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Reconciling University's Strategic Workspace Goals: How End-Users Influence the Resulting Design

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ABSTRACT

Background and Aim. This article examines the implementation of a university's strategic workspace goals through participatory design processes. It evaluates the goals and the university-level participatory approach and compares several unit-level participatory processes within a single building project. The study aims to identify the influence of end-user communities on the participatory design process, their engagement, and the alignment of outcomes with the strategic goals.

Methods and Data. The study investigates material from campus development project at a Finnish case university. The findings are derived through an inductive process of qualitative content analysis. The material comprises project documentation and 13 semi-structured interviews with various stakeholders, including management and designers.

Results. The university's strategic campus development incorporated both business- and cost-driven approaches, with financial saving emerging as priority. Despite formal participation strategies, early-stage decisions led to a predominantly solution-driven implementation. Unit-level participatory processes varied markedly in end-user involvement, resulting in inconsistent integration of strategic goals with end-user perspectives. These finding underscore limitations in the university-level spatial change process.

Originality. Participatory processes in academic workplace transformation remain underexplored. This study contributed by comparing university- and unit-level participatory approaches, revealing variations in change management, spatial planning, and user involvement.

Practical Implications. The results support improved end-user engagement in university development processes by emphasising the importance of early-stage involvement in goals setting and the need for adequate human resources to facilitate participatory processes.

Type of Paper. Full Research

KEYWORDS. academic workplace, end-users, engagement, participatory design process, strategic goals

INTRODUCTION

Universities have evolved through societal changes throughout their existence, and the campuses, the spatial forms of universities, have represented the change (Benneworth, 2014). One of the recent trends influencing campuses has been university mergers (Tienari et al., 2016) that, together with financial pressures and new ways of working, have led universities to reduce their footprint and retrofit existing facilities (den Heijer, 2011; Marmot, 2014). Academic work environments have been introduced with various open and flexible workspace models, such as activity-based offices (Berthelsen et al., 2018; Häne et al., 2020; Indergård & Hansen, 2024; Nooij et al., 2023) and a focal driver for implementing them has been cost reduction (Nooij et al., 2023). The benefits have been, e.g., increasing interactions and providing flexibility for future changes (Häne et al., 2020). However, the literature seems contradictory on whether activity-based environments are suitable for academic work (Häne et al., 2020; Marzban et al., 2023; Nooij et al., 2023).

As universities have adapted premises to the user needs, research on academic workplaces has also been growing (Indergård & Hansen, 2024), especially concerning the outcomes of change processes and end-user perceptions (Berthelsen *et al*., 2018; Häne *et al*., 2020; Indergård & Hansen, 2024; Nooij *et al*., 2023). However, not only the end-product, but the change process itself influences end-users' satisfaction towards the resulting work environments (Breutner & Roth, 2024) According to Boge et al. (2017) involving end-users in early-phase planning is among the most important factors for long-term value creation. While organisational changes and spatial change initiatives have long been debated (e.g., Skogland & Hansen, 2017), the university organisations' workspace initiatives and participatory processes in academic contexts require further research.

The aim of this study is to evaluate a university's strategic workspace goals and end-user engagement process to define if the goals are aligned with end-users' perspectives, and whether the goals are achieved through participatory processes. The article examines the implementation of a university's strategic workspace goals through the lens of a single building project. Firstly, the selected case provides a tangible example of how strategic objectives are translated into practical design solutions. Secondly, the comparative setting enables to reveal variations in change management approaches, spatial planning practices, and end-user engagement strategies and in turn, how end-users, here academic units functioning within a faculty, influence the participatory process and the strategic goals. With this stepwise comparison, the study enables a deep and bounded analysis of the participatory and building's transformation processes. The findings benefit research on change management and practice in formulating future participatory processes within academic environments. The main RQ is: *How are a university's strategic workspace goals implemented in a building transformation project?*

LITERATURE STUDY

As previously noted, university organisations have increasingly transformed their workspaces. Today, a variety of office types – including open, flexible and activity-based work environments (ABW) can be found within universities, with mixed outcomes and user experiences (Häne et al., 2020; Indergård & Hansen, 2024; Nooij et al., 2023). As in other knowledge-intensive environments, academic workspaces should support both collaborative and individual work (Indergård & Hansen, 2024). These strategic spatial changes are often driven by the dual aim of improving accommodation efficiency—primarily through cost reduction—and enhancing effectiveness by delivering greater value to end-users (van Ree, 2002). Similarly, Beckers et al. (1994) identified two core motivations behind workplace strategies: a cost-driven approach focused on financial savings, and a business-driven approach aimed at challenging conventional practices and exploring new ways of working.

