead should have occurred), followed by ABWs 3.92 and open-plan offices at 3.62 with a more significant margin. The reason for this result could be partly explained by the fact that, in cellular offices, the closest colleagues probably see each other more than they would in ABWs, but this consideration would not explain the corresponding low score of open-plan offices. However, equally surprising was that the noise and movement in PE5 caused a significant number of distractions in cellular offices 3.79, though this amount was still better than the other two workplace types' corresponding values 2.26 and 2.65.

The competence-based P4 item should not have been affected by an organisation's facilities. However, differences in that variable were observed. They could be explained by the fact that, in general, respondents in open-plan offices 4.19, followed by those from ABWs 4.23, were more negative in their answers compared to the respondents from cellular offices 4.26. In the following subsections, this trend persists, which led us to assume that this difference was the cause and not that they were competent in succeeding in their tasks. With this assumption, it could be speculated if the results should be adjusted by some amount. However, it could be making the productivity results for ABWs closer to or even higher than those of cellular offices.

4.2 Comparing the results between different work profiles

In this section, the different office types are compared based on users' most common work locations (Table 2). The three groups by location are:

(1) the "home" group, whose members spent 30%–80% of their work time at the office and most of the rest of their work time at home;

(2) the "other" group, whose members spent 30%–80% of their work time at the office and most of the rest of their work time in other workplaces; and

(3) the "office" group, whose members spent 90%–100% of their work time at the office.

Groups 1 and 2 were supposed to benefit from ABWs since they were naturally more active in location switching at their work, having already switched locations at least once a week. However, some workers might have escaped to their homes if they felt unable to work well in their offices. The first interesting highlight of this finding was that PE items was perceived quite similarly, regardless of how much time a worker spends in their office.

Generally, cellular offices continued to perform strongly in productivity items compared to ABWs, but the difference between the mobile ABW workers and cellular workers was narrower for all items than without such profiling. Again, a clear difference emerged between open-plan offices and ABWs, even for the respondents who mainly worked in their offices. Another interesting highlight concerned PE3, spontaneous interaction, since the workers who used ABWs and worked part-time from other offices experienced better spontaneous interaction than the rest of the ABW workers and the same level as the respondents in cellular offices. For cellular offices, this finding might be explained by the number of workers who saw their closest colleagues, but for the ABWs, this explanation would not fit.

Table 2.
Means and ANOVA of the results for activity-based workplaces, cellular offices and open-plan offices and different work profiles based on work locations

Item *n*	Cellular/ home 271	Cellular/ other 523	Cellular/ office 1,858	Open-plan/ home 168	Open-plan/ other 239	Open plan/ office 670	ABW/ home 410	ABW/ other 432	ABW/ office 873	Total 5,444	ANOVA *p*-value
1PE There is a space available for tasks that require concentration and peace at our workplace when needed	4.51	4.48	4.53	3.13	3.45	3.25	3.92	393	387	4.07	0.000
2PE There are enough rooms at my workplace for formal and informal meetings	3.83	3.51	3.83	2.47	2.63	2.90	3.29	3.38	3.33	3.45	0.000
3PE The facilities at my workplace enable spontaneous interaction between workers	3.89	3.83	4.10	3.40	3.59	3.62	3.90	4.09	3.88	3.91	0.000
4PE The ergonomic arrangements of the workstations at my workplace are in order	4.00	4.14	4.12	3.45	3.77	3.69	3.54	3.83	3.61	3.88	0.000
5PE There are generally no disruptive factors in my work environment (like sounds or movements)	3.64	3.77	3.80	2.20	2.46	2.25	2.60	2.87	2.58	3.12	0.000
6PE There is a place in which I can discuss or talk on the phone about matters which I do not want others to hear	4.13	4.28	4.35	3.33	3.67	3.48	3.88	3.88	3.84	4.01	0.000
7PE The facilities at my workplace are conducive to efficient working	4.33	4.29	4.45	2.93	3.18	3.09	3.36	3.55	3.36	3.83	0.000
1P I achieve satisfactory results in relation to my goals	4.10	4.05	4.12	4.10	4.08	3.99	4.18	4.17	4.05	4.09	0.001
2P I can take care of my work tasks fluently	4.11	4.03	4.09	3.98	3.98	3.93	4.12	4.07	4.00	4.05	0.000
3P I can use my working time for matters which are right for the goals	3.78	3.61	3.78	3.56	3.57	3.61	3.78	3.55	3.72	3.70	0.000
4P I have sufficient skills to accomplish my tasks efficiently	4.30	4.28	4.23	4.26	4.23	4.17	4.28	4.29	4.17	4.24	0.000
5P I can fulfil clients' expectations	4.13	4.01	4.05	3.99	3.94	4.01	4.11	4.06	4.02	4.04	0.003
6P The results of my work are of high quality	4.25	4.11	4.22	4.16	4.04	4.08	4.24	4.15	4.14	4.17	0.000
7P The group(s) of which I am a member work efficiently as an entity	3.73	3.62	3.67	3.39	3.50	3.64	3.64	3.68	3.70	3.65	0.000

