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RESEARCH ARTICLE **OPEN ACCESS**

A Study on Understanding the Required Conditions in Architectural Projects (Impact of Temporal Changes in the Client's Industry Domain Characteristics on Office Building Planning)

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Abstract:

Introduction: This paper aims to present a fundamental approach for understanding the requirements and specifications essential to a particular architectural project within the creative process. Specifically, it provides concrete insights by focusing on office buildings, which represent a typical form of architectural development.

Methods: The primary activities conducted within the office buildings targeted in this study are business-related operations. To understand the nature of these activities, this paper employs the concept of modularization to interpret industrial characteristics and proposes a new perspective on spatial creation for business activities.

Results: Through the investigation of various business activities, this study identified distinctive characteristics of each operational field and established a clear direction. In particular, by interpreting the characteristics of each sector from the perspective of modularization potential, the required design directions became more apparent.

Discussion: This paper highlights an aspect of the architectural creation process that creators should understand in order to respond quickly and accurately in environments where external factors change rapidly.

Conclusion: The findings of this study reveal a conceptual framework for architectural specifications that does not yet exist in current discourse. In response to various external environmental changes, including pandemics, this research clarifies part of the foundational thinking necessary for architectural design. However, as this study focuses solely on office buildings, further discussions will be necessary to address other building typologies.

Keywords: Industry trends, Business characteristics, Client requirements, Architecture concept, Modularization, Remote work.

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1. INTRODUCTION

In architectural planning, a primary objective is to create environments that effectively support users' activities. Traditionally, architectural practices have operated on the premise that clients articulate the necessary requirements for their intended activities, which architects and contractors then implement through design and construction. However, this approach often presents difficulties, as clients typically lack the specialized knowledge required to define such architectural specifications independently. Unless the client possesses considerable experience in architectural planning, it must be assumed that their understanding of architectural and spatial requirements is limited.

While clients or users may be capable of articulating the purpose or goals of their activities, they often cannot clearly define the environmental or spatial conditions necessary to support those activities, nor the specific architectural specifications required to realize them. Conversely, architects and other creators involved in the planning, design, and construction process may refer to precedents-existing buildings with similar functions-to inform their designs. Nevertheless, the essential approach for creators should not involve the mere replication of forms or specifications from prior examples.

Instead, a more fundamental task for architectural creators is to understand the underlying purposes of users' activities, identify the requirements necessary to support those activities, and translate them into appropriate spatial, structural, and technical solutions. Given the ongoing transformations in social, political, cultural, and economic contexts, as well as the continuous advancement of foundational technologies, the external environment surrounding architectural practice is in constant flux. Consequently, reliance on past examples alone is insufficient for addressing contemporary design challenges.

This paper investigates how architectural knowledge can be systematically organized to better respond to these evolving conditions. It aims to identify transferable insights by focusing on representative primary architectural functions. As an initial case study, the office building-one of the most widely recognized examples of a function-driven architectural type-will be examined. In the context of office planning, particular emphasis will be placed on the creation of optimal environments tailored to the specific operational needs of different organizations.

Despite the ongoing discourse on architectural planning methods for office buildings, limited attention has been given to the characteristics and organizational nature of office users. Architectural creators have traditionally concentrated on tangible design elements, such as spatial configurations, room layouts, furniture placement, HVAC systems, and lighting design. In practice, the planning process is often shaped primarily by the architect’s own investigation and by the contents of the owner’s requirements submitted by the client. However, these requirements are frequently developed by clients who lack specialized architectural knowledge, thereby limiting their ability to articulate planning specifications that accurately reflect their organizational needs.

This paper aims to propose a revised conceptual approach that enables architectural creators to acquire and apply more accurate and relevant knowledge in office planning. Specifically, it advances a typological framework of office user organizations, identifies distinct characteristics for each organizational type, and examines how these characteristics inform architectural requirements, particularly in the context of remote work–oriented environments. Through this framework, the paper offers a more concrete and analytically grounded direction for architectural planning-one that moves beyond the conventional reliance on client-supplied requirements.

To achieve this aim, the study systematically reviews existing academic literature on the characteristics and transformations of business activities, develops hypotheses informed by established theoretical models, and empirically tests these hypotheses. In doing so, it contributes to a more comprehensive understanding of how organizational characteristics should inform architectural decision-making in the contemporary office landscape.

2. THEORETICAL BACKGROUND

2.1. Understanding Business Activity Characteristics through Design Information and Component Interdependence

This section examines the planning of office environments, emphasizing the necessity of aligning spatial design with the characteristics of users’ business activities. As noted previously, a primary objective of architectural planning is to create an environment conducive to the development and execution of these activities. Within this context, designers of office spaces are tasked with interpreting the distinctive attributes of users’ business operations and translating them into appropriate spatial configurations. Notably, these business activities-and by extension, the organizational characteristics that significantly influence spatial requirements-are human-constructed phenomena, or artifacts.

In the broader context of artifact creation, prior research has highlighted that creators typically generate objects based on unique Design Information specific to their goals and context [1-4]. Here, the term artifact refers to any object that is intentionally designed. The design concept, which underlies this information, can be understood through various analytical lenses; a particularly influential perspective focuses on the interdependence of components [1, 2, 5-7]. In architectural design, as in other forms of artifact creation, the final product is composed of multiple interrelated components, and managing the interactions among these components is a core concern for the designer [1].

Previous studies have identified two principal strategies for managing component relationships: integration and modularization [2, 3]. The integration approach involves iterative fine-tuning of all design elements to achieve optimal overall performance [3].