Moreover, the success of spatial change is shaped by the implementation strategy. According to Beckers et al. (1994), this can be either solution-oriented—seeking to persuade employees to adopt a standardized workplace model—or process-oriented, involving end-users in the co-creation of diverse workplace solutions tailored to specific needs. Petrulaitiene and Jylhä (2015) further categorise workplace concept changes into four drivers: 1. external economic or social factors, such as economies of scale and aging society, 2. technological developments, 3. changes in business processes, and 4. changes in organisational structure.

Skogland and Hansen (2017) emphasise that the change management processes are inherently complex and multi-faceted. For spatial strategy to succeed, it must be embraced across all organisational levels and structures. Failure to adopt the strategy or misinterpretation by end-users can jeopardize the initiative. Therefore, successful change requires continuous development and evaluation throughout the implementation process. (Skogland and Hansen, 2017.) Wäistö et al. (2024) found that the strategy implementation has limited influence on the workspace design outcomes. However, successful design requires consideration of both organisational and human factors (Wäistö et al., 2024).

Organisational relocation entails multiple impacts, including relocation costs, operational disruption, employee reactions to change, satisfaction, and altered work practices (Christersson & Rothe, 2012). Boge et al. (2017) highlight that early-phase planning is critical for a building's usability and lifetime value creation. Van der Voordt and Jensen (2023) emphasise the importance of user involvement in the design process and change management during implementation for fostering healthy workplaces that support productivity. Similarly, Breutner and Roth (2024) found that change processes significantly influence end-user satisfaction with the resulting work environments.

End-user participation in the design process can be organised in various ways, depending on whether users are regarded as 'subjects' or 'partners' (Sanders & Stappers, 2008). According to Sanders and Stappers (2008), the early design phase is particularly ambivalent, as future users and their needs are considered. Horelli (2002) categorises user-involvement in participatory planning into four Indicative Levels of Participation: 1. Information, 2. Consultation, 3. Partnership, and 4. Community control. The first level reflects a passive user role, aligning with Sanders and Stappers' (2008) 'users as subjects', while the fourth represents active engagement, consistent with 'users as partners'.

METHODS AND DATA

This study examines strategic workspace goals and participatory processes through a single building case study. Case studies are typically qualitative (Yin, 2014), and this study investigates the phenomena by discovering patterns of association in inductive analysis of qualitative data (Blaikie, 2010). The case is a work environment change process in a building retrofit project within a larger university campus development process. The case building was selected due to its status as the first completed project within the framework of the campus development initiative. Focusing on this single building project (BP), the paper focuses on the participatory design processes, examining how end-users influence both the process and its outcomes, as well as the end-users' engagement with broader campus development initiatives. The building's internal comparative setting focuses, e.g., on spatial changes across different units. This focused approach enhances the research's validity by situating all actors and interventions within a shared architectural and organizational framework, constituting the case as a microcosm for assessing broader strategic and operational dynamics. The units selected for review were chosen due to their location on the same floor in the case building making them contextually comparable and because they frequently emerged from the interviews.

The material consists of two primary datasets: a. campus development documents and b. semi-structured interviews with key stakeholders. These datasets enable a comparative analysis between the stated strategic goals and guidelines (dataset 1) and stakeholder experiences (dataset 2). To examine the stated strategic goals, openly accessed campus development documents were collected from the university intranet: e.g., the Campus Development (CD) Strategy (2020) and the Facilities Programme (2021). These documents were analysed through qualitative word frequency analysis. The first dataset also includes supplementary material produced and collected by the CD project such as responses to a 2021 user survey aimed at broad university community participation prior to any building project, as well as official statements from academic management bodies (e.g., faculty councils) and employee associations (e.g., professors union) regarding the Facility Programme.

