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Strategies for a Circular Economy in the Construction and Demolition Sector: Identifying the Factors Affecting the Recommendation of Recycled Concrete

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Abstract: With increasing urbanisation, new approaches such as the Circular Economy (CE) are needed to reduce resource consumption. In Switzerland, Construction & Demolition (C&D) waste accounts for the largest portion of waste (84%). Beyond limiting the depletion of primary resources, implementing recycling strategies for C&D waste (such as using recycled aggregates to produce recycled concrete (RC)), can also decrease the amount of landfilled C&D waste. The use of RC still faces adoption barriers. In this research, we examined the factors driving the adoption of recycled products for a CE in the C&D sector by focusing on RC for structural applications. We developed a behavioural framework to understand the determinants of architects' decisions to recommend RC. We collected and analysed survey data from 727 respondents. The analyses focused on architects' a priori beliefs about RC, behavioural factors affecting their recommendations of RC, and project-specific contextual factors that might play a role in the recommendation of RC. Our results show that the factors that mainly facilitate the recommendation of RC by architects are: a senior position, a high level of RC knowledge and of the Minergie label, beliefs about the reduced environmental impact of RC, as well as favourable prescriptive social norms expressed by clients and other architects. We emphasise the importance of a holistic theoretical framework in approaching decision-making processes related to the adoption of innovation, and the importance of the agency of each involved actor for a transition towards a circular construction sector.

Keywords: circular economy; construction and demolition; survey; recycled concrete

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1. Introduction

With around 50% of its population living in cities [1], the world is becoming increasingly urban. While cities produce 80% of worldwide GDP, they also consume 75% of worldwide resources and produce 80% of global CO_2 emissions [2]. Thus, a transition towards urban sustainability is crucial [3,4]. To reduce resource consumption in cities, the Circular Economy (CE) has been proposed as a key concept as it focuses on using resources more efficiently through value retention processes and the minimisation of the amount of waste produced [5]. Although there are multiple strategies that can be implemented for a CE [6], recycling is the strategy that has received the most attention in the CE discourse to date [7].

While transitioning towards a CE requires a holistic and global vision [8], it is fundamental to initiate a discussion based on specific economic sectorial perspectives, in order to trigger causal loops that might pave the way for a global transition. For example, the European Commission [9,10] adopted an action plan to enhance global competitiveness, stimulate sustainable economic growth, and generate new jobs. Eight key product value chains were identified as priorities for accelerating the transition towards circularity. Among these value chains, the Construction and Demolition (C&D) sector is of particular interest, accounting for the highest amount of waste produced worldwide as compared to other economic activities (approximately 35% of the total waste generated in the European Union [11]). Today, cities are keen to learn about eco-innovation that can reduce their environmental impact, but need guidance and knowledge about best practices [12].

As the economy grows and the population increases, so do construction activities. In Switzerland, the construction industry is a "colossal business" [13], with the sector accounting for 50% of total primary energy demand and about 30% of total GHG emissions. In Switzerland, between 70 to 80 million tonnes of construction materials are required annually [13,14], and C&D waste represents the highest portion (84%) of total waste produced. While 75% of excavated materials and about 70% of deconstruction materials are recycled, a substantial amount of deconstruction materials (over 5 million t/a) is still landfilled or incinerated [13]. It seems clear that the recycling of C&D waste can be further enhanced.

C&D waste can be defined as a mixture of surplus, damaged products, and materials issuing from the construction, refurbishment, and demolition processes [15]. C&D waste recycling is receiving increased attention in Switzerland [16,17], not only for mitigating primary mineral resource depletion and associated environmental supply chain impacts (e.g., [18,19]), but also for minimising C&D waste streams to landfills [20–22]. In Switzerland, the problem is mainly related to the limited discharge volume: the procedure for opening a landfill site might require up to 10–20 years [23].

For inert waste that contains concrete, the use of recycled concrete aggregates (RCA) coming from C&D waste for producing recycled concrete (RC) is considered an important strategy to reduce the environmental impact of the C&D sector. In addition to other possible partial replacements for natural aggregates (NA) (e.g., asphalt, glass, tile, ceramics; [24,25]), the use of RCA is proposed as an alternative in road and building construction activities where concrete is used [26–28]. RC shows properties similar to concrete produced from NA [29,30], and can be used for most building applications [31–33]. Life Cycle Assessment studies [34] have shown that a lower environmental impact is associated with the use of RC (the reduction mostly deriving from the avoidance of natural aggregates extraction and diversion from landfills). In spite of this suitability, RC is still underutilised, and the reasons for its slow adoption rate by agents warrants further elucidation.

The recommendation and widespread use of RC still face adoption barriers [35,36]. To design interventions aimed at promoting behavioural change, it is pivotal to understand the agents' decision-making processes for choosing construction materials, and all of the factors that may foster or hinder the adoption of more sustainable alternatives. In fact, a growing interest in the social dimension of the transition towards a sustainable/circular C&D sector and in the role of agents has emerged, putting human needs, motivations, values, preferences and behaviour at the centre of system change [37–40]. Key concerns about concrete recycling are related to economic factors, policies and strategies, government support, certification of recycled materials, clear quality standards, planning of demolition projects, the availability of suitably-located recycling facilities, the cheap cost of landfill disposal as an alternative to recycling, and, most importantly, education and information [35,41,42]. The negative connotations associated with "waste" and a lack of sufficient knowledge about the environmental impact and technical properties of RC (as compared with conventional concrete) represent additional significant barriers. In Switzerland, evidence about the barriers to the recommendation and use of RC come from several cantons. For example, in the Canton of Geneva [43], inert materials are not sufficiently recycled or valorised due to the lack of experience in the domain and the absence of adequate organisation of the recycling chain. Moreover, the actors do not appear psychologically ready to follow this path. In the Canton of Vaud [44], the advantages of the use of RC in terms of sustainable development are often opposed by certain professional users (e.g., architects, engineers, entrepreneurs). In the Canton of Zurich, it is a major difficulty to convince the numerous actors involved in the C&D sector that the use of recycled materials in concrete meets safety requirements and the need for aesthetic appeal [12,45].

A better understanding of the specific factors that affect the decision of actors to recommend the use of RC is required. An encompassing behavioural model combining "personal-sphere" elements [46] with elements of (technological) innovation adoption theories (e.g., [47]) seems suitable for such an analysis. To our knowledge, such an approach is missing, particularly in enquiring about the topic of circular materials recommendations in the construction process. There is a need for a holistic understanding of the adoption process to foster discussion and reflection on potential interventions.

For the use of RC, [48] identified the key actors involved in the selection of materials in structural engineering in Switzerland: awarding authorities, structural and civil engineers, architects and contractors. Since these actors could strongly influence and be influenced by others, any change in their behaviour would greatly influence the system. Architects appear to be key in the stakeholder interaction chain of the building design process, when submitting proposals and delivering recommendations on project specifications. At the stage of project design, the most influential factors for an architects' decisions to recommend the use of RC are the recommendations of engineers, the expected costs, and the aesthetic aspects [41]. However, previous studies have been performed using a limited number of potentially influencing factors, administrating a questionnaire to weight the criteria and alternatives per criterion in pair-wise judgements, and analysing results based on a limited number of cases. A behaviour reporting study, encompassing the potential effect of more factors and considering a broader sample, would add insights to existing studies from the previous decade.

The remainder of the paper is structured as follows. Section 2 presents the aims of the study and the hypotheses derived from the information available in the pertinent literature. Section 3 describes the theoretical background that represents the basis for the development of the framework, and the framework itself. Section 4 presents the methodology. Section 5 reports the results. Section 6 presents the discussion, limitations of the research, and avenues for further investigation. Section 7 concludes.

2. Study Aims and Hypotheses

The goal of this study is to develop, operationalise, and apply a framework in order to identify and analyse the factors that affect the decision of architects to recommend the use of RC. In doing so we contribute to supporting the implementation of recycling strategies for a CE in the C&D sector. We explore a priori beliefs associated with RC, and the factors that lead architects to recommend RC in their projects. The research questions addressed are:

- How do the beliefs of architects with prior knowledge of RC differ from those of architects with no knowledge of RC?
- What are the behavioural drivers affecting the choice to recommend RC?
- Which contextual factors affect the recommendation of RC by architects?

In the introduction, we highlighted the literature reporting on the major barriers to the use of recycled construction materials, and specifically, to the recommendation of RC. Based on this information, five main hypotheses can be developed about the factors influencing the decision of architects to recommend RC.

