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Sources of challenges for sustainability in the building design – The relationship between designers and clients

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Abstract. Sustainability demands have changed the building design nature, which gained complexity due to the increased diversity of requirements, activities, agents, and tools. Building Information Modeling (BIM) has a potential to contribute to sustainability enabling the building integrated design, performance simulations, life cycle assessment and information use throughout the building life cycle. The aim of this paper is to investigate the sources of challenges in the relation between architectural and engineering (AE) design firms and clients (developers or private individuals) for promoting sustainability in the building design. Also, it is investigated if BIM has been implemented by the firms and how it relates to management and sustainability. The research method adopted is qualitative and participatory based on focus groups. Two groups were interviewed: eight AE design firms and six developers and/or construction companies. Analysing the research findings, the sources of challenges that were identified are the lack of definition and communication about the stakeholders' sustainability approach; the lack of a more detailed design scope and required qualifications by the clients, but also the lack of business management and firm's performance evaluation processes by designers; the traditional project delivery systems, traditional work relationships, tools and processes that do not support the collaboration needs. In addition, AE design firms' organization affects the client relationship and design quality including the consideration of sustainability issues in the design solutions. The sources are found in the AE design firm's processes of strategy planning, business and marketing, design, people, and knowledge management. So, further research will be carried out about managerial and organizational capabilities of AE design firms for sustainability and BIM.

1. Introduction

Design is a critical stage when many decisions influencing the building performance are made; it is also instrumental in meeting the project sustainability goals [1]. The design stage has gained complexity due to the diversity of requirements, activities, agents, and tools regarding sustainability. It means more challenges in the interrelationships among the stakeholders, not only in the decision-making processes of each, but in their information exchange and market operation [2].

Frequently, sustainability has been related to technology as design solutions in terms of building and external environment, energy, water and materials efficiency, waste reduction, indoor air quality, thermal comfort, health etc. More often, sustainability is discussed in the sustainability certification context. However, to achieve the sustainability goals, it must be considered that building design is the



result of the interaction among different professionals from different firms. Each firm has its own structure, culture, procedures, and tools creating tensions that should be identified and managed to improve processes and products [3, 4].

Correspondingly to sustainability, Building Information Modeling (BIM) has been often reduced to technology but in terms of software potential as an isolated firm's tool for digital drawings generating information automatically [5, 6]. According to [7] companies, managers, public authorities, researchers etc. have focused most of their attention on technological innovation. They are not very interested in other forms of innovation, such as managerial innovation. However, managerial innovation is the main factor that explains the company's performance.

This paper considers the managerial facet of sustainability and BIM, the importance of managerial and organizational capabilities of the firms involved in the building project and the relation among them. Thus, it aims to investigate the sources of challenges in the relation between architectural and engineering (AE) design firms and clients (developers or private individuals) for promoting sustainability in the building design. Also investigated is if BIM has been implemented by the firms and how it relates to management and sustainability.

2. Literature Review

Relating sustainability to management enables the discussion about how the set of firms' management processes and the relation among the firms affect sustainability in the building design process. [8] categorised the body of knowledge on sustainability integration in management of construction projects into seven dimensions: motivations, stakeholder orientation, organizational context, temporal orientation, benefits, barriers, and risks. This present paper can be associated to the dimensions of motivation (why designers, developers and construction companies take initiatives for sustainability consideration); stakeholder orientation (initiatives of designers and clients for sustainability integration); organizational context, project personnel (how or at what level sustainability integration can happen in an organizational context; personnel or actors that need to be included in the project organization to facilitate the sustainability integration).

Building projects with sustainability goals require a high level of communication, integration, and coordination among the stakeholders [1, 9]. Developers and construction companies define the building project goals and select the AE design firms. A request for proposal (RFP) or request for qualifications (RFQ) is recommended in the selection process providing a clear description of the design services, also addressing the needed qualifications in green design and sustainable design strategies [1, 9]. Then, during the contract stage, an agreement describes the scope of services, roles and responsibilities, payment, insurance, and indemnification, along with other important provisions [1].