The second data set focuses on stakeholder experiences. 13 semi-structured interviews were conducted with key stakeholders. By using snowball sampling, interviewees were selected from various stakeholder groups regarding the BP to ensure a comprehensive understanding of the project's objectives, processes, and outcomes. Interviewees include university and faculty management, end-user representatives (science and management fields), campus development and facilities experts, design experts (architects and engineers), and a property owner. The interviews were conducted in summer-fall 2024, when BP had been completed, and end-users had recently moved to the retrofitted premises. The interview question set included three main topics: 1. the nature, productivity and effectiveness of academic work; 2. the campus development process and building projects: perceived goals, values, process, user participation, and data collection; and 3. the outcome and space utilization. This paper focuses on second and third sets. The interviews lasted between 45

and 70 minutes and all interviews were transcribed. The data sets were analysed through several iterative rounds in Atlas.ti by two researchers. The process comprised three main phases. The first phase began in fall 2024 with independent analysis of the interview data (dataset 2) in Atlas.ti, followed by joint analysis rounds with a third researcher. This phase focused on the building project goals and outcomes. The initial findings informed the second phase, which consisted of collecting and analysing the CD documents (data set 1) in Atlas.ti. The third phase consisted of merging the findings from the two previous phases. These three steps led to the following sub-RQs:

1. What were the strategic goals of the campus development project?
2. How was the participation organised in campus development and in a building project?
3. How were the strategic goals for the work environments achieved in a building project?

RESULTS

The results are organised into two main parts and four sections. The findings presented in the two first sections focus on the strategic workspace goals and the end-user engagement process at the early stages of the campus development. The last two sections focus on the building project goals and related end-user engagement.

Result section 1: University's Spatial Development Strategy

The first section responses to the sub-RQ 1: "What were the strategic goals of the campus development project?". The findings are based on both the university's strategic-level documents and on the stakeholder interviews and are mirrored to the Becker et al.'s (1994) framework of business- vs. cost-driven approach and process- vs. solution-driven implementation strategies.

Table 1 presents three main strategic goals in the CD strategy and the Facilities Programme (FP): a. economic, b. social and c. ecological, which all are intended *"to support university daily life and core activities"*. The economic goal emphasises financial savings through space reductions and increased efficiency. The social goal includes the aim to support, e.g. workplace well-being, community development and synergy benefits. Ecological goal aims to improve occupancy rates and to achieve carbon neutrality.

The cost-driven approach is emphasised in both the CD Strategy and the Facilities Programme, as reflected in the increasing prominence of related aspects (Table 1). The interviewees found all three goals important but also emphasised the cost-driven approach to be the most significant to influence the BPs. While interviewees acknowledged the social and ecological goals, they were only few mentions on, e.g., ecological responsibility or fostering community interaction.

Table 1 The appearance of strategic goals in CD Strategy and Facilities Programme

Identified goal	Appearance in the CD Strategy	Appearance in the Facilities Programme	Percentual change in appearance from CD to FP stage
Economic	18	319	*1672%*
Social	134	268	*100%*
Ecologic	16	68	*325%*

Figure 1. places these goals along two axes: cost- and business-driven approaches (X-axis) and solution- and process-oriented implementation strategies (Y-axis). Economic (ECN) and ecologic (ECL) goals, are interpreted as cost-driven and implemented through solution-oriented strategies, primarily via space reductions and ABW. Social goals (SO) are viewed as more business-driven as they are intended for renewal of the organization, but with solution-oriented implementation strategies of ABW and more efficient space use. However, other means to pursue synergy benefits, e.g., strategic

co-location of the units is not visually communicated. Workplace wellbeing is additionally framed as a more business-driven approach with process-oriented implementation due to possibilities of the BP specific participatory processes.