Hypothesis 1 (H1). *Based on [35,41–43], it is expected that a higher degree of knowledge of RC will be a predictor of architects' recommendation of RC.*

Hypothesis 2 (H2). *Based on [35,41,42,49], it is expected that believing that the use of RC will not increase the cost of the project will be a predictor of architects' recommendation of RC.*

Hypothesis 3 (H3). *Based on [34], it is expected that believing that RC has a lower environmental impact in comparison with conventional concrete will be a predictor of architects' recommendation of RC.*

Hypothesis 4 (H4). *Based on [44,49], it is expected that possessing stronger environmental values will be a predictor of architects' recommendation of RC.*

Hypothesis 5 (H5). *Based on [41,48], it is expected that prescriptive social norms will be influential in the recommendation of RC.*

In addition to testing these hypotheses, we also perform additional explorative analyses, based upon additional data gathered on multiple factors that could potentially influence architects' decisions to recommend RC.

3. Theoretical Background

Manifold behavioural decision-making theories and models have been developed to increase our understanding of the determinants and processes influencing an actor's decision to perform specific behaviours [50], and to help enhance pro-environmental behaviours [49,51]. Yet, no specific behavioural model has been proposed for enquiring into the choice of recommending RC in construction projects. Our conceptual framework that guides the study of architects' behaviour of recommending RC is based on the integration of existing frameworks in psychology and management, which encompass the key elements playing a role in the decision-making process of architects as a subsystem of the larger construction system.

The inspiration for the presented framework stems from the integrative agent-centred (IAC) framework [52], which has already integrated Structuration Theory (ST; [53]) and the Theory of Interpersonal Behaviour (TIB; [54]). We also found inspiration in the work of Ajzen's Theory of Planned Behaviour (TPB; [50]), which has been widely deployed for predicting pro-environmental behaviour at an individual level [55]. Although TPB helps to explain fundamental patterns of behaviour, it should be adapted for specific purposes and contexts [49]. Since our focus is on the recommendation of a specific material that entails environmental benefits, we also consider the theoretical perspective of Rogers' adoption of innovation [56]. The first two approaches (IAC and TPB) offered a complementary basis and enhanced the consideration of the adoption process as a decision process, while the latter approach aided in integrating a perspective that is more focused on the peculiarities of the innovation. In Appendix A, we introduce each theoretical perspective, and how it is integrated into the theoretical framework (A more exhaustive presentation of Giddens' ST and Triandis' TIB can be found in [52]).

In the conceptual framework (Figure 1), an agent's decision to implement a behaviour is influenced by external and internal drivers. The external drivers consist of contextual factors (such as facilitating conditions or barriers), and of the behaviour that is performed by actors in the social network. The internal drivers relate to habit (i.e., the frequency of past behaviour), subjective cultural factors (social norms, roles, and values), socio/demographic attributes (e.g., age), perceived behavioural control (i.e., the perception of the degree of difficulty in performing the behaviour), and attitude (beliefs about the outcomes of the behaviour, risk propensity in performing the behaviour, and knowledge about the behaviour and its object). The agent's behaviour entails consequences that trigger a feedback loop towards internal and external behavioural drivers, which thus influences future decisions. A brief explanation of the framework components is provided in the following paragraphs.

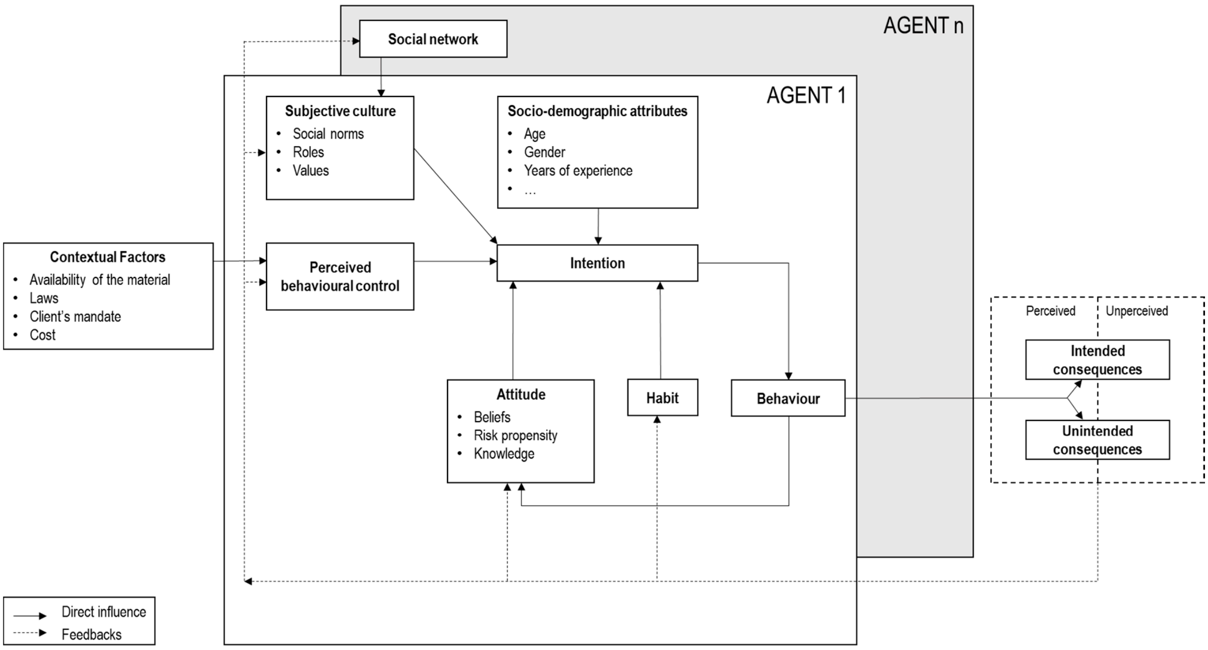

Figure 1. Framework integrating the factors potentially affecting the intentions to recommend recycled concrete (RC) and corresponding behaviour in their construction projects (based on [52]).

Intentions to perform a given behaviour are an indication "of how hard people are willing to try [. . .] in order to perform a given behaviour" [50]. Intentions can lead to the implementation of the behaviour if the agent has the possibility of doing so, i.e., if the agent "can decide at will to perform or not perform the behaviour" [50]. Research focused on the intention-behaviour gap is vast and sometimes mixed (e.g., [57–60]). Previous studies have reported positive relationships between behavioural intention and actual behaviour in the construction sector [49,61]. Research findings also acknowledge that in certain cases, reported intentions to perform a behaviour may be influenced by socially desirable responses or tendencies to give answers that align with perceived social expectations [62–64]. Therefore, in our framework, we consider that the intention to recommend RC leads to the implementation of the behaviour (recommending RC) when the opportunity is present. For this reason, we collect data on the performed behaviour, and consider it a dependent variable in the statistical analyses.

Contextual factors refer to objective factors present in the outside environment "out there" [54], that can be considered either as a facilitating condition or as a barrier. Examples of contextual factors in the case of an architect's behaviour are the legislative context and existing laws, i.e., whether there is any law or regulation that enforces or bans the use of a certain material, and the client's mandate, i.e., whether or not the use of the material is required by the client through the contract.

Socio-demographic attributes of architects (respondents) considered in this study are: age, gender, company size, country of study, job position, years of experience, and the number of projects per year.

Subjective culture refers to a "human group's characteristic way of viewing the human-made part of the environment" and "consists of ways of categorising experience" [54]. In the framework, it consists of social norms, roles and values. Norms are considered to be "*self-instructions to do what is perceived to be correct and appropriate by members of a culture in certain situations*" [54]. They are globally measured by asking respondents to rate the degree to which "significant others" would approve or not of their performance of a particular behaviour (prescriptive social influence). They can refer to what others think one ought to do. In this project, respondents are asked, for instance, if people who are important to them think that they should recommend RC in their construction projects, or whether it is expected that they know the content of the SIA (Swiss Society of Engineers and Architects) [28] norms in relation to RC when recommending the use of RC in their construction projects. Roles are "concerned with behaviours that are considered correct or appropriate for persons holding a particular position in a group, society or a broader social system" [54]. For example, in the specific case of architects, respondents are asked if their role as architects is to fulfil the client's demands even in cases where there is disagreement, or if it is their role to consider environmental issues when recommending the use of construction materials. Values are "relationships among abstract categories with strong affective components, implying a preference for a certain kind of action" [54] (e.g., conservation or preservation of the environment, concern about environmental issues).

Perceived behavioural control (PBC) refers to how easy or difficult an individual perceives the implementation of a certain behaviour to be [50]. PBC can change based on the situation and action. In our research, as an indicator of PBC, respondents are asked to evaluate how easy or difficult they perceive the action of recommending RC to be.