Source: Author

For ABWs, the results of the PE section were similar for each of the groups to the expected results. For the productivity-related variables, the overall results were better for Groups 1 and 2, which were more active in their work. However, for the P7 variable, team efficiency, the results were lower for the respondents who were more actively changing locations than those at the office. This finding could be explained as follows: the more workers see each other and hear how each other has been doing, the more likely they are to better evaluate team efficiency. Overall, the difference between the groups was not as great as expected. P4, which was used as a control variable, was rather interesting in that achieved lower scores for the respondents who worked from the office than for the others. This difference was not large, but it raised the question of whether this variable was just a control variable or whether a small difference in competencies was observed between the different worker activity profiles.

4.3 Comparing the results between workers who are satisfied or unsatisfied to the current design and implementation

In this section, the results are analysed based on whether workers were satisfied with their facilities (Table 3). There are many ways to measure employees' satisfaction with facilities, but in this study, the deciding factor was the item PE7, whether a worker felt that their facilities enabled efficient working. The respondents who had answered with a four or a five were counted as *satisfied*, and the respondents who answered with scores of one to three were counted as *unsatisfied*. As the n *in Table 3* shows, 88% of the workers in cellular offices were satisfied in this regard; for the open-plan office workers, the corresponding value was 46% versus 55% for the ABW respondents.

Table 3 presents the key points in the current discussion between ABWs and cellular offices. Cellular offices work well for most workers (88% satisfied), while ABWs are not a good option for all workers (55% satisfied), at least in their current implementations. However, again, a clear result is that ABW was seen as a better option than open-plan offices by every measure used in this study (Items P1–P7). The greatest insight from this study is that workers who are satisfied in ABW settings have higher productivity values than those who also use cellular offices. It should also be highlighted that ABW workers have lower overall satisfaction with the efficiency of their PE7, but they still perceive their productivity to be higher. This finding demands more studies to explain the reason behind it, but one explanation could be that ABWs require better management and clear goals, which also influence perceived productivity.

Surprisingly, for the satisfied workers, open-plan offices also scored higher values in five of the categories (except P4 and P6) compared to cellular offices, but this difference is less clear than that between ABWs and cellular offices. The characteristics of each office type can be seen in the PE results, in which cellular offices' advantages in concentration and collaboration options are visible. However, ABWs achieved the advantage in spontaneous interaction by a clear margin. The competence-related variable showed a difference of around 0.15–0.20 points between the satisfied and unsatisfied workers, but even after adjusting for this difference, other differences were observed between the groups.

5. Discussion

5.1 How activity-based workplaces compare to cellular offices and open-plan offices

The overall results (Table 1) reveal that respondents from cellular offices have the highest scores on almost all of the categories followed by ABWs and, far behind them, open-plan offices. This result aligns with, for example, the finding by De Been and Beijer (2014) concerning cellular offices having the highest satisfaction levels. However, two of the

Table 3. Means and ANOVA of the results for respondents from activity-based workplaces, cellular offices and open-plan offices based on their degree of satisfaction with their facilities