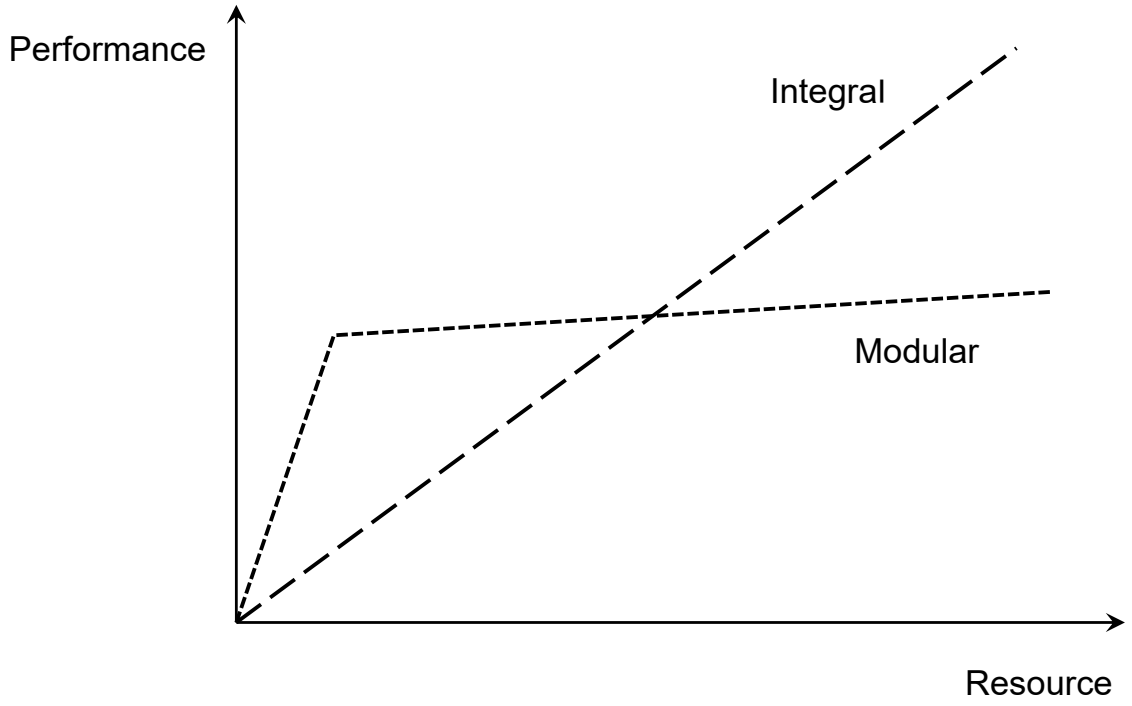

Fig. (1). Performance tendency of artifact with design concept.

In contrast, modularization entails grouping related components into discrete modules, enabling simplified design and production processes by reducing system complexity [2, 8]. These approaches, commonly referred to as the 'Architecture Concept,' have been extensively studied, particularly in relation to the structural composition of the final product and the procedural organization of the design process itself [9, 10].

As illustrated in Fig. (**1**), the choice between integral and modular design strategies has significant implications for the relationship between economic resources and product performance. In integral design, performance tends to increase proportionally with greater investment of resources [3, 11]. Conversely, modular design offers efficiency and reduced complexity when performance goals are clearly defined; however, it can be difficult to adjust if initial assumptions prove inaccurate [12].

This perspective represents an academic effort to elucidate the underlying logic by which various judgments are structured in the process of designing and producing human-made artifacts. More specifically, it seeks to identify the tendencies inherent in a creator's design philosophy, thereby enabling an objective understanding of both the cognitive framework guiding the design phase and the characteristics of the resulting artifacts.

From the standpoint of practical business models, modularity plays a critical role in shaping industrial structures by partitioning the value chain along clearly defined technical interfaces. This segmentation facilitates specialization and fosters innovation, particularly by enabling new entrants to contribute to discrete portions of the production process. However, while the utility of modularity has been well recognized, the mechanisms underlying its emergence and evolution remain insufficiently understood. In certain sectors-most notably information technology-firms appear to operate in alignment with modularity theory. In contrast, sectors such as manufacturing often deviate from this pattern.

Modularity theory has drawn connections between the vertical disaggregation of industry structures and the acceleration of innovation and development at the sectoral level [13, 14]. Through standardized interfaces between modules, firms are able to specialize and innovate independently, thereby promoting diverse experimentation and expediting technological progress across the industry [2, 7, 13]. A paradigmatic example is the information technology industry, where modularity enables the construction of personal computers from standardized components and separates the design and manufacturing of semiconductor chips across different firms [2]. Empirical evidence suggests that design-specialized semiconductor firms have played a central role in the proliferation of patents in this field [15], indicating that modularization in both product composition and creative processes has become foundational to the industry's developmental trajectory. Subsequently, modularity-based frameworks have expanded into adjacent domains, including automotive computing systems, smartphones, wearable technologies, biomedical implants, and cloud computing platforms [16].

Nevertheless, despite the demonstrated efficacy of modularity, key questions persist regarding the conditions

under which it emerges and is sustained. Colfer and Baldwin [7] posit that firms may seek to appropriate value by controlling standardized module interfaces, yet in practice, companies often confront strategic trade-offs when deciding whether to adopt modular approaches [17]. As a result, multiple instances of de-modularization-the reintegration of previously separated components-have been documented within various industries [18-20]. More broadly, many firms exhibit limited incentives to develop thin crossing points or interface protocols that facilitate modularity. In some cases, they may even resist innovations that would otherwise lead to highly modular, rapidly evolving industrial structures [21, 22].