Attitude is developed by individuals based on their beliefs about the behaviour, and about the object of the behaviour (in this case, RC). In order to form a belief about an object, an individual correlates the object with particular attributes (e.g., with other objects, features or situations). An attitude towards a certain behaviour refers to the level to which an individual has a positive or negative assessment of the concerned behaviour. Attitude is "an idea, charged with affect, that predisposes a set of actions to a particular set of social situations" [65]. Beliefs correspond with the anticipated consequences of an act, their incidence (i.e., probability of occurring) and their value. Within the frame of this case study, beliefs considered can relate to the perceived environmental impact associated with RC, and to the technical properties (durability) of RC (see for instance [66,67] for perception of relative benefits and costs in the context of waste management infrastructure use). Risk taking [68] and knowledge can be linked to shaping attitude [69]. It is expected that individuals who are risk takers would be more likely to recommend a new material as compared to individuals that are less likely or less willing to take a risk. In our framework, knowledge is deemed as shaping attitudes by facilitating development of informed opinions about beliefs (see for instance [70,71] in the context of the waste management infrastructure use).

A **habit** is established when a behaviour is repetitively performed. Subsequent behaviour occurs at least in part because of habit. Habits can be determined by how frequent a behaviour takes place, by the subject's judgments of how likely a behaviour will happen in dissimilar types of situations, and by their response to how recurrently he or she has carried out something [54]. Habits are measured in this project by asking the individuals (respondents) about the number of projects in which they have recommended the use of RC in the last five years.

Consequences refer to the result or effect of a behaviour [54]. Consequences trigger a feedback loop that affects the individual who has performed the action, but also external agents (conceptualised as the social network). In our case, consequences are assessed by asking architects whether they had a positive/negative experience associated with the recommendation of RC, and whether they received positive/negative feedback from other stakeholders.

Social networks are seen as affecting intentions by means of descriptive social influence (what others do), [72–74] and the relative influence that the behaviour of others has on the agent. In Giddens' words, "the reflexive monitoring of activity is a chronic feature of everyday action and involves the conduct not just of the individual but also of others" [53]. Considering the choices made by architects, the fact that other architects or experts are inclined to select a certain material could have an impact on the actor's own decision. The interactions among agents can occur in either a direct or an indirect way. Direct interactions are dependent upon the agents' network (e.g., extension, density, and heterogeneity). Indirect interactions occur as consequences of behaviour, which can accumulate at the following upper hierarchical level, and be regarded and redefined by singular agents [52].

4. Methods

In this section, we describe the main steps of the research design, followed by the presentation of the content of the questionnaire and the description of the statistical analyses that were conducted.

4.1. Transfer and Operationalisation of the Framework

The framework (Figure 1) was operationalised through a literature review and semi-structured interviews. Thereby, as a first step, for each framework component, a set of variables for operationalising the concept was selected in a literature review. In a second step, we performed 16 semi-structured expert interviews with architects working in Switzerland (details about the interviewees are summarised in Appendix B). During the interviews, the framework itself was first validated. The variables potentially influencing the studied behaviour (e.g., the belief that the use of RC would imply an increase in the cost of the project) were associated with the framework components (e.g., beliefs). In Appendix C, we report examples of interview extracts that were associated with the components of the framework. The interviews helped to transfer the general framework developed by [52] to the decision-making process on the recommendation of RC in Switzerland (e.g., specific labels and building regulations). The interviews were performed in person or on the phone in English, Italian or French. They lasted for approximately one hour, and were transcribed, translated to English, and coded with the MAXQDA software.

4.2. Questionnaire

The selected variables were measured through a structured questionnaire. The aim of the questionnaire was to collect three main types of data: (i) the a priori beliefs of architects about RC with no prior knowledge of RC; (ii) behavioural factors influencing the decision to recommend RC; (iii) contextual factors specific to construction projects in which RC was, or was not, recommended.

The questionnaire consisted of open and closed questions, multiple-choice questions and scales. The questionnaire was pre-tested with eight architects and then submitted to the ethical committee of the research institute which approved the questionnaire and the process of obtaining the potential respondents' contact information.

The main sections of the survey covered:

- Socio-demographic variables (e.g., age, gender, country of study, job title);
- Questions on the perceived role of the architect in the construction process, on environmental values, and on the propensity to take risks by recommending materials that were not previously used by the architect;
- A self-assessment on knowledge about the materials;
- Asking if the architect has ever recommended RC;
- Questions on beliefs associated with RC;
- Questions about contextual factors related to the last project in which RC was or was not recommended by the architect.

4.3. Survey

The contact information for the potential respondents was gathered through Swiss databases of architects' associations that are publicly available online (only architects at least 18 years old were selected). The databases had national coverage and their integration led to a list of 7804 potential respondents. The survey was prepared via Qualtrics software. Individual links for participation to the online survey were sent via email, and invited persons had the option of responding in English, French, German or Italian. The survey was conducted between September and October 2020. Participation in the survey was voluntary, the anonymity of the respondents was guaranteed, and no financial compensation was paid. Respondents could start the survey and save their progress in order to complete the questionnaire within the deadline fixed by the researchers.

750 people completed the survey. Some participants were excluded from the data analyses if, for instance, they were not working in Switzerland. As a result, 727 participants with valid responses were considered for the data analysis, including 314 who completed the German version, 262 the French version, 124 the Italian version, and 27 the English version. The number of interpretable responses varied between the survey items because some items included the option "Prefer not to reply" or "I don't know", which were considered as missing entries.

The coverage of the Swiss cantons based on the location where the surveyed architects work (even partially) on construction projects is shown in Figure 2. The only canton from which we did not receive any replies was Obwalden (which is one of the smallest Swiss Cantons as it accounts for only approximately 0.4% of the Swiss population).

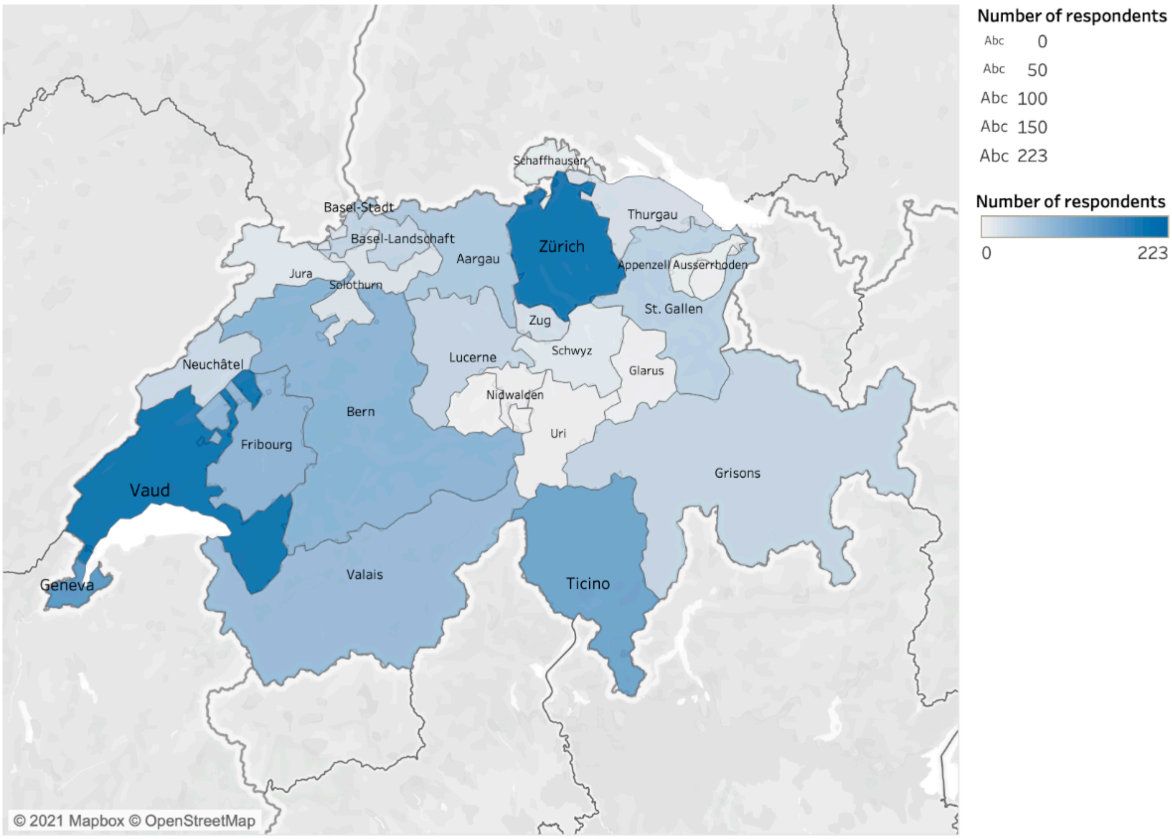

Figure 2. Geographical coverage/distribution of the survey respondents. Only the Canton of Obwalden was not covered. Minimum number of respondents per canton = 2 (Cantons of Glarus and Appenzell Innerrhoden); Maximum number of respondents per canton = 223 (Vaud).