In turn, managerial and organizational capabilities of the AE design firms are determinants for meeting the client's needs in terms of design quality and sustainability goals. [10] analysed the influence of environmental sustainability on practices of architectural design, consulting, and construction companies from France. Management information was highlighted by interviewees as essential for developing projects with sustainable requirements. In a study conducted by [11], experience and knowledge of green building, an organizational green culture, and innovation capability were ranked as the most important factors in projects with environmental objectives in achieving higher ratings in Green Mark, a certification system utilized in Singapore.

As stated by [12], sustainability competences have specific roles in the initial inspiration for eco-design, project development and the involvement of stakeholders. In their study, the most apparent competences were related to strategic management and action, diversity, interdisciplinarity, and interpersonal aspects; while systems thinking, foresighted thinking and normative competences were not as recurrent in the research results.

Concerning the relationship among stakeholders, project delivery systems have a key role [1, 9]. [13] found that project delivery systems influence the integration in the project team, affecting the achievement of building sustainability goals. Also, these authors highlighted the owner commitment,

team characteristics, and starting point of stakeholder interaction as relevant aspects to the integration level in the project. They concluded that sustainable strategies increase project complexity and require increased interdisciplinary interaction, early involvement of stakeholders, and communication and collaboration through various methods [13].

[4] demonstrated that the project stakeholders adopt different approaches to sustainability based on their own perceptions about what is considered sustainable and how to achieve it. Those approaches are dynamic and create tensions impacting the initial project goals, project planning and design phases. [3] found that processes in green building projects are influenced by four tensions that can either enhance or hinder collaboration and innovation: strategic–tactical, collaborative–competitive, participative–effective and individual–collective. Those tensions should be managed, contributing to the product and process performance.

According to [14], the motivations that drive architectural designers to engage with sustainable design are mainly autonomous motivations of personal commitment and an ethical imperative, as well as self-identity, pursuit of quality and awareness of the design work impact on people; and the influence of regulation and client demand. Autonomous motivations align with sustainability principles including design for durability, high standards and technical expertise [14].

[15] states that the adoption of sustainable solutions can be stimulated through public policies at the market level that can be positive or negative incentives (penalties and compensations). However, [14] highlight the risks of reliance on extrinsic motivators such as regulation for sustainability promotion: policy inconstancy, minimal requirements compliance, lack of responsibility engagement, restriction of creativity and decrease of autonomous motivations. The authors suggest the importance of engaging professionals, especially designers considered agents of change. According to [16], "... the architectural designer has primary responsibility in guiding clients towards greater environmental sustainability". Yet, this responsibility and the role of sustainability in the firm's business development are not recognized by designers [16].

BIM has a great potential for improving collaboration and design quality, lowering costs, and supporting sustainability; also, a potential to impact companies and firms' performance [9, 17]. However, BIM is not a tool or software, it is a set of interacting policies, processes, and technologies [18]. BIM success depends on how it is understood and implemented by the firms that participate in the building project and the level of collaboration among them. Providing an environment for BIM is essential for achieving its benefits, which means having suitable project delivery systems [13], companies and firms' capabilities in management, people, process, knowledge, and technology. A successful consideration of sustainable aspects in the design solutions depends on this environment and a BIM plan including the modeling of sustainability information (defining what information and its use for simulations) producing the needed evidence according to the building project goals.

3. Research Methodology

The research method adopted is qualitative and participatory based on focus group. Focus group was chosen since a group effect could guide the research to an investigation field expanding the researcher's perceptions from the participants' experience sharing [19, 20]. A focus-group interview is conducted through guided group discussion, question and answer and interactive dialogue with 3 to 12 participants [20]. The present research has followed the stages recommended by [19] for conducting the focus group: planning, participant recruitment, implementation of discussion sessions, data organization, result analysis, final report, and dissemination.

The aims of the focus group were: to encourage the participants sharing design experiences with sustainability concerns; to lead participants reflecting on unfavourable aspects and enablers for sustainability in the building design process; to investigate if there are problems or challenges whose causes are related to design firm's management; to investigate if BIM is being used and whether it relates to the firm management or sustainability.