2.2. Modularity and Industry Structure

Baldwin and Clark synthesized and extended prior academic research on the concept of modularity, particularly in relation to technological innovation and product development processes [2]. This body of literature addresses the growing complexity associated with the creation of technology-based products and applications [23, 24]. Modularity has been proposed as a potential solution to such complexity, wherein firms decompose complex problems into smaller, manageable modules [2]. Importantly, modularity is not limited to product design but also applies to the processes involved in creating products and services [25].

Technical modularity enables firms to structure tasks into distinct modules, allowing for greater manageability and efficiency in both design and production. This technical structure often influences the organizational structure of firms, as internal divisions may mirror the technical boundaries of the problems they seek to solve [7]. Moreover, the concept of organizational modularity extends beyond the firm level, allowing multiple firms to form ecosystems in which each specializes in a particular module. Such arrangements have enabled the decentralized development of highly complex systems, including airplanes and computers [2, 26]. As a result, the division of both technical and organizational complexity facilitates the decentralization of innovation and development across entire industries [2, 15, 27, 28].

To enable modularization, it is essential to design “thin” interfaces that permit external entities to execute specific tasks independently [27]. When tasks are distributed across distinct domains, and most task-specific information is encapsulated within each domain, only minimal exchanges of materials, energy, or information are required between them. This results in a network architecture characterized by limited, well-defined points of interaction-referred to as “thin crossing points” - between modular sub-networks. These interfaces effectively isolate modules within a larger system, allowing each to operate with minimal interdependence [28].

Interfaces thus play a central role in mediating interactions between modules and are critical to enabling decentralized innovation. This structure underpins what Baldwin and Clark define as modularity-a complex ecosystem shaped by technical interfaces and guided by user choice [2]. One representative example of such modular ecosystems is computer platform architecture [29-31].

Collectively, these studies demonstrate that modularization has been extensively applied within the information and computing industries, particularly in terms of industrial structure and sectoral evolution. However, there is notable variation in the perspectives adopted across different strands of the literature. Some studies focus on inter-firm coordination and labor division, while others examine the structure of manufacturing processes or the composition of final products [32, 33]. These diverse approaches are often treated in parallel, without a unified theoretical framework.

Moreover, there is a significant gap in the literature regarding the implications of modularity for functional configurations within office spaces-particularly those involving headquarters functions-which directly influence architectural planning. To address this gap, the present study hypothesizes that modularization trends are emerging in the organization and function of office spaces within the information and computing industries. The paper aims to empirically investigate this hypothesis. If confirmed, such findings could offer a novel perspective on office building design-one that reflects evolving functional requirements and has not yet been fully articulated in existing architectural discourse.

2.3. Modularization in the Context of Knowledge Acquisition for Office Building Planning

This section examines the concept of modularization as it pertains to acquiring the knowledge necessary for office building planning. In this context, business activities conducted within office environments are treated as artifacts, constructed and organized by human intention. As discussed in earlier sections, numerous studies have addressed design approaches that emphasize the interdependence of constituent elements-an analytical framework that has proven instrumental in modeling user-side business activities, which serve as a foundational consideration in office planning [10, 34]. These studies explore how individuals and organizations comprehend the overall structure of business operations, extract patterns, and derive insights to inform effective planning strategies. Particularly relevant are discussions concerning modularization, standardization, and the integration of interfaces, which provide mechanisms for managing and reducing complexity [3, 34].

Baldwin and Clark have underscored the benefits of both technical and organizational modularity at the industry level, while also highlighting a key limitation: individual firms often lack sufficient incentives to develop or disclose standardized technical interfaces [2]. Similarly, Pil and Cohen argue that increased modularity facilitates component-level innovation, but also heightens the risk of imitation by competitors [17]. These insights contribute to an objective understanding of firm behavior within specific industrial contexts, emphasizing the importance of

accounting for industry-specific characteristics when analyzing modularization trends [21, 22].

Standardization and normalization are fundamental processes underpinning modularization and are closely linked to network effects. In particular, within digital and platform-based industries, standardization has been widely recognized as a critical enabler of innovation and technology diffusion [35-37]. However, standardization processes are not uniform. While often driven by dominant stakeholders, emerging scholarship emphasizes the complexity of multi-modal standardization-in which a diverse range of actors participate in shaping standards and making crucial design decisions [38, 39]. This phenomenon has been especially salient in digital technology–intensive sectors.

Furthermore, as standardization becomes embedded within an industry's design philosophy, it can facilitate the evolution of interfirm interdependencies, foster mutual capability development, and enhance value creation within established workflows [40-42]. For instance, standardization of data-sharing protocols and interoperability frameworks can lower entry barriers for new firms, potentially loosening the structural constraints imposed by earlier modular configurations [32, 43-46]. These findings suggest that standardization is a dynamic and ongoing process, shaped by the interactions of stakeholders with varying incentives and technical capabilities. Such interactions may prompt the revision of existing standards, leading to shifts in industry architectures over time. A critical parameter in this process is whether the foundational technologies of a given industry lend themselves to modularization.

Building on this line of research, it has been proposed that cross-industry comparisons of architectural design principles can reveal both industry-specific modularization trends and regional differences in design philosophy. For example, in the Japanese automotive industry, an integral design approach tends to prevail, whereas in U.S.-based computer-related industries, modularity is more dominant [2, 3, 47, 48].