The independent variables used for the statistical analyses and their description are reported in Table 1. In Tables 2 and 3 we report, respectively, the profiles of the categorical and continuous variables (full sample). The gender distribution of the participants was 80.6% males, 18.4% females, and 1% preferred not to reply. The average age of the participants was 50.3 years (median = 50, min = 18, max = 85, SD = 10.99). Among the respondents, 82.1% had obtained their highest architectural degree in Switzerland, and 17.9% in another country. 69.3% had a senior position. 52.8% of the respondents had more than 20 years of professional experience as an architect, and 41.4% worked on more than five construction projects per year. 28.2% of the respondents had no prior knowledge about RC. 61.5% of the respondents with at least basic knowledge about RC (n_{tot} = 522) had recommended RC at least once in their construction projects in the last five years.

Table 1. List and description of the independent variables considered for the analyses, and to which component of the framework they refer to.

Framework Component	Variable	Description
Socio-demographic attributes	Age	Respondent's age in years
	Gender	0 = Male; 1 = Female
	Company size	Number of employees of the company where the respondent works 0 = $\leq$10; 1 = >10
	Country of study	Country where the respondent obtained the highest architectural degree 0 = Switzerland; 1 = Other
	Senior position	1 = Senior position; 0 = Other
	Years of experience	0 = $\leq$20 years; 1 = >20 years
	Number of projects/year	0 = $\leq$5; 1 = >5
Subjective culture	Perceived role: client's demand	"My role as an architect is to fulfil the client's demands, even in the case of disagreement". 5-point Likert scale: 1 = Strongly agree, 5 = Strongly disagree
	Perceived role: Environmental issues	"When working on a construction project and recommending the use of construction materials, it is my role as an architect to take environmental issues into account". 5-point Likert scale: 1 = Strongly agree, 5 = Strongly disagree
	Perceived role: Minimal requirements	"When choosing construction materials, it is my role as an architect to comply with the minimal technical requirements with no need to go beyond that". 5-point Likert scale: 1 = Strongly agree, 5 = Strongly disagree
	Values: Environment as an important value	"The preservation of the environment is an important value for me". 5-point Likert scale: 1 = Strongly agree, 5 = Strongly disagree
	Values: Concern about the environment	"I find it hard to get concerned about environmental issues". 5-point Likert scale: 1 = Strongly agree, 5 = Strongly disagree
	Social norm: recycled concrete (RC) recommendation	"Most people who are important to me think that I should recommend Recycled Concrete in my construction projects". 5-point Likert scale: 1 = Strongly disagree, 5 = Strongly agree
	Social norm: SIA norms	"It is expected from me to know the content of the SIA norms on Recycled Concrete when recommending the use of Recycled Concrete in my construction projects. 5-point Likert scale: 1 = Strongly disagree, 5 = Strongly agree
	Prescriptive social influence: Architects	Ratio of the professional network of architects that has recommended using RC. (0; $\frac{1}{4}$; $\frac{1}{2}$; $\frac{3}{4}$; 1)
	Prescriptive social influence: Building engineers	Ratio of the professional network of building engineers that has recommended using RC. (0; $\frac{1}{4}$; $\frac{1}{2}$; $\frac{3}{4}$; 1)
	Prescriptive social influence: Construction companies	Ratio of the professional network of construction companies that has recommended using RC. (0; $\frac{1}{4}$; $\frac{1}{2}$; $\frac{3}{4}$; 1)
	Prescriptive social influence: Policy makers	Ratio of the professional network of policy makers that has recommended using RC. (0; $\frac{1}{4}$; $\frac{1}{2}$; $\frac{3}{4}$; 1)

Table 1. *Cont.*

Framework Component	Variable	Description
	Prescriptive social influence: Researchers	Ratio of the professional network of researchers that has recommended using RC. (0; $\frac{1}{4}$; $\frac{1}{2}$; $\frac{3}{4}$; 1)
	Prescriptive social influence: Suppliers	Ratio of the professional network of suppliers that has recommended using RC. (0; $\frac{1}{4}$; $\frac{1}{2}$; $\frac{3}{4}$; 1)
	Prescriptive social influence: Clients	Ratio of the professional network of clients that has recommended using RC. (0; $\frac{1}{4}$; $\frac{1}{2}$; $\frac{3}{4}$; 1)
Social network	Descriptive social influence: Influence of other architects' behaviour	"If other architects recommend the use of Recycled Concrete, this would influence my decision to recommend Recycled Concrete in my projects". 5-point Likert scale: 1 = Strongly disagree, 5 = Strongly agree
	Descriptive social influence: Behaviour of architects	Percentage of the architects in the professional network that have recommended RC in their projects.
Attitude	Risk propensity: New materials	"I like to innovate and recommend the use of construction materials that I have not used before". 5-point Likert scale: 1 = Strongly disagree, 5 = Strongly agree
	Risk propensity: Client's request	"It is ok for me to recommend construction materials, even if they differ from the original client's request. 5-point Likert scale: 1 = Strongly disagree, 5 = Strongly agree
	Belief environmental impact	"How much higher or lower is the environmental impact of RC, if compared to conventional concrete?" 5-point Liker scale 1 = Much higher, 5 = Much lower
	Belief company benefit	"My decision to recommend Recycled Concrete might benefit my company". 5-point Likert scale: 1 = Strongly disagree, 5 = Strongly agree
	Belief durability properties	"The technical properties (durability) of RC, in comparison to conventional concrete, are overall: 5-point Likert scale: 1 = Much worse, 5 = Much better
	Belief delays	"The use of RC in the construction of a building would delay the construction process". 5-point Likert scale: 1 = Strongly agree, 5 = Strongly disagree
	Belief cost	"The use of RC in the construction of a building would increase the cost of the construction project". 5-point Likert scale: 1 = Strongly agree, 5 = Strongly disagree
	Belief impact aesthetics	"The use of RC in the construction of a building would compromise the aesthetic of the building". 5-point Likert scale: 1 = Strongly agree, 5 = Strongly disagree
	Self-assessed knowledge	Level of knowledge about RC. 1 = No knowledge, 2 = Basic Knowledge, 3 = Good knowledge
	Knowledge of Minergie	Level of knowledge about the Minergie label 5-point Likert scale: 1 = Very low, 5 = Very high
	Visual knowledge	Events in which the architect has seen concrete, knowing that it was RC 0 = Never, 1 = at least once
	RC-related events	RC-related events that took place in the last year (distance < 50 km) 0 = $\leq$1, 1 = >1

Table 1. *Cont.*

Framework Component	Variable	Description
Perceived behavioural control	PBC: Difficulty of the task	"I feel that recommending the use of Recycled Concrete in my construction project is a difficult task. 5-point Likert scale: 1 = Strongly agree, 5 = Strongly disagree
	PBC: Need for external approval	"Even if I wanted to recommend Recycled Concrete, I would need the approval of other experts". 5-point Likert scale: 1 = Strongly agree, 5 = Strongly disagree
Consequences	Propensity to recommend RC again	"I have recommended the use of RC but I will never do it again". 5-point Likert scale: 1 = Strongly agree, 5 = Strongly disagree
	Feedback on the recommendation of RC	Type of overall feedback received by other architects, engineers, construction enterprises, policy makers, researchers, suppliers, clients, other (e.g., specialised journals) 5-point Likert scale 0 = no feedback, 1 = definitely negative, 5 = definitely positive
Contextual factors	Building typology	Typology of the construction 0 = Residential Building; 1 = Other
	Awarding authority	Typology of the awarding authority 0 = Public; 1 = Private
	Cost of the project	Overall budget of the construction project 0 = ≤1 MioCHF; 1 = >1 MioCHF
	Consideration of environmental labels	Whether a label implying environmental targets was considered in the context of the construction project. 1 = Yes; 2 = No
	Price difference	Approximately how much higher or lower (in%) was the price of RC, compared to conventional concrete? 11-point Likert scale 1 = More than 45% lower, 11 = More than 45% higher
	Suppliers	Number of suppliers producing RC within a radius of 25 km from the construction site, if any. Na = 0, 0 = 1, 1 = >1

Table 2. Descriptive statistics of independent categorical variables (full sample). For each variable, the percentages of each category and number of observations are reported.