Although CD documents acknowledge the diverse needs of units and users, they predominantly reflect a solution-oriented strategies. Workspace goals are based on ABW, increased sharing practices, and multi-use spaces, indicating substantial changes to existing partial an operational model. The quantitative goals, such as financial initiatives, are communicated more clearly than quality ones, such as workspace design. For example, the visual FP documents demonstrate different proposals of relinquished buildings or building parts, faculty relocations, and their economic impacts. While they reference underlying values, such as existing special facilities, cultural and historical values, constraints of certain buildings, and campus synergies, they omit current significant places for the campus community. The FP's reduction versions were assumingly tested using ABW measures as a strategic goal, suggesting a solution-oriented approach that either overlooks end-user needs or fails to communicate their implications in the planning documents at a strategic level. Although both interviews and CD documentation addressed the development of new practices and the renewal of space utilisation principles, changes in operational practices and spatial use were primarily driven by predefined spatial solutions and economic incentives, rather than emerging originally from the development process itself.

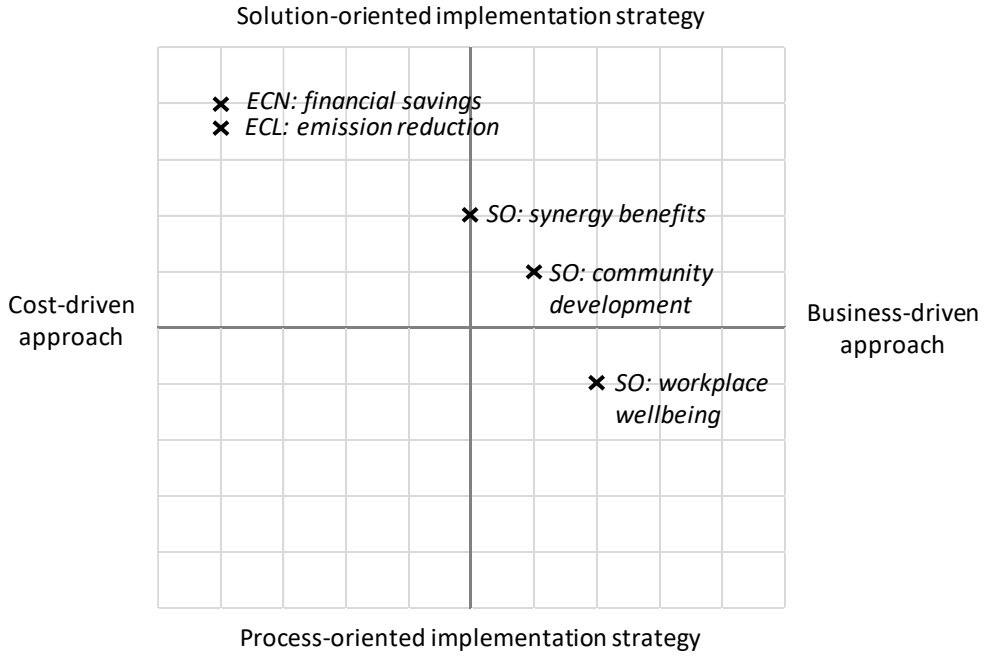

Figure 2. University's Spatial Development Goals. Source: Authors' own work.

Result section 2: End-user Engagement in the Early Stages

This section discusses how the university community was involved in defining the strategic goals of CD. Thus, responding to the first part of the sub-RQ 2. "How was the participation organised in campus development and building retrofit projects?".

All strategic documents emphasise the implementation of participatory processes in building projects to "achieve user-centred environments" and "engage users to emerging new space solutions and operational models". However, CD appears to have organized numerous user participation activities prior to BPs. Figure 2 illustrates the timeline of CD document publications and participation events, revealing that both main documents were published prior to the first instance of end-user involvement. The goals of CD seem to have been defined primarily by experts and university leadership.

In 2019, during the early stages of CD, end-user engagement was conducted through data collection methods, such as, questionnaires, interviews, and space utilization observations. Following the publication the FP's work environment goals, end-users' participation in 2021 took two main forms (Figure 2): first, a survey of generic post-COVID end-user needs; second, a request for statements from the university community regarding CD's main documents involving 1) end-users, 2) academic administration and councils, and 3) representative groups.

In 2022, Community Expert Groups were established to define the university community's generic end-user needs. The groups operated within the boundaries set by the FP, whose strategic goals had already been defined but not visually communicated. Based on the analysis, the impact of participatory measures on the FP remains unclear. It was not possible to determine whether the 2021 survey or the 2022 community expert groups influenced the implementation of strategic goals.