Item *n*	Cellular/not satisfied 336/12%	Cellular/ satisfied 2,505/88%	Open-plan/ not satisfied 648/54%	Open-plan/ satisfied 550/46%	ABW/not satisfied 809/45%	ABW/ satisfied 981/55%	Total 5,829	ANOVA *p*-value
1PE There is a space available for tasks that require concentration and peace at our workplace when needed	339	4.69	2.60	4.02	3.08	4.55	4.07	0.000
2PE There are enough rooms at my workplace for formal and informal meetings	277	3.93	2.41	3.28	2.69	3.83	3.45	0.000
3PE The facilities at my workplace enable spontaneous interaction between workers	295	4.17	3.23	4.08	3.32	4.41	3.91	0.000
4PE The ergonomic arrangements of the workstations at my workplace are in order	325	4.25	3.30	4.14	2.91	4.20	3.88	0.000
5PE There are generally no disruptive factors in my work environment (like sounds or movements)	242	3.97	1.57	3.08	1.76	3.38	3.12	0.000
6PE There is a place in which I can discuss or talk on the phone about matters which I do not want others to hear	315	4.49	2.98	4.10	3.23	4.33	4.01	0.000
7PE The facilities at my workplace are conducive to efficient working	247	4.68	2.10	4.25	2.11	4.44	3.83	0.000
1P I achieve satisfactory results in relation to my goals	377	4.16	3.89	4.18	3.88	4.30	4.09	0.000
2P I can take care of my work tasks fluently	371	4.14	3.74	4.20	3.75	4.28	4.05	0.000
3P I can use my working time for matters which are right for the goals	323	3.82	3.34	3.89	3.35	3.96	3.70	0.000
4P I have sufficient skills to accomplish my tasks efficiently	406	4.28	4.12	4.27	4.11	4.33	4.24	0.000
5P I can fulfil clients' expectations	378	4.10	3.87	4.12	3.90	4.17	4.04	0.000
6P The results of my work are of high quality	395	4.25	3.98	4.20	4.03	4.27	4.17	0.000
7P The group(s) of which I am a member work efficiently as an entity	317	3.74	3.37	3.79	3.45	3.87	3.65	0.000

Source: Author

productivity variables had similar averages for ABWs and cellular offices and thus, differs from existing knowledge. The comparison between ABWs and open-plan offices favours ABWs even though ergonomics were experienced as better in open-plan settings with appointed workstations. This result was also as expected based on previous studies (Divett, 2020; Candido *et al.*, 2019).

As mentioned in the Section 2.1 and, for example, by Engelen *et al.* (2018), the critical information needed to make judgements about the benefits of different office layouts is typically incomplete. While the current study also used incomplete data, in Tables 2 and 3, it contributes more information about the critical success factors of an ABW.

5.2 How workers with different profiles experienced productivity

In the current study's theoretical background, several studies highlighted that the ABW is not a good option for all kinds of work profiles. Haynes *et al.* (2019) suggested that this setting is more suitable for workers who experience more natural changes in their work tasks during the day. For example, Leesman (2017) deemed it catastrophic that 71% of workers in ABW setting had not changed their workstations at all during the day, and obviously, in such cases, the ABW is not the correct office type. While this study could not track the exact nature of the respondents' work, it sheds light on how the different location-based work profiles benefit from ABW settings.

Comparing the results between different work profiles in ABWs shows that workers with more than just an office-location profile experienced productivity in ABWs better than those who might not switch location their work that much. This result was expected, and it supports the ABW's principle that effective working in such a setting requires switching workstations based on work tasks. Comparing the productivity variables of the ABW with active work profiles and cellular office types with different work profiles reveals the gap between the two types, but cellular offices still offer a slight advantage over ABWs. The productivity comparison between ABWs and open-plan offices once again clearly favours ABWs.

5.3 How satisfaction with a current implementation influences productivity

The final perspective on the data was applied using satisfaction with the current implementation at an office as a dividing factor since the workers who were the most satisfied with a layout were using their facilities currently or had the correct facilities for their work. Ruostela *et al.* (2015) and Brunia *et al.* (2016) found that the workers most satisfied with their implementations had implementations that were successful and met their needs. Also, for example, Hoendervanger *et al.* (2016) found that workers who switched desks at least a few times a day in ABWs were significantly more satisfied with their offices, and they were also mainly the workers with very mobile work profiles.

Unsurprisingly, cellular offices are the most satisfying option for 88% of workers who are offered the option, especially in Finland, where this type has been the standard for many decades in public organisations. What is surprising is that 55% of workers in ABW settings are satisfied with the office type offered. This level of satisfaction differs from the results of Hoendervanger *et al.* (2016), which suggests that the ABW works only for a small minority of workers. In open-plan offices, 46% of workers are satisfied with the office type offered, which is also less than in ABWs.