Variable	N	Distribution of Full Sample
Gender	720	
Male		586 (81.4%)
Female		134 (18.6%)
Company size	727	
≤10		460 (63.3%)
>10		267 (36.7%)
Country of study	727	
Switzerland		597 (82.1%)
Other		130 (17.9%)
Job position	727	
Senior position		504 (69.3%)
Other		223 (30.7%)
Years of experience	727	
≤20 years		343 (47.2%)
>20 years		384 (52.8%)
Number of projects/year	727	
≤5		426 (58.6%)
>5		301 (41.4%)
Visual knowledge	522	
Never seen RC		332 (63.6%)
RC seen at least once		190 (36.4%)
RC-related events	522	
≤1		320 (61.3%)
>1		202 (38.7%)
Building typology	740	
Residential		370 (50%)
Other		370 (50%)
Awarding authority	603	
Public		239 (39.6%)
Private		364 (60.4%)
Cost of the project	748	
≤1 MioCHF		159 (21.26%)
>1 MioCHF		589 (78.74%)
Consideration of environmental labels	655	
Yes		159 (24.3%)
No		496 (75.7%)
Suppliers	264	
1		112 (42.4%)
>1		152 (57.6%)

4.4. Statistical Analyses

We first compared the respondents with and without prior knowledge of RC in terms of socio-demographic attributes and beliefs associated with RC by performing the Two-sample Wilcoxon rank-sum (Mann-Whitney) test for continuous variables and the Chi2 test of independence for categorical variables.

Subsequently, the recommendation of RC in construction projects was defined in probabilistic terms, by specifying a logistic regression equation. The general logistic model was specified as follows (Equation (1)).

$$\ln\,[\mathrm{P}/1 - \mathrm{P}] = \beta_0 + \beta_{1\,\times\,1} + \beta_2 X_2 + \ldots\ \beta_k X_k \quad (1)$$

where:

- P is the probability of the outcome (the recommendation of RC);
- β_0 is the intercept term;
- $\beta_1, \beta_2, \ldots\ \beta_k$ are the coefficients associated with each explanatory variable

- X_1, X_2, ... X_k are the explanatory variables. The subscript k denotes the k-th variable in the model [75].

Table 3. Descriptive statistics of independent continuous variables (full sample). For each variable, mean, standard deviation, and number of observations are reported.

Variable	N	Mean	SD
Age	727	50.3	10.99
Perceived role: client's demand	721	2.48	1.13
Perceived role: environment	725	4.49	0.79
Perceived role: minimal requirements	720	3.61	1.25
Environment as an important value	725	4.66	0.60
Values: Concern about the environment	724	4.37	0.91
Social norm: RC recommendation	427	3.18	1.04
Social norm: SIA norms	509	3.58	1.34
Prescriptive social influence: Architects	522	16.43	24.38
Prescriptive social influence: Building engineers	522	26.25	30.57
Prescriptive social influence: Construction companies	522	10.44	21.55
Prescriptive social influence: Policy makers	522	12.64	24.90
Prescriptive social influence: Researchers	522	12.79	27.20
Prescriptive social influence: Suppliers	481	6.34	18.90
Prescriptive social influence: Clients	522	9.58	20.47
Descriptive social influence: Influence of other architects' behaviour	471	2.91	1.06
Descriptive social influence: Behaviour of other architects	245	28.87	24.26
Risk propensity: New materials	725	3.58	0.98
Risk propensity: Client's request	725	4.11	0.86
Belief environmental impact	646	3.84	1.13
Belief company benefit	635	3.16	1.00
Belief durability properties	595	2.86	0.53
Belief delays	594	3.81	0.94
Belief cost	603	3.12	1.07
Belief impact aesthetics	645	3.81	0.96
Knowledge of Minergie	522	2.61	1.17
Self-assessed knowledge of RC	727	1.81	0.58
Perceived behavioural control: Difficulty of the task	502	3.21	1.04
Perceived behavioural control: Need for external approval	515	1.84	0.96
Reticence to recommend RC again	295	1.51	0.84
Feedback on the recommendation of RC	195	3.62	0.68
Price difference	655	6.75	1.27

Only data on the respondents that reported having at least basic knowledge of RC was used for this step. The possible outcomes of the logistic regression were coded as 0 ("never recommended RC"), and 1 ("recommended RC at least once in the last five years"). To select the variables to input into the regression model, we performed bivariate analyses to compare, for each variable, the groups of architects that had never recommended RC with those that had recommended RC at least once in the last five years. Only the variables whose values were significantly different between the two groups were input into the regression model (Appendix D, Tables A3 and A4). The regression allowed for quantification of the influences of the selected variables on the architects' decisions to recommend RC, and to test their significance. Since some of the "I don't know" answers led to missing data, we performed a multivariate sequential imputation (35 imputations, predictive mean matching (pmm); random-number seed 1234; K-nearest neighbour (knn) = 5 [76]).

Finally, we analysed the importance of contextual factors in the decision to recommend RC. In this case, we focused on specific projects. We used the data we had collected by asking each respondent to provide information about the last project in which he/she had recommended RC, and the last project in which he/she had not recommended RC. Hence, in some cases, the respondent provided information regarding both cases. We retained only those cases in which the number of RC suppliers was non-zero. We performed a bivariate analysis to select those variables whose values were significantly different between the groups (cases in which RC was recommended and cases in which RC was not recommended; Appendix E, Table A5). We performed a logistic regression with the selected variables. All statistical analyses were performed using STATA 16.1.

5. Results

5.1. Differences Relating to the Level of Knowledge

The profiles of the respondents in terms of their age and their beliefs associated to RC, based on their level of knowledge of RC (Not knowledgeable, i.e., with no prior knowledge of RC, and Knowledgeable, i.e., with at least basic knowledge of RC) are reported in Table 4.

Table 4. Profiles of respondents for the full sample and for the 2 subsamples (Not knowledgeable/Knowledgeable) for continuous independent variables. All items use a 5-point Likert scale. The scales are also reported in Table 1.

	Distribution of Full Sample		Distribution of Subsamples				Wilcoxon Rank-Sum (df = 1)
			Not Knowledgeable		Knowledgeable		
	Mean	SD	Mean	SD	Mean	SD	
Age	**50.3**	**10.99**	**48.84**	**11.75**	**50.82**	**10.64**	**z = −2.343, $p < 0.05$ ***
Beliefs							
a. Environmental impact	3.84	1.13	3.80	1.09	3.86	1.15	z = −0.967, $p = 0.033$
b. Company benefit	3.16	1.00	3.23	1.05	3.14	1.00	z = 0.941, $p = 0.347$
c. Durability properties	**2.86**	**0.53**	**2.95**	**0.45**	**2.83**	**0.54**	**z = 2.351, $p < 0.05$ ***
d. Increased delays	**3.81**	**0.94**	**3.43**	**0.97**	**3.91**	**0.90**	**z = −4.992, $p < 0.001$ *****
e. Higher costs	**3.12**	**1.07**	**2.84**	**1.01**	**3.20**	**1.08**	**z = −3.264, $p < 0.01$ ****
f. Impacted aesthetics	3.81	0.96	3.71	1.00	3.84	0.95	z = −1.359, $p = 0.174$

Variable a. uses the scale: 1 (Much higher)–5 (Much lower). Variable b. uses the scale: 1 (Strongly disagree)–5 (Strongly agree). Variable c uses the scale: 1 (Much worse)–5 (Much better). Variables d, e, f use the scale 1 (Strongly agree)–5 (Strongly disagree). Responses from the "I don't know" category were excluded. Significance levels *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$. Variables for which significant differences were found are reported in bold.

The two groups (architects knowledgeable and not knowledgeable about RC) differed significantly from each other regarding their age and their beliefs about the durability properties of RC, the expected increased delays when using RC, as well as the potential higher costs incurred from the use of RC in the construction project. Overall, architects knowledgeable about RC tended to be older. They also tended to have a slightly worse opinion about RC durability properties. Finally, they tended to consider increased delays and higher costs as less problematic in cases where RC was used.

5.2. Behavioural Factors

In Table 5, we present the results of the logistic regression and the variables that had a significant impact on the recommendation of RC (in bold). The overall model achieved a large predictive power with Pseudo R^2 of 75%. The results showed that six factors had a positive and significant influence on the decision of architects to recommend RC in their construction projects. These factors were: (i) a senior position; (ii) knowledge about the Minergie label [77]; (iii) visual knowledge of RC (having seen RC at least once); (iv) believing that the environmental impact of RC is lower than the impact of conventional concrete; and prescriptive social influence by (v) other architects and (vi) by clients. Hence, hypothesis 1, 3 and 5 were confirmed. The strongest factors were knowledge about the Minergie label (Standardised $\beta = 7.067$) and visual knowledge (Standardised $\beta = 3.597$). In Appendix F, we report the plots of the predictive margins associated to the six variables found to be significant through the logistic regression model. Among the non-significant variables, there were also predictors hypothesised to be relevant through the remaining hypotheses. In fact, environmental values and beliefs about the increased cost of the project if RC was used were not found to be significant. Notably, the latter was not used in the regression since no significant difference in the bivariate analysis was found (Appendix D, Table A3). Therefore, hypotheses 2 and 4 were refuted.