Two-hour synchronous interviews with one moderator and interviewer, one rapporteur and one observer were conducted using the Zoom platform in August and September, 2021. Two groups were

interviewed: eight AE design firms (GF1) and six developers and/or construction companies (GF2). The firms and companies operate in the building subsector (residential, commercial, industrial and/or social) of Brazil. The participants were selected from the register of the Management Development Program for Design Firms (Research Line of Management Design, Department of Civil Construction Engineering, University of Sao Paulo) and analysed on the website LinkedIn. In addition, in the case of GF2, a ranking of the most active developers and construction companies from the Metropolitan Region of Sao Paulo was consulted (Top Real Estate Award, partnership between the Brazilian Company for Heritage Studies - EMBRAESP and the newspaper O Estado de S. Paulo, Base Year 2020, <https://embraesp.com.br/premios/>).

An unstructured pilot interview was conducted with an architectural firm about sustainability and management identifying a set of questions. Then, the questions were discussed among the researchers, including a professional with focus group experience, deriving four open-ended questions to guide the focus group interviews: (1) When you hear the term “sustainability of design”, what design situations or experiences come to your mind? (2) What aspects do you consider unfavourable for sustainability in the design process? What aspects do you consider enablers for sustainability in the design process? (4) Would you have suggestions for promoting sustainability in the design process?

An online profile questionnaire was also developed on the Google Forms platform collecting the firm’s characteristics. The data were collected from the interview recordings and rapporteur’s and observer reports. Statements and fact checking supported the data analysis; fact checking is the review of the interview or transcripts for accuracy [20]. The statements were formed from the categorization of the participants’ position in the interactive discussion and the recordings were revisited to check the composition of the statements. An online collaborative whiteboard platform called Miro was used to organise and analyse the findings since the interviews also respected the discussion course in the groups, not exactly the four questions above. Although the findings cannot be generalized about the building subsector, the participants have a relevant experience in the market and important research evidence was found and them discussed through the literature.

4. Findings and Discussion

4.1. Characteristics of the groups

The following characteristics were collected from the online profile questionnaire answered by the participants before the interview. Regarding the GF1, six out of eight (6/8) participants are architects while the other two are engineers (civil and electrical engineers respectively); one (1/8) has completed the master’s degree. Half of the participants (4/8) have more than 23 years of design experience while the other half (4/8) have between 7 and 14 years of experience. Except for one participant who is a design coordinator, all the others are firm’s founders. The AE design firms’ characteristics are shown in Table 1. The firms are located in Sao Paulo, but five out of eight (5/8) also operate in other Brazilian states.

Table 1. AE design firms (GF1)

Firms	Design specialty	Years of operation	Number of employees	Market segment	Type of client
1	Architecture, Residential Renovation	2,5	4	R	P
2	Mechanical, Electrical and Plumbing	9	10	R, C, I	D, C
3	Architecture	1,4	2	R, C	P, O
4	Landscaping, Exterior Architecture	20	8	R, C, I, S	P, D, C, O
5	Architecture	26	4	R, C, S	P, D, C, PI
6	Architecture, Design, Illustration	16	3	R, C, I, S	P, D, C, O, PI, B
7	Architecture	7	5	R, C	D, C
8	Mechanical, Electrical and Plumbing	51	20	R, C	D, C

Legend: R – Residential; C – Commercial; I – Industrial; S – Social. P – Private Individuals; D – Developers; C – Construction Companies; O – Other Private Companies; PI – Public Institutions; B – Banking Institutions

In six out of eight (6/8) AE design firms, clients have demanded sustainability aspects in the building design (Table 2). Half of the firms (4/8) have experienced sustainability certification processes, mostly AQUA-HQE, then LEED, Selo Procel or Fitwell. Interesting to notice is that despite having sustainability demands from clients, two (2/6) firms do not have any certification.