The hypothesis derived from this perspective posits that unique architectural characteristics emerge within specific regional and industrial contexts, shaped by historical timing and technological environments. Consequently, the planning and design strategies that align with these characteristics will likewise vary depending on the industry's structural and technological landscape.

2.4. Client Requirements in Architectural Briefing

In architectural planning, a process known as briefing is employed to organize the required conditions, including the needs and expectations of the end users. Considerable scholarly attention has been devoted to the nature and significance of briefing. Project briefing is defined as the process of investigating, developing, and articulating the client’s needs and communicating them to the supply side of the construction industry [49]. Given the increasing complexity of both client organizations and the buildings themselves, briefing has become a more intricate process [50]. Various studies have explored the evolution and scope of user engagement in the architectural design process, discussing multiple ways in which end users of buildings can actively participate in this process [51]. However, there has been limited research on effective engagement with users who have special needs or communication difficulties.

The briefing process is considered the initial and essential step in establishing an effective relationship between the client and the architect or designer. It represents a critical phase of every project and must be planned and implemented according to the specific needs of the client. A project brief should be clear and actionable, providing a robust foundation for both project requirements and design [52].

Given that the briefing process plays a crucial role in eliciting client requirements and conveying them to the design and construction teams, it is regarded as a key factor in achieving client satisfaction [53]. Most of the critical decisions made during the project briefing phase exert a significant influence throughout the entire project lifecycle. For most authors who use the term briefing, it is assumed to refer to the process of identifying, clarifying, defining, and documenting design requirements during the early stages of a project, such as planning and preliminary investigation [54, 55]. However, some articles argue that briefing is a dynamic process that occurs throughout the entire life cycle of a facility, including design, construction, and operation [56, 57].

Just as effective requirements management helps stakeholders build appropriate relationships and make beneficial decisions for the project, some researchers have incorporated value management techniques into the analysis of requirements in construction projects [58, 59]. These techniques enable project teams to identify optimal value and derive appropriate solutions that satisfy client requirements [54, 60, 61]. However, these studies primarily focus on discussing appropriate project delivery methods and techniques for investigating client requirements; they are methodological in nature. Notably, none of these studies address what kinds of content or information clients actually need. Therefore, the present study examines office building planning as a representative case of an architectural project. It seeks to explore how the characteristics of clients can be understood, and what aspects are important in relation to those characteristics.

3. METHODS

3.1. Direction of Environmental Requirements for Business Activities

Based on the discussions presented thus far, it becomes evident that the business activities conducted by organizations within office spaces-one of the primary uses of such environments-are not homogeneous. Rather, these activities exhibit considerable variation depending on the industrial domain, geographic region, or national context. Moreover, the environmental requirements that support these activities are shaped by the specific nature of the business and are subject to change over time. While all of

these variables warrant in-depth examination, this paper, as an initial inquiry, narrows its focus to the characteristics of business activities within industrial domains. Comparative analysis across regions and countries is left for future research.

A key objective here is to identify and analyze the foundational factors that give rise to the distinctive characteristics of business activities in each industrial sector. Drawing on prior studies, it can be posited that each industrial domain is shaped by a set of unique factors, which in turn generate distinct tendencies and operational requirements. One such influential factor is the nature of the foundational technologies underpinning each industry. In the context of architectural planning and building design, recognizing these sector-specific technological characteristics is considered essential for making informed decisions throughout the planning, design, and construction phases.

Of particular interest are industrial sectors whose foundational technologies are digitally oriented. These industries are more likely to be amenable to modularization, a characteristic that may significantly influence the types of environments that are most conducive to their business operations. Thus, this paper hypothesizes that the degree of digitalization in foundational technologies within an industry may directly affect the environmental requirements of office spaces designed to support such business activities.

In accordance with this hypothesis, the paper proposes a categorization framework for industrial domains based on the degree to which digital technologies serve as foundational components in product composition and production processes. As a first step, it is essential to identify industrial sectors where digital technologies play a central role. Subsequent research will compare these digitally intensive sectors with others, using this classification to explore how foundational technological characteristics influence spatial and environmental needs in the context of office planning.

3.2. Survey on Business Environments

In alignment with the hypotheses grounded in prior modularization studies, this section presents an empirical investigation into actual business environments with the aim of acquiring knowledge relevant to architectural planning. The following subsections outline the premises, methodology, and analytical direction of the survey. Given that this research is in its initial phase, efforts were made to minimize complexity and uncertainty in the selection of target industries. Therefore, the study adopts a conventional industrial classification framework while distinguishing between sectors with digitally oriented foundational technologies and those without. By employing this segmentation, the research seeks to enable comparative analysis across industry types. Recent transformations in office environments-such as the adoption of remote work, free-address systems, and open-plan offices-reflect shifting functional demands. Among these developments, remote work stands out as particularly consequential from the perspective of architectural production, as it raises fundamental questions about the necessity of physical office spaces. Accordingly, this study places specific emphasis on remote work practices in its empirical investigation.

The survey was designed to assess office environments within three industry categories: (1) information and communications, representing sectors underpinned by digital foundational technologies, (2) manufacturing, and (3) finance and securities. These industries were selected to facilitate inter-industry comparison based on the degree of digital technological influence. The survey was administered online during 2023 and 2024, utilizing random sampling methods. Participants were full-time or contract employees aged between 25 and 55, drawn from the target industries. A total of 100 respondents were selected in accordance with these criteria.