Table 5. Results of the logistic regression including behavioural factors affecting the recommendation of RC in construction projects, $n = 522$.

	β	SE	Standardised β	t	Sig.	(95% Conf. Interval)	
Age	−0.034	0.028	−0.738	−1.21	$p = 0.225$	−0.088	0.021
Company size	0.247	0.476	0.247	0.52	$p = 0.603$	−0.685	1.179
Senior position	**1.729**	**0.563**	**1.592**	**3.07**	**$p < 0.01$ ****	**0.625**	**2.833**
Years of experience	1.179	0.665	1.196	1.77	$p = 0.076$	−0.125	2.483
Number of projects per year	−0.181	0.457	−0.183	−0.4	$p = 0.692$	−1.077	0.715
Perceived role: Environmental issues	0.206	0.298	0.324	0.69	$p = 0.491$	−0.379	0.791
Perceived role: Minimal requirements	−0.028	0.187	−0.069	−0.15	$p = 0.881$	−0.394	0.338
Values: Concern about the environment	−0.088	0.260	−0.151	−0.34	$p = 0.735$	−0.599	0.422
Self-assessed knowledge	0.798	0.619	0.537	1.29	$p = 0.198$	−0.416	2.012
Knowledge of Minergie	**2.960**	**0.376**	**7.067**	**7.87**	**$p < 0.001$ *****	**2.223**	**3.698**
Visual knowledge	**3.663**	**0.924**	**3.597**	**3.96**	**$p < 0.001$ *****	**1.851**	**5.474**
Belief environmental impact	**0.405**	**0.205**	**0.950**	**1.97**	**$p < 0.05$ ***	**0.002**	**0.808**
Belief delays	0.344	0.287	0.632	1.2	$p = 0.231$	−0.219	0.907
Social norm: RC recommendation	−0.161	0.225	−0.342	−0.72	$p = 0.474$	−0.603	0.280
Social norm: SIA norms	−0.059	0.213	−0.137	−0.28	$p = 0.782$	−0.476	0.358
Prescriptive social influence: Architects	**0.025**	**0.010**	**1.244**	**2.36**	**$p < 0.05$ ***	**0.004**	**0.045**
Prescriptive social influence: Building engineers	0.009	0.009	0.561	0.99	$p = 0.323$	−0.008	0.026
Prescriptive social influence: Construction companies	0.020	0.016	0.879	1.25	$p = 0.212$	−0.011	0.051
Prescriptive social influence: Policy makers	0.017	0.013	0.863	1.32	$p = 0.188$	−0.008	0.042
Prescriptive social influence: Researchers	−0.012	0.009	−0.666	−1.4	$p = 0.162$	−0.030	0.005
Prescriptive social influence: Suppliers	−0.011	0.019	−0.406	−0.61	$p = 0.544$	−0.049	0.026
Prescriptive social influence: Clients	**0.047**	**0.016**	**1.963**	**3.03**	**$p < 0.01$ ****	**0.017**	**0.078**
Perceived behavioural control: Difficulty of the task	−0.148	0.227	−0.314	−0.65	$p = 0.513$	−0.593	0.296

Variables for which significant differences were found are reported in bold (at least $p < 0.05$). Pseudo-$R^2 = 0.752$. Significance levels *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$.

5.3. Contextual Factors

In our sample, the number of suppliers (whether only one was available, or more) did not differ between the cases in which RC was or was not recommended (Chi2 independence test results: df = 1, chi2 = 1.75, $p = 0.186$). Furthermore, based on the answers provided by the respondents, the actual price of RC and conventional concrete was about the same for cases in which RC was recommended and for those in which it was not. No significant difference between the two subsamples could be identified (Figure 3; Wilcoxon rank-sum test results: df = 1, z = 0.112, $p = 0.911$). The remaining contextual factors were input into the regression, and the results are reported in Table 6.

Table 6. Results of the logistic regression including contextual factors affecting the recommendation of RC in construction projects, $n = 556$.

	β	SE	Standardised β	z	Sig.	(95% Conf. Interval)	
a. Awarding authority	−0.212	0.232	−0.051	−0.91	$p = 0.361$	−0.667	0.243
b. Building typology	**0.477**	**0.220**	**0.119**	**2.17**	**$p < 0.05$ ***	**0.046**	**0.907**
c. Cost of the project	0.501	0.354	0.072	1.42	$p = 0.157$	−0.193	1.195
d. Consideration of environmental labels	**−1.526**	**0.234**	**−0.331**	**−6.52**	**$p < 0.001$ *****	**−1.984**	**−1.067**

a. Coded 0 = public, 1 = private. b. Coded 0 = non-residential, 1 = residential. c. Coded 0 = ≤1 Million CHF, 1 = >1 Million CHF. d. Coded 1 = Label considered, 2 = Label not considered. In bold, the variables with significant *p*-values (at least $p < 0.05$). Pseudo-$R^2 = 0.1108$. Significance levels *: $p < 0.05$; < 0.01; ***: $p < 0.001$.

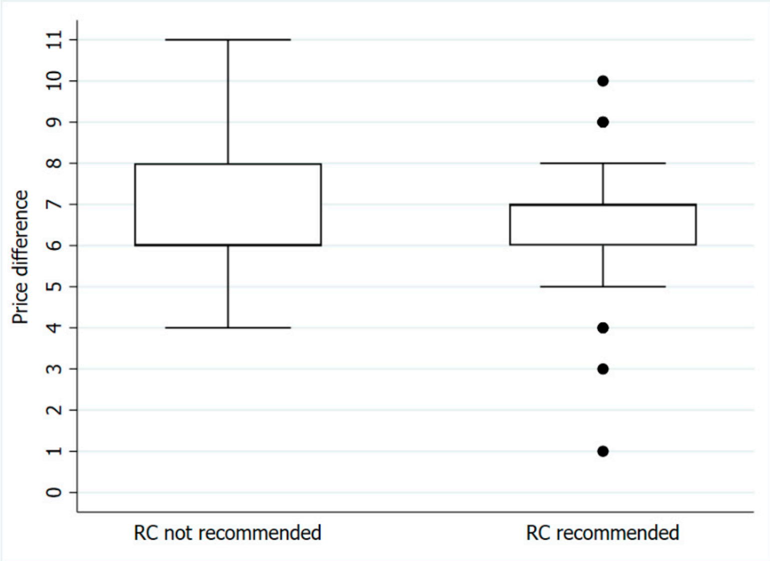

Figure 3. Box plot of ratings of "price difference" in the group of projects where RC was and was not recommended. The scale used (reported in Table 1) goes from 1 to 11 (6: "RC and conventional concrete (CC) have approximately the same price: price of RC is between 5% higher or lower than CC"). No significant differences are found between the two groups. "RC not recommended": mean = 6.83; SD = 1.25; median = 6. "RC recommended": mean = 6.69; SD = 1.28; median = 7. Mean of the full sample: 6.75.

6. Discussion

This study aimed at developing, operationalising, and applying a framework in order to identify and analyse the factors that affect the decision of architects to recommend the use of RC. We explored a priori beliefs associated with RC, and the factors that lead architects to recommend RC in their projects. In doing so, we contributed to an understanding of actors' behaviour with the intention of fostering the implementation of recycling strategies for a CE in the C&D sector. In this section, we discuss the main findings and elaborate on the recommendation of interventions (Section 6.1). We discuss the theoretical and practical contributions of the present research (Section 6.2). Finally, we acknowledge the limitations of the study and suggest avenues for further research (Section 6.3).

6.1. Discussion of Results

The results of this study suggest multiple insights, which are elaborated in the subsequent paragraphs (Sections 6.1.1 and 6.1.2). First, the high number of cases in which architects recommended RC showed the importance of these actors in the decision-making process on the choice of this construction material. From the data analyses, we could infer that some characteristics of architects with prior knowledge about RC were significantly different in comparison with those of architects lacking knowledge about RC. Overall, architects who were knowledgeable about RC tended to be older, and tended to have slightly worse opinions about the durability properties of RC. Finally, they tended to consider increased delays and higher costs as less problematic in cases where RC was used. Some behavioural factors appeared to be significant in predicting the recommendation of RC: a senior position, knowledge about the Minergie label, the fact of having seen RC at least once, the belief that RC has a lower environmental impact than conventional concrete, and the number of architects and clients recommending RC to the actor. Finally, the statistical analyses indicate that the recommendation of RC was influenced by the building typology (non-residential), and by the decision to target a construction label (e.g., Minergie).