All the firms (7/8) have experienced BIM: (3/8) in all the designs; (3/8) in a small part of the designs (25%); (1/8) in half of the designs; (1/8) starting the implementation.

Table 2. Demands of sustainability aspects

Firms	Clients' demands of sustainability
2	Certification - AQUA-HQE, Procel, Edge
3	Natural lighting, cross-ventilation and landscape as a thermal and visual comfort strategy
4	“Unfortunately, we didn't notice a real concern of the clients about the sustainability topic, they just seek meeting the certification requirements”. Main demands: specification of native species with less maintenance, low water consumption and non-invasive; slab use for green roofs; light colors for floors reducing heat emission
5	Water saving, demands related to HVAC, and maintenance in general
7	Waste destination and storage, demands related to energy, construction
8	Management of water and energy, water reuse, consumption measurement, resources use

Regarding GF2, four out of six (4/6) participants have completed a postgraduate level while the other two are civil engineer and business administrator. Except for one participant, who has a 10-year experience in the civil construction field, all the others (5/6) have 20 years or more of professional experience. Over half of the participants are managers (4/6) in the areas of project, business, or quality; while two are a design coordinator and an architect, respectively.

The companies' characteristics (GF2) can be seen in Table 3. They are located in Sao Paulo; two of them also operate in other Brazilian states. Nearly all the companies (5/6) have been demanding sustainability aspects when contracting building designs (Table 3). All the companies have at least one sustainability certification, for example, LEED, AQUA-HQE, Selo Casa Azul CAIXA and Etiqueta PBE Edifica.

N.	Company type	Years of operation	Number of employees	Market segment	Demand of sustainability aspects when contracting designs
1	Developer and construction	35	65	R, C, S	Resources reuse, area for clean transport (bicycle), material reuse during the construction stage
2	Developer	86	20	R, C	-
3	Developer and construction	60	8000	R, C	Resource optimization (expected inputs), demand optimization (for calculations in all disciplines), rationalization in all design disciplines
4	Developer and construction	40	500	R	Rainwater reuse, solar heating, waste selective collection for users
5	Developer and construction	27	300	R	Individualized measurement of water and gas, rainwater reuse
6	Construction	45	2500	C, S	Dimensioning of glass and facades, water reuse, solar energy, air conditioning
<i>Legend:</i> R – Residential; C – Commercial; I – Industrial; S – Social					

Four in six (4/6) companies have employed BIM in a small part (25%) of the building projects; among them, three have employed BIM in the design and construction stages while one has only employed it in the design stage. Two (2/6) companies have not employed BIM in any stage.

4.2. Statements according to the group interviews

The following statements (S) were established from the data analysis of the focus groups GF1 and GF2 for discussion in this paper.

GF1, S1 – Designers expressed a feeling of frustration about how sustainability has been considered in the building design process. At the beginning of the interview, when the participants were asked about situations or experiences regarding “sustainability of design”, the first reaction was “what kind of stories do you want to hear, is it about consulting?”. Among the participants, there was a sense that sustainability is related to marketing purposes in civil construction.

The sustainability concept is not limited to a certification or consulting, it can be understood as an intrinsic aspect of the design building that includes analysis of the location, the climate conditions, the materials needed and the construction process [21]. However, it was found that greenwashing is a present concern leading the designers to question if a certified building is a sustainable building. [21] argued that teaching design incorporating sustainability to architecture students is a challenge, because of “the trend to label every design as sustainable or green even though it is not different from a more traditional one.”

GF1, S2 – The type of client affects how sustainability is considered in the building design process. Two types of clients were found among the AE design firms: developers and private individuals. While the building as a real estate market product is previously defined by developers and then designers develop the design solutions, in the case of private individuals, designers are hired for guiding them in understanding users’ needs, converting the latter into design solutions. The clients’ purposes are different; while developers are concerned about profit margins and risks, private individuals are the end-users concerned about comfort and needs (relation environment-user). Thus, designers have more freedom and power to influence the clients and express creativity in the second situation, including their responsibility in influencing sustainability aspects as pointed out by [16]. In

the first situation, in many cases, designers are limited to product definitions provided by developers in a sequential design process.