Overall, a discrepancy appears within the CD's documentation, which simultaneously promotes solution-driven strategies and process-oriented implementation. For instance, the feedback CD collected from end-users in 2021 indicates that a major concern within the university community was the participation strategy itself, as well as the CD's impact on work communities, cultures and core activities. Additionally, end-users expressed concern over CD documents not presenting visually any work environment solutions over the lack of visual representation of campus work environment solutions or building plans in CS documents, which hindered their ability to assess the implications of each CD strategic goal.

While a cost-driven approach dominates the strategic documents and was emphasised by interviewees, the 2021 CD survey reveals that the end-user prioritised business-driven goals. Specifically, they valued support for the university's core activities and alignment of unit locations with future needs. In contrast, financial objectives were considered least important by end-users.

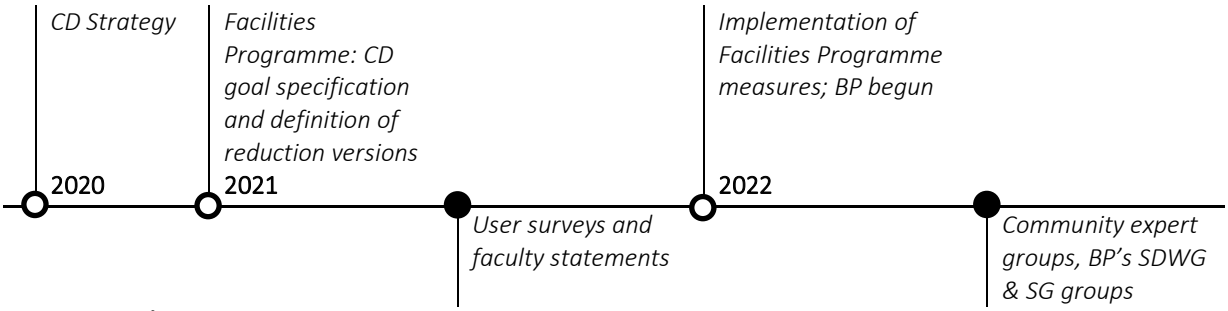

Figure 2 CD process and university community participation. Source: Authors' own work

Result section 3: Goals of the Building Project

This section evaluates the presence of CD's strategic goals within the BP project, drawing on interviews and BP documentation to partially address sub-RQ3: "How were the strategic goals for the work environments achieved in a building project?".

Interviews suggest that no explicit strategic goals were set or discussed for BP. Instead, end-user units articulated their own objectives, such as fostering community and increasing informal encounters. Nevertheless, CD's workspace strategy emerged in the interviews through three distinctive attitudes. First, a defensive stance was observed among end-user representatives who opposed CD's workspace goals, emphasising the importance of private office using terms like "individual" or "personal". Second, a contemptuous attitude was expressed interviewees who dismissed the demands for single-person offices, referring to them as "cells" or "booths", and were defending ABWs. Third, a positive attitude was evident among those open to change and new spatial solutions. These interviewees acknowledged the diversity of end-users needs and noted that ABWs are not universally applicable or optimal.

Result section 4: Participatory Processes and End-user Engagement with Strategic Workspace Goals

This section addresses the latter part of sub-RQ2: "How was the participation organised in campus development and in a building project?" and partially responds to sub-RQ3: "How were the strategic goals for the work environments achieved in a building project?". The findings are analysed in relation to Horelli's (2002) levels of participation and Sanders & Stappers' (2008) user roles.

Section 4.1 Managerial Organisation of Participatory Processes

The CD documents state that all university building projects are to be implemented through similar participatory processes. In the BP, participatory was meticulously organised into three main participatory groups to manage the process. Table 2 outlines these groups and their stakeholder representatives, based on the interviews and CD documentation.

First, the "Space Development Working Group" (SDWG) was tasked with co-developing spatial solutions and representing end-users from each involved unit (units being administrational entities under faculties). CD documents describe end-user representatives as the link between the SDWG and their respective unit. In the BP case, four units from two faculties were presented.

Second, the "Steering Group" (SG) oversaw and guided the SDWG and approve architectural plans. Third, the "Faculty Campus Development Group" (FCDG) played a preparatory and informative role, regularly addressing process and spatial solutions related to BP.