6.1.1. Role of the Architect

In our work, we stress the importance of focusing on each actor who has a role in a specific process, in this case the construction process. Our decision to focus on a specific actor (i.e., architect) represents a first step towards the creation of a systemic perspective, which should encompass the interconnections between different actors. According to this standpoint, we suggest the identification of each actor's role and potential agency, beyond what is commonly assessed as his/her basic responsibility. Accordingly, the insights from the interviews highlighted the importance of establishing a perception of agency among architects through the creation of a sense of responsibility that goes beyond mere legal liability and motivates architects to propose and discuss the use of alternative materials, once sensitised to environmental and social concerns. As mentioned throughout the interviews, the architect is not only responsible for concretising his/her ideas and focusing on the aesthetic and design details of the building, but also needs to be "proactive" [#Interview 11]. As part of their *"ethical" and "ecological responsibility"* [Interviews #7 and #10], architects should consider all the measures and techniques that could make a building more ecological [Interview #6] and suggest such measures through proposal submissions to clients [e.g., Interviews #8, #11 and #13]. That being said, these suggestions also need to be discussed, checked and approved by other involved stakeholders, mainly other implicated architects, engineers and clients.

6.1.2. Factors Affecting the Recommendation of RC

Our results regarding a priori beliefs about RC showed that architects with no prior knowledge of RC did not hold strong negative opinions about the material. However, significant differences are found between the groups of knowledgeable and non-knowledgeable architects about RC, regarding beliefs on increased delays and higher costs, with the first group having a more optimistic perception about these potential disadvantages. Potential delays and higher costs are certainly not desirable, in a sector in which each project is arguably unique in terms of design and construction, and where many constraints need to be faced due to limited space, increasing complexity, limited budgets, tight time-frames, and the constant demand for innovation [78]. These beliefs could induce architects to be reluctant to recommend RC. Indeed, construction projects entail considerable investments and potentially severe penalties in case of project delays [79]. This could also impede the development of new collaborative and joint work initiatives between the different supply chain actors (ibid.). Hence, sharing success stories in which the negative effects associated with the use of RC (relating to delays or increased costs) were not experienced might convince other architects with no prior knowledge of the material to recommend it in their construction projects.

Our results suggested that holding a senior position positively affected the recommendation to use RC (Table 5). This seniority could imply either more acquired knowledge and experience (or training), or the capacity to bear more risk, due to more decisional power and leverage, thus implying a higher professional independence in the decision-making process. As interviewee #12, owner of an architectural studio, pointed out: *"I have responsibility! About the client, [. . .] you have to be a brilliant seller. [. . .] It's really difficult. I also lost clients".* Arguably, the risk associated with proposing an alternative material could be attenuated by the established reputation of the architect embedded in his/her senior position.

The results showed the importance of knowledge about the Minergie label (which implies the use of RC), and the architects' visual knowledge (i.e., if they have seen RC at least once) regarding the recommendation of RC. Our findings thus confirmed hypothesis 1. Although the results for the variable "self-assessed knowledge" showed the non-significance of this variable, this might have been caused by the nature of the variable itself. As reported in the methodology, only cases in which the architect had at least basic knowledge of RC were retained in the logistic regression. In the logistic regression, the values of the variable "self-assessed knowledge", could only take up values 2 (basic knowledge) and 3 (good knowledge). Therefore, these values might not have been sufficient for differentiation between the levels of knowledge among the respondents and their influence. The overall influence of the level of architects' knowledge of RC was demonstrated with the initial bivariate analysis, by highlighting the differences observed in the beliefs of architects associated with RC with—and completely without—prior knowledge of RC (Table 4). The significant values of the other two knowledge-related variables (Minergie label and visual knowledge) confirm the importance of these aspects for the recommendation of RC. Three points of leverage for increasing the recommendation of RC were previously identified in the literature, [41]: knowledge (information), education of construction experts, and labelling. To generalise our findings, a lack of knowledge and sharing of best practices, combined with a limited capacity or time to learn and attend informative courses, could represent barriers for an accelerated transition to a CE in the built environment [80]. The urgent need for educational interventions to enhance the recommendations and use of RC is also motivated by the surprising finding that 28% of the survey respondents had no knowledge of RC, which has been on the market for quite some time (at least 15 years). This consideration also takes into account the potential bias of the sample: the focus on RC was mentioned in the invitation; architects with no knowledge about RC might have abstained from completing the questionnaire, thus implying that an even higher percentage of architects are not familiar with RC. Regarding the need for knowledge sharing, our results suggested which specific topics should be the focus of educational interventions: the material itself, the Minergie label (with Minergie-ECO requiring the use of RC), and the possibility for architects to view the material in person, evaluating its physical appearance. Such actions have already been the focus of events and workshops where it was suggested that RC actually contributes to the aesthetic value of a building [81]; we believe such events and workshops should be replicated. In addition to education, we argue that having more large-scale demonstrative and pilot projects, as well as experience with new technologies or new circular materials within the built environment (as also highlighted by Circle Economy and wbcsd, 2018), would positively affect the decisions by architects to recommend RC. The construction industry being relatively conservative, resisting change and adapting slowly to new technological developments [82,83], it is imperative to share knowledge and experience on innovative materials and to make key actors aware of the different choices of materials and their uses. This would enable these actors to evaluate the suitability of different materials for their projects and to build an informed opinion. The likelihood of actors recommending the use of recycled materials in general, and RC in particular could then increase. As one interview highlighted, "I think more information and examples of buildings that have already been done by some local firms can remove [. . .] doubts from the minds of architects" [Interview #2].

Hypothesis 2 (the prediction of a link between the beliefs associated with an increased cost of the project in cases where RC was used) was refuted, since the bivariate analysis showed no difference in the values of this variable between the group of architects that recommended RC and those that did not recommend it (Table A3). Hypothesis 3, related to environmental values and as predictors of the RC recommendation, was also refuted (Tables 6 and A3). However, Hypothesis 4, which predicted a significant effect of the belief in the lower environmental impact of RC as compared to conventional concrete, was confirmed, thus highlighting the importance of sharing Life Cycle Assessment (LCA) information for the adoption of RC.

Other significantly influencing behavioural factors included the prescriptive social influence of clients and other architects, confirming Hypothesis 5. As part of his/her role, the architect should respect and meet the needs and requests of the client once communicated. With the important role of the client in the decision-making process, the client being *"fundamental"* in a project [Interview #15], and since *"all decisions are made with the client"* [Interview # 1], architects considerably factor in the clients' expectations. Hence, this would explain the significant impact of this factor on the architect's behaviour and decision to recommend RC or not. For instance, if a client requested the use of RC (e.g., to obtain a label), this would have a significant impact on the decision of architects to recommend RC. Additionally, the results of the survey mirrored what the interviewed architects further highlighted, i.e., the relative importance they accord to what other architects suggest. One interviewee mentioned that "the opinion of my colleagues and partners is fundamental when working on a project" [Interview #15]. Another stressed that *"architecture colleagues would be the most important"* in his/her network [Interview #12], because they *"do the same work and hold the same profession"* [Interview #12]. Hence, establishing the recommendation of RC as a conventional practice could increase the number of architects with relevant experience that could advise their peers on RC.

Through our results, we gathered notable insights, specifically regarding the role of consequences in shaping the architect's habit of recommendation. It is important to see how a negative feedback loop could be established if no recognition for the effort of recommending new sustainable materials, such as RC, were granted. As stated by a survey respondent, "architects do not often have the time to do research in parallel to obtain clear and precise information adapted to the project. This commitment to innovation and the achievement of sustainable constructions which is done at the expense of the architect is rarely recognised or even seen as an advantage". Without a positive feedback loop, it might be extremely difficult to establish a RC recommendation habit. The shortcoming of a limited advantage in recommending RC becomes clearer through the application of Roger's innovation adoption theory, which helped us to identify specific issues relating to the characteristics of the material itself that could represent a barrier to adoption. Specifically, Roger's innovation adoption theory presupposes that, for an innovation to be adopted, it should offer a relative advantage in comparison to its alternatives, and it should be observable, i.e., "the easier it is for individuals to see the results of an innovation, the more likely they are to adopt it. Such visibility stimulates peer discussion of a new idea" [56]. What emerges from our study is the absence of a real advantage for architects to recommend RC, rather increasing workload and risk. Although architects who recommended RC at least once in their projects tended to be optimistic about a future recommendation and received positive overall feedback from other involved actors (Table 3), this might not represent a sufficient incentive to recommend RC again. In fact, as in many sustainability-related problems, the benefits of a pro-environmental behaviour might not directly affect the actor implementing the behaviour. In this regard, within the perspective of a CE, public authorities have an important role to play by creating incentives, for example by implementing measures that generate rewards for the implementation of circular economy solutions [80]. These measures should encourage and stimulate materials recycling and re-use, support the use of innovative materials, and further promote a circular built environment through the championing of best practices [80]. In fact, a positive influence of regulatory pressure on the behavioural intentions of builders towards the recycling of C&D waste exists [49]. As a measure for the development of recycling behaviour, governments could play a role by raising awareness and informing actors of the environmental impacts of C&D waste and the eventual (personal and societal) benefits of recycling and using recycled products [49].