That first scenario probably explains the designers' frustration since their motivations towards sustainable design [14] have been affected. That also indicates tensions [3, 4] among designers and developers affecting how sustainability is considered in the design solutions, especially as an intrinsic aspect of the product. In addition, the project delivery system does not seem to provide the suitable needed collaboration for sustainable designs, as remarked by [1, 9, 13].

GF1, S3 – The firm's organization directly and indirectly affects how sustainability is considered in the building design process. It was discussed that a firm's founding architect or engineer has two roles: designer and manager. Usually, AE design firms have a small work structure, and the activities are centralized in the founding figure. Apart from technical knowledge, a firm demands knowledge and efforts in many areas (strategy, marketing, finance, people management etc.); the founder can thus be overloaded if the firm does not have a suitable process organization. The challenge for small design firm owners to accumulate roles was also found in our previous research [22, 23].

According to the participants, time is a critical aspect in the firms; also, there is a lack of training and knowledge management. The firms can be easily affected by the economic scenario, making knowledge loss through dismissals a risk for them. The pandemic scenario was a challenge for the firms: one participant has operated the firm with a reduced structure sharing the physical space with other professionals; one participant stopped signing new agreements to organize the activities in that new scenario; communication and information exchange were affected in one of the firms, management tools and work processes were implemented for meeting needs perceived more clearly due to the pandemic.

The participants highlighted the need for organization and review of management processes in the AE design firms since the firm's managerial context affects the design quality and sustainability. The firm's management should support the sustainable design development through people, time management, training, management knowledge, physical space, agreements and strategy, management tools, work processes etc. Besides, if the sustainability concept is expanded, the conditions in which the design is developed should be questioned.

GF1, S4 – Defining and trusting the strategies is the way. It was pointed out that having strategies in terms of the firm's mission, vision and values can guide the founders and help them to deal with the coexistence of the roles of designer, manager, and entrepreneur. Focusing on the strategies would help the founders spend resources only on what they want without getting into the cycle of running out of time due to demands that are not the firm's core business. It means selling the firm's design process, declining some clients who are not aligned to the strategies, not making sudden decisions that are not profitable in the long-term. This finding corroborates our previous research alerting about the risk of making sudden decisions [22] and providing guidelines on strategic planning [24]. Participating in discussion forums was pointed out as a helpful way for thinking out of the box, making the firm evolve.

GF1, S5 – BIM. The investments' cost was pointed out as a barrier for implementing BIM. Conversely, BIM was recognized by the users as a worthy investment due to its global benefits. [17] found that BIM developmental and operational costs are not equally distributed among the stakeholders, and that architectural firms must bear the majority of the costs and risks related to BIM implementation. According to the author, architectural firms must overcome three BIM barriers: human, infrastructural and business.

A clear relation between BIM and sustainability was not found. As can be seen in this paper, it is important to discuss the lack of management in the firms and stakeholders' conflicts creating a favourable environment for BIM in order to achieve its benefits, including the information modeling for sustainability and performance purposes.

GF2, S1 – Sustainability depends on the building class or interests of the company. It was observed that the way participants expressed themselves about sustainability is related to the building class or interests of the companies they work in. Sustainability was linked to: durability and efficiency in the

case of high-income housing buildings; cost in the context of low-income housing buildings; operation in the company that owns buildings, interested in long term advantages; rationalization indicating interests in financial saving through resource saving, also sustainability certification was linked to sales margin (for example, certification was not understood as a differential by residential building clients, the unit sales did not increase in certified buildings; this is the reason why the company no longer seeks the certification in this segment).

Different approaches to sustainability can be seen among the participants [4]; thus, the company's culture or strategy has an impact on how sustainability is considered in the buildings. It also leads to the question "Is sustainability for everyone?" since sustainability as durability and efficiency seems more present in the case of high-income housing buildings.