The survey comprised five questions, structured around two primary analytical perspectives. Respondents were asked to describe the conditions present in their current organizations. The first perspective concerns the degree of standardization in business content or processes, either at the organizational or industry level. This inquiry draws on the notion that modularized systems are typically composed of standardized components, a concept closely linked to interface design and rule-setting in modular design thinking [22].

The second perspective investigates the prevalence and effectiveness of remote work as an operational phenomenon. Remote work implies that tasks can be performed without physical proximity, which in turn suggests that interface-based coordination (as opposed to ongoing, in-person adjustment) may be sufficient. From a design standpoint, this implies a departure from the principles of integral design, in which high interdependence between tasks necessitates continuous adjustment, toward a modular design approach that reduces such dependencies.

The analysis proceeds in two stages. The first stage examines potential correlations between the degree of process standardization and the prevalence of remote work. If a relationship is identified, it may indicate that modularization on the business user side enables or reinforces the adoption of remote work practices. The second stage explores whether such relationships differ across industrial domains, thereby identifying sector-specific tendencies in the interplay between business process modularization and spatial requirements.

If significant correlations are found, this would support the hypothesis that user-side modularization influences the spatial logic of office planning. In such cases, industry-specific considerations-particularly those related to foundational technologies-may warrant differentiated planning strategies. The ultimate aim of this analysis is to investigate the viability of office design methodologies that are informed by the modularization characteristics of business activities across diverse industrial sectors.

4. RESULT

4.1. Analysis of the Relationship Between Business Activity Modularization and the Adoption of Remote Work

In this section, we analyze the survey results with a particular focus on the differences across industries, examining the relationship between the modularization of business activities and the implementation of remote work. This analysis aims to reveal how industry-specific characteristics manifest through the interrelationship of these two dimensions.

The data are summarized in Tables **1**-**12**. The vertical axis ((1) and (2)) in each table represents the degree of standardization and modularization of business operations, while the horizontal axis (A, B, C) indicates the status of remote work implementation within organizations. These tables provide a cross-tabulated overview of the relationship between the two axes. Preliminary examination of the distribution suggests a potential correlation between the degree of business modularization and the extent of remote work adoption. To quantitatively assess this relationship, the average percentages for each data point are presented in Table **13**, and the correlation coefficients between the two evaluative dimensions are shown in Tables **14** and **15**. Table **13** indicates that the results from the two survey periods are approximately consistent. Furthermore, all correlation coefficients exceed 0.3, suggesting a certain level of association between the two variables.

Table 1. Interrelationship between A) and (1) (2023).

-		N	A) What percentage of departments do work in remote work in your company?				
			90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
(1) What percentage of processes that are standerdized in your business?	100%-75%	8	6	2	0	0	0
	75%-50%	26	5	3	11	1	6
	50%-25%	27	2	3	6	6	10
	25%-0%	39	1	0	2	2	34

Table 2. Interrelationship between A) and (1) (2024).

-		N	A) What percentage of departments do work in remote work in your company?				
			90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
(1) What percentage of processes that are standerdized in your business?	100%-75%	4	1	0	1	0	2
	75%-50%	32	6	4	13	4	5
	50%-25%	32	1	2	3	9	17
	25%-0%	32	0	1	1	1	29

Table 3. Interrelationship between A) and (2) (2023).

-		N	A) What percentage of departments do work in remote work in your company?				
			90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
(2) What percentage of requirements to suppliers that are based upon modularity?	100%-75%	6	2	0	0	0	4
	75%-50%	37	8	5	12	2	10
	50%-25%	31	3	3	4	4	17
	25%-0%	26	1	0	3	3	19

Table 4. Interrelationship between A) and (2) (2024).

-		N	A) What percentage of departments do work in remote work in your company?				
			90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
(2) What percentage of requirements to suppliers that are based upon modularity?	100%-75%	4	1	0	1	0	2
	75%-50%	43	4	4	11	11	13
	50%-25%	34	3	2	5	2	22
	25%-0%	19	0	1	1	1	16

Table 5. Interrelationship between B) and (1) (2023).

-		N	B) What percentage of departments that have a right to do remote work in your company?				
			90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
(1) What percentage of processes that are standerdized in your business?	100%-75%	8	4	4	0	0	0
	75%-50%	26	3	5	13	1	4
	50%-25%	27	2	1	7	8	9
	25%-0%	39	1	1	1	3	33

Table 6. Interrelationship between B) and (1) (2024).

-		N	B) What percentage of departments that have a right to do remote work in your company?				
			90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
(1) What percentage of processes that are standerdized in your business?	100%-75%	4	1	0	1	0	2
	75%-50%	32	8	7	9	3	5
	50%-25%	32	1	1	10	8	12
	25%-0%	32	2	1	2	2	25

Table 7. Interrelationship between B) and (2) (2023).

-		N	B) What percentage of departments that have a right to do remote work in your company?				
			90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
(2) What percentage of requirements to suppliers that are based upon modularity?	100%-75%	6	1	1	0	0	4
	75%-50%	37	5	8	14	3	7
	50%-25%	31	3	1	5	7	15
	25%-0%	26	1	1	2	2	20

Table 8. Interrelationship between B) and (2) (2024).

-		N	B) What percentage of departments that have a right to do remote work in your company?				
			90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
(2) What percentage of requirements to suppliers that are based upon modularity?	100%-75%	4	1	0	1	0	2
	75%-50%	43	7	5	12	8	11
	50%-25%	34	4	4	6	3	17
	25%-0%	19	0	0	3	2	14

Table 9. Interrelationship between C) and (1) (2023).