Due to the scale of the BP and the number of units involved, a fourth group was formed. The SDWG was subdivided into three Co-Development Groups (CoDG) by faculty and unit to address unit-specific concerns more effectively. . However, representatives from CD and facility services were often unable to participate due to time constraints. Interview data revealed three distinct unit-specific processes with varying manners of end-user participation: a) A.1, b) A.2, and c) B.1.

Table 2 The main participatory groups and stakeholder representatives. Source: Authors' own work

Group	CD representatives	Faculty management representatives	End-user representatives	Architect / Expert representatives
SDWG	x	-	X	x
SG	x	x	-	x
FCDG	x	x	X	-
CoDG	-	-	X	x

The decision to divide the SDWG into CoDGs within the BP enabled unit-specific variation in the implementation of participatory processes which later influenced the resulting workspaces. The three distinct processes also differed also in terms of the end-users' readiness to change, engagement, and attitudes toward CD. Although CD Strategy had predefined workspace goals, the separation of unit-specific participation highlighted varying degrees of alignment with strategic objectives, particularly regarding time- and activity-based work environment and shared use of spaces.

Interview data indicates that unit A.1 was receptive to new space solutions and actively engaging with the process. In contrast, units A.2 and B.1 demonstrated greater resistance, with low readiness for change and limited engagement with CD's workspace goals. These units expressed a strong preference for traditional spatial arrangements, such as private, single-person offices.

Furthermore, , the trajectory of the BP process appears to have been shaped by the roles and status of the end-user representatives. In unit A.1, the representative was a researcher and work environment

specialist with a proactive attitude and relevant expertise. In unit A.2, the original representative was replaced early on by the head of the unit, as the initial representative was either unwilling or unable to engage with the complex and managerial scope of the project. Unit B.1 had five representatives– likely due to its size, comprising of both research and teaching staff.

Section 4.2 Variations in Data Collection within Participatory Processes

According to the documentation, each BP process utilised unit-specific preliminary data to identify end-users needs, including number of users, time profiles and work profiles and architects employed as a basis for the initial draft plans.

The differentiated processes appear to have influenced the data collection as well. Once SG and SDWGs were established, all three units operated with considerable autonomy in identifying user needs and organising participatory processes. Unit A.1 adopted a partnership or community-control approach, collecting input through surveys and interactive discussions to redefine spatial needs and work practices beyond habitual preconceived assumptions. This unit aimed to ground decisions in existing research and knowledge. In contrast, units A.2 and B.1 followed a consultation approach, without join discussions. In A.2 unit, each employee was asked individually about their personal needs and working habits. Similarly, B.1 unit conducted independent user needs assessments based on conventional spatial needs, such as private offices.

Section 4.3 Resulting Workspaces and Strategic Goal Alignment

This section evaluates whether the BP workspaces meet either the strategic goals or end-user satisfaction. The process and outcome of A.1 unit appear relatively efficient and successful. Final plans were iterated collaboratively between the architect and the end-users, with a shared motivation to explore new ways of working. The resulting work environment aligns with all strategic goals while accommodating end-user preferences. The layout entails both ABW with hot-desking, shared-use rooms and desks, and some individual offices as well. Interview data suggests end-users are satisfied with the outcome.

In contrast, unit A.2 followed a more dichotomous process. Although the architect initially drafted plans based on the needs assessment, the proposal did not meet the end-users' request for individual offices. Through further co-development the unit's needs were eventually reconciled with economic goals. The final layout includes more individual offices and fewer ABW spaces than A.1, along with some shared spaces. However, the lack of sufficient meeting rooms –due to reduced allocated space, and the prioritisation of single offices–resulted in only partial alignment with strategic goals and mixed end-user satisfaction.

Unit B.1 proactively produced preliminary user needs data, but end-users perceived the allocated space as insufficient. The unit independently conducted time-intensive planning process, prioritising individual offices, and submitted its proposal to the architect. Interviewees noted t strong resistance to change, which led to inflated space demands and the rental of an additional floor – ultimately failing to meet the CD project' economic and workspace goals. From end-user's viewpoint, the process was also unsuccessful. During the construction phase, B.1 temporarily relocated to facilities featuring more ABWs and shared-use spaces. Their experience was positive, prompting a request to either remain in the temporary space or retrofit the newly retrofitted permanent premises accordingly. Neither request was granted.