GF2, S2 – There is a gap between the product conception and the design stage. As mentioned by GF1, it was also pointed out by GF2 that the building product is previously defined by developers in a sequential process affecting the decision timing and then limiting changes in the design stage. It was argued that designers have a passive behaviour in the relations; also, a lack of qualification, experience, awareness, and training in the AE design firms.

Analysing the participants' speeches of GF1 and GF2, it is not clear if the designers have a passive behaviour because of the lack of freedom in the design activity, prioritizing the developers' demands – also, considering developers and construction companies are big and powerful and it could inhibit the participation of small firms – or if AE design firms are not prepared to meet clients' requirements affecting their position in the building project team. However, that scenario is a point of conflict related to both project delivery systems (sequential process) and communication (a RFP or RFQ could help in the needed qualifications definition, as recommended by [1, 9]).

GF2, S3 – Building design with sustainability certification purposes is more expensive. A participant argued that if sustainability is an intrinsic aspect of the design (design feature), why is it more expensive when the design has certification purposes? Other participants raised the issues of more hours worked and consultants contracting by the AE design firms in the case of a certification. It can be questioned if the AE design firm's activities including those aimed at certification have not been clear to the client (scope of contract) or if the client has depreciated the activities. The clear differentiation between the design solutions development and certification activities are critical in the scope and communication between the stakeholders, avoiding conflicts.

According to a participant, regarding Selo Azul da Caixa, the designers have been familiar with the design solutions adopted and there have not been changes in their activities due to the label. However, as the participant said, there remains the doubt if the solutions are really sustainable. It seems there is a risk of only complying with minimal requirements [14] for meeting, for example, Selo Azul da Caixa which is a government incentive for sustainability in the case of low-income housing buildings. Sustainability was linked to cost by the participant, leaving the question "Can sustainable solutions be implemented through intrinsic goals of the building project without necessarily increasing the design or building cost?".

GF2, S4 – Factors that stimulate sustainability. According to the participants, the following factors stimulate sustainability: the technology advancement becoming more affordable; the appropriate legislation; the demands for the Brazilian performance standard, Selo Azul da Caixa; the subsidies for meeting sustainability requirements.

GF2, S5 – BIM. Although BIM has been considered a trend, its deployment has been modest among the participants, as can be seen in some of their speeches: "we are modeling our part"; "a future that never comes"; "we are starting". Thus, BIM for sustainability was not an issue raised in GF2.

5. Conclusions and Further Research

This paper investigates the sources of challenges in the relation between AE design firms and clients for promoting sustainability in the building design. Analysing the research findings, a source of challenges that could be pointed out is the lack of definition and communication about the stakeholders' sustainability approach bringing them into conflicts or affecting their motivation.

Moreover, the lack of a more detailed design scope and required qualifications by the clients, but also the lack of business management and firm's performance evaluation processes by designers may hinder the relation between them, as well as sustainability promotion.

Some other sources of challenge are the traditional project delivery systems, traditional work relationships, tools and processes that do not support the collaboration needs. Besides, AE design firm organization affects the client relationship and design quality including the consideration of sustainability issues in the design solutions. Analysing the cited challenges by the participants, the sources are found in the AE design firm's processes of strategy planning, business and marketing, design, people, and knowledge management.

Efforts of developers, construction companies and AE design firms are required when implementing sustainable solutions through the intrinsic goals of the building project without necessarily increasing the design or building cost. Those goals cannot be achieved by traditional management solutions. Designers are primarily involved with design solutions influencing clients with technical arguments considering the society's environmental, social, and economic concerns. As the sources of challenges are related to management, further research will be carried out about managerial and organizational capabilities of AE design firms for sustainability and BIM.

Successful BIM implementation and evolution depend on the firm's capabilities in strategy, people, process, information, business management and marketing, finance, and performance evaluation; also, on collaboration and partnership among different firms and companies. Therefore, BIM could be a reason for improving the firm's management processes towards a digital transformation and, consequently, improving the design quality towards sustainability. Although BIM usage is currently modest in the firms and companies, it is important to evolve having a plan and recognizing the challenges in order to achieve more collaborative ways to produce buildings.

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