-		N	C) What percentage of departments do most staff do telework in your company?				
			90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
(1) What percentage of processes that are standerdized in your business?	100%-75%	8	5	2	1	0	0
	75%-50%	26	1	6	5	6	8
	50%-25%	27	1	0	7	3	16
	25%-0%	39	0	1	0	4	34

Table 10. Interrelationship between C) and (1) (2024).

-		N	C) What percentage of departments do most staff do telework in your company?				
			90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
(1) What percentage of processes that are standerdized in your business?	100%-75%	4	1	0	1	0	2
	75%-50%	32	4	6	8	6	8
	50%-25%	32	1	1	3	5	22
	25%-0%	32	0	0	1	1	30

Table 11. Interrelationship between C) and (2) (2023).

-		N	C) What percentage of departments do most staff do telework in your company?				
			90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
(2) What percentage of requirements to suppliers that are based upon modularity?	100%-75%	6	2	0	0	0	4
	75%-50%	37	4	7	8	6	12
	50%-25%	31	1	1	4	5	20
	25%-0%	26	0	1	1	2	22

Table 12. Interrelationship between C) and (2) (2024).

-		N	C) What percentage of departments do most staff do telework in your company?				
			90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
(2) What percentage of requirements to suppliers that are based upon modularity?	100%-75%	4	1	0	1	0	2
	75%-50%	43	2	6	6	9	20
	50%-25%	34	3	1	5	3	22
	25%-0%	19	0	0	1	0	18

Table 13. Average percentage of each data.

-	(1) What percentage of processes that are standerdized in your business?	(2) What percentage of requirements to suppliers that are based upon modularity?	A) What percentage of departments do work in remote work in your company?	B) What percentage of departments that have a right to do remote work in your company?	C) What percentage of departments do most staff do telework in your company?
2023	38.3%	43.5%	33.5%	33.5%	38.3%
2024	39.5%	45.5%	27.7%	34.4%	39.5%

Table 14. Correlation coefficient of each data (2023).

-		A) What percentage of departments do work in remote work in your company?	B) What percentage of departments that have a right to do remote work in your company?	C) What percentage of departments do most staff do telework in your company?
(1) What percentage of processes that are standerdized in your business?	Correlation coefficient	0.67	0.68	0.65
	-	Moderate correlation	Moderate correlation	Moderate correlation
(2) What percentage of requirements to suppliers that are based upon modularity?	Correlation coefficient	0.34	0.37	0.39
	-	Weak correlations	Weak correlation	Weak correlation

Table 15. Correlation coefficient of each data (2024).

-		A) What percentage of departments do work in remote work in your company?	B) What percentage of departments that have a right to do remote work in your company?	C) What percentage of departments do most staff do telework in your company?
(1) **What percentage of processes that are standerdized in your business?**	**Correlation coefficient**	**0.55**	**0.46**	**0.53**
	-	**Moderate correlation**	**Moderate correlation**	**Moderate correlation**
(2) **What percentage of requirements to suppliers that are based upon modularity?**	**Correlation coefficient**	**0.32**	**0.32**	**0.30**
	-	**Weak correlation**	**Weak correlation**	**Weak correlation**

According to Guilford's empirical rule [62], an absolute correlation coefficient between 0.7 and 1.0 indicates a strong correlation, between 0.4 and 0.7 a moderate correlation, between 0.2 and 0.4 a weak correlation, and between 0 and 0.2 little to no correlation. Based on this criterion, the present findings can be interpreted as indicating a modest degree of correlation. Notably, several coefficients exceed 0.5, suggesting a moderate positive correlation. These results provide partial support for the tendency that a higher degree of modularization in business activities is associated with a higher rate of remote work adoption.

Based on these results, two key observations can be made. First, the findings provide a certain degree of support for the reliability of the survey. The same survey was conducted twice at different points in time, and the results demonstrated consistent numerical trends. This consistency suggests that the survey outcomes were not significantly influenced by random environmental factors associated with the timing of the surveys. Second, the findings offer insights into the impact of the COVID-19 pandemic. Although the direct effects of the pandemic are generally considered to have persisted until around 2022, the surveys were conducted in 2023 and 2024. The absence of substantial differences between the two sets of results implies that the direct impact of the pandemic on the business domains examined in this study was likely limited.

4.2. Analysis of the Relationship Between Business Activity Modularization and Remote Work Adoption by Industry Domain

Building upon the established correlations, this section classifies the survey indicators according to industry domains to identify potential industry-specific trends. The central premise is that systematic differences or biases observed across industry categories may reflect underlying sector-specific factors influencing business activities. In particular, consistent with the working hypothesis, it is critical to examine whether industries characterized by modularized foundational technologies exhibit distinct patterns in the adoption of remote work and related office business activities. To this end, the data have been reorganized by industry domain, and the results are presented in Tables **16**-**20**.

The analysis focuses on four industry domains - telecommunications, information industries, manufacturing, and financial securities-to maintain consistency in comparison across tables. For each domain, mean values, variances, and standard deviations were computed for the relevant indicators.

Table 16. Percentages for each industry regarding A).

-	Industrial Field	N	90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
A) What percentage of departments do work in remote work in your company?	**Manufacturing industry**	**67**	3	4	11	8	41
	Information and communication	**20**	4	1	7	5	3
	Finance and securities	**13**	1	2	0	1	9
	Total	**100**	**8**	**7**	**18**	**14**	**53**

Table 17. Percentages for each industry regarding B).