DISCUSSION

The first part of the study addressed sub-RQ1: *"What were the strategic goals of the campus development project?"*. The identified main strategic goals –economic, social, and ecological– align with the triple bottom line perspective for organizational success (Christersson & Rothe, 2012). These goals reflect both the cost- and business-driven approaches (Becker *et al*., 1994), with strong emphasis on the economic and quantitative aspects, which are more readily measurable (Christersson and Rothe, 2012). While the cost-efficiency, such as space reductions, dominated both CD documents and

interview data, business-driven values, such as unit location and support for future needs, were important for the university community. However, these were not adequately reflected in the BP's workspaces, where financial savings were perceived as the primary objective.

All four organisational workplace change concepts identified by Petrulaitiene and Jylhä (2015, p.261) appear to underpin CD's workspace goals. External economic factors were the most influential. Technological developments, particularly hybrid work modes, were discussed but had mixed influence on BP outcomes. Although no major changes in business processes were evident, the university merger–the initial driver of CD– altered organisational structure, yet its strategic impact was minimally reflected in the goals.

Sub-RQ2 asked: "How was the participation organised in campus development and in a building project?". Initially, the implementation followed a solution-oriented strategy, shifting toward a more process-oriented approach during the BP phase. Despite various forms of stakeholders and end-user engagement, early participation remained at the levels of information and consultation (Horelli, 2002), with workspace goals defined prior to meaningful input. Higher levels of participation – partnership and community control (Horelli, 2002) – emerged only during BP phase. The solution-oriented implementation strategy aligned with both cost-driven and business-driven approaches but occasionally conflicted with process-oriented implementation, limiting effectiveness. Findings suggest that timely and meaningful participation throughout the process could have improved end-user engagement with strategic goals.

Sub-RQ3 asked "How were the strategic goals for the work environments achieved in a building project?". The division into CoDGs enabled unit-specific processes that shaped end-user engagement and influenced alignment with strategic goals. A critical success factors seems to be related with what type of needs assessment data is collected, who collects it and in what phase. While unit-specific processes enhanced co-development and end-user engagement, they also reduced interaction with other stakeholders, potentially affecting achieving strategic goals. Involving a community or change management expert could improve the co-development process and foster mutual understanding between architects and users.

The findings highlight a clear contrast between lower levels of participation—characterized by one-way communication—and higher levels involving co-development and collective reflection on current and future needs. Active end-user involvement is essential to ensure that their needs are accurately represented in design outcomes.

The main workspace goals—time- and activity-based environments and increased shared use of spaces—aim to reduce spatial footprint, meet diverse user needs, and enable future adaptability. These goals provide serve a sound strategic foundation for aligning organizational and user requirements. However, conflicting findings on ABW in academic contexts (Berthelsen *et al*., 2018; Nooij *et al*., 2023; Toivanen *et al*., 2023) suggest that campus development may require more nuanced strategic goals or a redefinition of workspace quality.

This study's limitations lie in its single-case design, although it includes comparison of three units. End-user satisfaction with renewed premises was not surveyed, presenting an opportunity for future research. Further studies could also compare other campus development initiatives and contexts, strengthening the case study approach.

CONCLUSIONS

This article reviewed a case university's strategic workspace goals and their implementation in a single building case study. The underlying approaches behind identified strategic goals were both business-driven—aiming, e.g., to renewal of work practices—and cost-driven, with financial savings ultimately dominating during the implementation phase. In addition, the cost-driven approach may have been emphasised because the implementation strategy was solution-oriented in the strategic

development stage and moved towards process-oriented only in the building project stage when all strategic solutions were set.

Effective and timely end-user engagement is vital for developing environments that reflect user cultures and work practices, meet organizational and user requirements, and prevent later conflicts. This involves setting quantitative and qualitative strategic goals with users from the outset. Additionally, the participation process—how, by whom, and with whom it is conducted—must be carefully planned.

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AI DECLARATION

The authors employed Microsoft Co-Pilot to proofread, improve grammar, and summarize expression.

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