Comparing the results between the workers in cellular and ABW settings and between those who are satisfied with their settings achieved opposite outcomes to the previous literature's findings (De Been and Beijer, 2014; Leesman, 2017). The results indicate that workers in ABWs experience higher productivity than those in cellular offices. While

cellular offices have been a popular option for most workers, this result should at least raise interest in whether ABWs could perform even better in work productivity alone, without considering their other benefits (see, e.g. Ruostela *et al.*, 2015). The comparison between ABWs and open-plan offices favoured ABWs, as expected. Another interesting result when comparing the three office types is that, for satisfied workers, the amount of spontaneous interaction is highest in ABWs. Enabling better spontaneous interaction is one of the expected benefits of ABWs in the literature, and this result supports that.

6. Conclusions

As a conclusion, the theoretical implication of this study is three-fold. Firstly, the study compares different office types and clearly indicates with a large data set that ABWs are a better option than open-plan offices from the experienced work productivity perspective. A comparison with ABW and cellular offices has been more debatable in the previous literature where the case studies (Ruostela *et al.*, 2015; Brunia *et al.*, 2016) have pointed out positive results while studies with large data sets (De Been and Beijer, 2014; Leesman, 2017) have not been able to find the same results. However, opposed to the previous studies (Engelen *et al.*, 2018; Marzban *et al.*, 2022) this study statistically points out that ABW can provide at least similar experienced productivity for many knowledge workers than a cellular office.

Secondly, the result of this study highlights that workers who move more during their work week have higher experienced productivity in ABW than those who are not moving that much. The findings also confirm the previous findings from Brunia *et al.* (2016), Engelen *et al.* (2018), Babapour (2019) and Marzban *et al.* (2022) that the implementation of ABW matters. In addition, this study also presents the difference in experienced productivity when the workers are satisfied to the implementation or not.

Thirdly, it takes the discussion of the outcomes of the ABW to a new level by pointing out the importance of information about the nature of the design and implementation when evaluating work environment research. Previous studies like De Been and Beijer (2014) and Leesman(2017) do not provide much of that information and, thus consider respondents working in each setting as one group whether they are satisfied to their setting or using it right (e.g. not switching). This paper clearly shows if a worker uses different locations during the week or how satisfied they are for the current office implementation, it has a significant impact on how they experience their productivity. The lack of information might also explain why many case studies have found more positive results for ABW than statistical studies. In addition to previous studies, this paper also presents openly how the productivity is measured and encourages future studies to also add quantity and quality plus individual and team levels to their productivity variables.

As a practical implication, this study offers empirical evidence for the managers and workplace designers to make the decisions about different types of layouts and especially ABW. The paper strengthens the knowledge that ABW setting is not good for all the knowledge workers, but there are many from whom it is very good in terms of work productivity. Previous studies have presented that the problems with ABW implementation are result from bad planning or the misuse of facilities, and the current study confirms that and adds up the importance of understanding the nature of work. The paper suggests to the practitioners planning of adopting an ABW involve two key phases for successful results:

(1) determining work profiles and planning the work environment that supports workers' needs; and

(2) implementing the solution and ensuring the correct use of facilities.

For the society the well-implemented ABW can have a big impact as it is, for some knowledge workers, the most productive of these layouts. Like, for example, Ruostela *et al.* (2015) highlighted the ABW requires also lot less square metres per person which has societal level huge impact on CO_2 emissions.

While this study demands more background information about the studied settings and points to issues in previous studies, it also faced several limitations. The data were collected over five years the survey tool was created now 10 years ago. This approach led to a failure to collect all the background information, which limited the kinds of analyses that could be conducted and at which levels. More detailed information on work profiles and the number of changes in work desks in a day would have been especially useful. Another limitation with these kinds of vast survey data is that it is unclear, for example, what kind of ABW setting was experienced, how it was designed, when it was implemented and what kind of environment workers had experienced previously.

Future research should resolve the limitations mentioned for the current study. Especially necessary in future ABW papers are well-documented, large samples with pre and post-data. These kinds of data with actual, objective performance measures are difficult to obtain, but they would be a key step in answering the question of whether ABWs are good or bad for productivity in knowledge work.

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