-	Industrial Field	N	90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
B) What percentage of departments that have a right to do remote work in your company?	**Manufacturing industry**	**67**	4	4	18	9	32
	Information and communication	**20**	6	3	4	4	3
	Finance and securities	**13**	2	2	0	0	9
	Total	**100**	**12**	**9**	**22**	**13**	**44**

Table 18. Percentages for each industry regarding C).

-	Industrial Field	N	90%-100%	70%-90%	30%-70%	10%-30%	0%-10%
C) What percentage of departments do most staff do telework in your company?	**Manufacturing industry**	**67**	0	4	9	8	46
	Information and communication	**20**	5	2	4	4	5
	Finance and securities	**13**	1	1	0	0	11
	Total	**100**	**6**	**7**	**13**	**12**	**62**

Table 19. Percentages for each industry regarding (1).

-	Industrial Field	N	90%-100%	50%-90%	10%-50%	0%-10%
(1) **What percentage of your company's business processes are standardized?**	**Manufacturing industry**	**67**	2	17	23	25
	Information and communication	**20**	1	12	6	1
	Finance and securities	**13**	1	3	3	6
	Total	**100**	**4**	**32**	**32**	**32**

Table 20. Percentages for each industry regarding (2).

-	Industrial Field	N	90%-100%	70%-90%	30%-70%	10%-30%
(2) **Are the elements supplied by the supply chain standardized in the industry?**	**Manufacturing industry**	**67**	3	25	23	16
	Information and communication	**20**	1	12	7	0
	Finance and securities	**13**	0	6	4	3
	Total	**100**	**4**	**43**	**34**	**19**

Table 21. Average values (%) for each industry from tables 8-12.

-	A) What percentage of your company's work is done through telework?	B) What percentage of your company's work processes are permitted to be done through telework?	C) What percentage of your company's departments have most of the staff working through telework?	(1) What percentage of your company's business processes are standardized?	(2) What percentage of your company's supply content is standardized from suppliers?
Manufacturing industry	**22.7**	**29.0**	**17.3**	**32.8**	**40.7**
Information and communication	**46.3**	**55.3**	**47.0**	**56.0**	**57.3**
Finance and securities	**24.6**	**30.4**	**17.7**	**32.7**	**41.5**

As shown in Table **16**, the proportion of departments implementing remote work is markedly higher in the telecommunications and information industries compared to the manufacturing and financial securities sectors. While the latter two exhibit adoption rates in the low twenties percentile range, telecommunications and information industries report an average of 46.3%. Moreover, the variance and standard deviation in these two domains are greater than those in the other sectors, suggesting not only a higher overall uptake of remote work but also greater heterogeneity in its implementation across organizations within these industries.

Tables **17** and **18** reinforce this pattern, with telecommunications and information sectors demonstrating remote work adoption rates of 51.0% and 42.7%, respectively, substantially exceeding the 9.0% to 28.6% range observed in manufacturing and financial sectors. These findings indicate a more vigorous and varied engagement with remote work practices within digital technology-intensive industries.

Tables **19** and **20** examine the degree of standardization in business processes, revealing analogous trends in average values, variance, and standard deviation as those observed in Tables **16**-**18**. These results provide further evidence of the modularized nature of business processes within the telecommunications and information industries and highlight the potential influence of such modularization on operational practices, including remote work adoption.

Table **21** presents the mean percentage values for each data set. Examining panels A), B), and C) (corresponding to Tables **8**-**10**), a clear distinction emerges between industries within the telecommunications and information sectors and those outside these sectors.

Table 22. Variance of the values from tables 8-12 for each industry.

-	A) What percentage of your company's work is done through telework?	B) What percentage of your company's work processes are permitted to be done through telework?	C) What percentage of your company's departments have most of the staff working through telework?	(1) What percentage of your company's business processes are standardized?	(2) What percentage of your company's supply content is standardized from suppliers?
Manufacturing industry	745.0	819.8	483.1	757.7	796.1
Information and communication	1,704.6	2,597.3	1,824.1	526.5	428.7
Finance and securities	333.3	564.5	80.8	975.4	722.9

Table 23. Standard deviation of the values from tables 8-12 for each industry.

-	A) What percentage of your company's work is done through telework?	B) What percentage of your company's work processes are permitted to be done through telework?	C) What percentage of your company's departments have most of the staff working through telework?	(1) What percentage of your company's business processes are standardized?	(2) What percentage of your company's supply content is standardized from suppliers?
Manufacturing industry	27.3	28.6	22.0	27.5	28.2
Information and communication	41.3	51.0	42.7	22.9	20.7
Finance and securities	18.3	23.8	9.0	31.2	26.9

Specifically, in the manufacturing, financial, and securities industries, inter-category differences remain minimal, within approximately 2%. In contrast, the telecommunications and information industries demonstrate substantially larger differences, ranging from approximately 20% to 30%. This pattern suggests a more advanced stage of telework adoption within the telecommunications and information industries relative to other sectors.

Similarly, values corresponding to indicators (1) and (2) (Tables **19** and **20**) reveal analogous inter-industry divergence patterns. Manufacturing and financial and securities industries exhibit differences of less than 1%, whereas the telecommunications and information industries show disparities on the order of 15% to 20%. These findings imply a more pronounced advancement in the standardization of business processes within the telecommunications and information sectors, which, from the perspective of modularization theory, indicates a higher degree of organizational modularity compared to other industries.

Table **22** reports the variance of each indicator, and Table **23** presents the corresponding standard deviations. Notably, the standard deviation values for telework adoption (A, B, and C) in the telecommunications and information industries are relatively high-41.3, 51.0, and 42.7, respectively-highlighting considerable heterogeneity in adoption rates across companies within these sectors. Conversely, the manufacturing, financial, and securities industries display substantially lower standard deviations, indicating more homogeneous telework adoption patterns.

Conversely, indicators related to the standardization of business processes ((1) and (2)) reveal an inverse pattern: the telecommunications and information industries exhibit lower standard deviations compared to other sectors, suggesting comparatively uniform levels of business process standardization among firms in these industries. Collectively, these results underscore that office activities in the telecommunications and information industries manifest distinct characteristics relative to those in manufacturing and financial and securities industries. Specifically, these sectors show both higher degrees of business process standardization and more extensive telework adoption. The relatively small inter-organizational variability in process standardization further indicates convergence in modularized operational practices within these industries. Recognizing these industry-specific trends, which have not been previously emphasized in architectural planning discourse, is essential for a nuanced understanding of office business activities. This insight may inform more tailored and effective architectural strategies aligned with the evolving characteristics of different industrial domains.

5. DISCUSSION

The survey findings presented above are consistent with the theoretical discussions and hypotheses proposed throughout this study. Specifically, the data support the proposition that industrial domains characterized by digitized technological foundations exhibit a higher degree of compatibility with standardized business processes and the implementation of remote work practices. A critical

observation emerging from this analysis is that such digital technology-based industries tend to emphasize the integration of standardized components within both business operations and organizational workflows. This trend reflects the application of modular design principles not only to physical products but also to service structures and business processes. Conversely, in industrial domains where integral design philosophies prevail, the associated product and service architectures-as well as business activities-tend to rely on holistic optimization and interdependent coordination. These attributes are inherently aligned with conventional office environments that prioritize synchronous, co-located communication and face-to-face collaboration.

Based on these findings, it may be concluded that the technological characteristics underpinning an industry exert a significant influence on the spatial and functional requirements of office environments within that industry. In domains where digital technologies and modular system architectures are dominant, a shift toward remote or hybrid office models is more feasible and often preferable. This shift, in turn, reflects deeper changes in the structure of work and the organization of knowledge within such industries.

From an architectural planning perspective, these insights highlight the necessity of aligning spatial design strategies with the technological and organizational characteristics of the industry in question. Architectural practitioners and designers must therefore adopt a more analytically informed approach, proposing spatial compositions that not only accommodate but actively support the modularized and distributed nature of user activities in digitally intensive sectors.

5. STUDY LIMITATION

While the study presents a novel conceptual approach, its scope was limited to a single analytical dimension-namely, the interdependence of business components as a means to explore the modular-integral spectrum. Future research should expand on this foundation by incorporating additional perspectives and examining a wider range of user activities beyond office work or remote business practices. Doing so will further enable architects to respond with greater precision and foresight to the increasingly complex and heterogeneous demands placed upon architectural design in contemporary society.

CONCLUSION

The primary aim of this study was to propose a conceptual framework that enables architects to acquire more accurate and context-sensitive insights into the functional and spatial requirements of architectural projects. As a concrete application, the study investigated the characteristics of office building functions across different industrial domains, with particular attention to how these characteristics influence spatial specifications in relation to the adoption of remote work.

Given the dynamic nature of the external environment-shaped by technological advances, socio-economic shifts, and crises such as the COVID-19 pandemic-it is increasingly insufficient for architects to rely solely on a static understanding of client requirements at a single point in time. Furthermore, when such requirements are provided by clients who lack specialized architectural or organizational expertise, it becomes evident that a more rigorous and proactive approach is necessary. Specifically, this study underscores the need for architects to develop methods for objectively analyzing and interpreting the operational characteristics of user organizations, particularly in office building design.

To address this challenge, the paper employed a framework rooted in the theory of interdependence among system components, drawing from modularity and integration theory in organizational and technological domains. This allowed for a logical and evidence-based approach to understanding how varying technological foundations across industries shape business activity patterns and, consequently, influence spatial needs.

By applying the proposed framework, it becomes possible to advance the discourse on architectural requirements beyond reactive design practices. For instance, even when clients request conventional office layouts based on precedent or familiarity, architects equipped with a deeper understanding of user activity characteristics-especially those informed by industry-specific modular or integral design logics-can develop spatial proposals that more accurately align with users' latent functional needs.

Conversely, in cases where clients request facilities designed around contemporary practices such as remote work, architects can critically assess whether such arrangements are indeed appropriate given the operational logic and interdependencies of the user's business. If the analysis suggests otherwise, they can make evidence-based counter-proposals, contributing to a more functionally coherent architectural solution.

This research contributes to ongoing discussions surrounding the evolving role of architecture in response to social transformation. The architectural profession has historically operated within paradigms shaped by established typologies and conventional supply-side thinking. However, as societal expectations shift, architects are increasingly called upon to develop creative and adaptive responses grounded in an objective understanding of users' unspoken or emergent needs. Given that users themselves often lack the language or frameworks to fully articulate their spatial requirements, the responsibility falls on architects to navigate this ambiguity and translate implicit needs into spatial strategies.

AUTHORS' CONTRIBUTIONS

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of the article will be available from the corresponding author [S.Y] upon reasonable request.

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