The relevant role of labels in the recommendation of the use of RC [41] was also confirmed by the results of the regression run with project-specific contextual factors (Table 6). In particular, the integration of the CE in quality certifications and labels, and the inclusion of circular criteria into reference standards would indeed help in scaling the CE in the construction sector and built environment [80]. In our sample, the building typology (non-residential) also positively affected the recommendation of RC. This information could be used to identify potential projects in which the use of RC could be proposed early on in the design phase of the construction project. Overall, the results showed the diversity of factors that play a role in the recommendation of RC by architects. These insights contributed to going beyond the general view that the decision of the engineer to use RC and the price of RC are, respectively, the sole enabler and barrier to the recommendation of RC. In fact, although the price of RC was slightly (5%–15%) higher on average than conventional concrete, we found no significant difference between projects in which RC was or was not recommended. According to our analyses price considerations alone seem not to be the decisive factor in choosing whether to recommend RC or not.

6.2. Theoretical and Practical Contributions

The theoretical framework combines different theories and takes into account behavioural drivers and project specific factors, which might have been disregarded in previous research work. The framework stresses the importance of approaching the behavioural choices of agents from a holistic perspective, taking into account actor-related behavioural drivers (e.g., subjective norms and perceived behavioural control), context-specific factors, the effect of social networks, and the influence of the consequences of the behaviour. Through the framework, we highlight the importance of approaching the study of behavioural choices from a holistic perspective, which is pivotal in the study of adoption of innovation. Although, in the specific context of our study, many factors were not found to significantly affect the behaviour, we encourage researchers to adopt the same approach for studying other behavioural choices from a holistic perspective.

As practical contributions, through the analysis of survey results, we emphasise further recommendations of interventions and actions to support and enhance the use of RC. By holding semi-structured interviews with the actors, we contributed to the representation of the researcher as the instrument for qualitative data collection (e.g., [84,85]). We reinforce the important role that the researcher has in producing knowledge and directing the research material [86]. Both the interviews and the survey indirectly raised awareness and generated knowledge and new information for the involved actors, particularly for those who were not (fully) knowledgeable about RC. Some respondents mentioned in the survey that they would look up RC to fill the gap in their knowledge. The interest sparked by the research is also reflected in the decision of all of the interviewed architects, and of the 235 survey respondents, to be further contacted with the study results. This confirms that the researcher also has a role in bringing additional knowledge to the attention of respondents, by asking specific questions and encouraging them to consider or explore a topic previously unexamined or unknown to them.

6.3. Limitations & Further Research

We recognise the existence of some limitations to this research. The choice of actor was limited to architects. We are aware that the consideration of only one actor within the scope of this study might be viewed as a restraint, as a construction project involves the collaboration and decision-making process of a multitude of different stakeholders. The architects that were surveyed also mentioned and emphasised the important role of the engineers in the recommendation and use of RC. We acknowledge this consideration, and we recommend performing related studies that include all of the construction actors that have a role in the building process. Further research could also focus on the synergetic role of multiple actors involved in the same project. Interviewing or setting up workshops involving several different stakeholders could yield more and diverse perspectives. In addition, more knowledge-focused research projects [87,88], based, for instance, on social network analysis [89,90], could highlight interesting results for the specific case of RC recommendation.

Although the survey response rate was acceptable (9.3%, with 727 valid responses out of 7804 sent survey invitations), a higher number of respondents would have been more advantageous for the analysis. This problem is not new to survey studies, especially when respondents are not incentivised economically. The larger the sample size considered, the more information gathered, and the more accurate and reliable the results.

The design of the survey is susceptible to potential biases based on the number of questions posed. A trade-off was achieved regarding the length of the survey, the required time for its completion, and the amount of information and insights able to be gathered. While more items used to measure the predictor variables could have been considered for the analysis and in the regression equation, this number was limited in order not to overload participants.

Finally, we acknowledge that, for a CE to be achieved, incremental changes in the materials used to build cities will not be enough. Hence, we are aware that materials other than RC might be more suitable for reducing the environmental impact of construction. Disruptive, innovative ways of living and building are pivotal for radical change towards circularity and sustainability. What is needed is radical technological and social innovation, whose adoption should be guided by sound and holistic theoretical perspectives.

7. Conclusions

This paper presented an integrative theoretical framework, which provided a conceptual structure for investigating architects' recommendation of RC in construction projects. By applying the framework and collecting survey data, we identified multiple factors influencing their choices. The final recommendation and use of sustainable "new" materials, such as RC, is dependent on the interaction among the construction actors, and the interplay effect among the prevalent behavioural and contextual factors. Some behavioural factors appear to be significant in predicting the recommendation of RC by architects: a senior position; knowledge about the Minergie label; the fact of having seen RC at least once; the belief that RC has a lower environmental impact than conventional concrete; the number of architects and clients recommending RC to the actor. Finally, the statistical analyses indicate that the recommendation of RC is more likely to occur if the building is non-residential, and if the awarding authority targets a construction label (e.g., Minergie). We urge an acknowledgement that the construction process, which involves the actions of many actors, can be shaped towards more circular/sustainable practices if all the involved actors collaborate, recognise their respective potential agency, and act beyond their mere basic responsibilities, as highlighted in other reports on the topic [78,79]. We argue that the effectiveness of strategies for fostering circularity in the construction sector, and in all sectors generally, depends on an understanding of the motivations and consequences of behavioural choices and the relevance of each agent's contribution.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of EPFL (HREC No: 055-2019/27.09.2019).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Presentation of the Theoretical Perspectives Informing the Development of the Behavioural Framework Presented in This Study

Giddens' ST combines the micro (social actor) and macro (structure) levels: it recognises the contribution of individuals to the reproduction of social structure and, reciprocally, how social structures influence the actions of individuals (duality of structure, see [53]). The ST explains how actors influence, and are influenced by, social structures, triggering a feedback loop that gives individuals new information with which they can reassess their standpoints. One integration of Giddens' TS into our framework is in the feedback loops that are triggered by the consequences of behaviour.

TIB is a psychological framework that aims to explain the "interpersonal" behaviour of individuals [54]. In TIB, intentions, habit, physiological arousal, and contextual factors influence the agent's current behaviour. In addition, normative, cognitive, and affective antecedents determine intentions. In our framework, which specifically focuses on the recommendation of RC, physiological arousal was not integrated, since the recommendation of RC needs time and multiple verifications, and it is not a decision that can be made under a specific state of physiological arousal. The integration of Triandis' TIB into our framework also lies, in part, in the recognition of the importance that an individual's social network has in developing an intention to implement a behaviour.

At the agent level, Ajzen's TPB [50] defines the intention of the agent to implement a specific behaviour as being determined in a joint manner, by the perceived behavioural control (the ease of implementing the behaviour), the attitude towards the behaviour (the evaluation of the behaviour) and the subjective norms (the perceived social pressure to perform the behaviour). TPB has been extensively used in behavioural studies. Notably, in the construction sector, [49] applied it to an analysis of the attitude of builders towards construction and demolition waste recycling in India. The integration of TPB into our framework is based in the recognition of all of these components in shaping the agent's intention and behaviour.

According to Rogers' Adoption of innovation [56], an innovation is "*an idea, practice, or object that is perceived as new by an individual or other unit of adoption*". In the case of our research, RC is considered an innovation, and conventional concrete as the standard alternative. Even though RC has been on the market for more than 15 years, this is not a relevant factor *per se* from an innovation adoption perspective. In fact, it is not important "*whether or not an idea is objectively new as measured by the lapse of time since its first use or discovery. The perceived newness of the idea for the individual determines his or her reaction to it*" [56]. From an innovation adoption perspective, five characteristics of an innovation are deemed important and help to explain its rate of adoption [56]: relative advantage, compatibility, complexity, trialability, and observability. Relative advantage "*is the degree to which an innovation is perceived as better than the idea it supersedes*". Compatibility "*is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters*". These characteristics are integrated within our framework in the attitude of the agent, shaped by the beliefs that he/she associates with RC and its use. Complexity "*is the degree to which an innovation is perceived as difficult to understand and use*". This component is integrated within the perceived behavioural control. Trialability "*is the degree to which an innovation may be experimented with on a limited basis*". Trialability could be associated with the capacity to get knowledge and experience in using the material. Finally, observability "*is the degree to which the results of an innovation are visible to others*" and affects the stimulation of a discussion about the innovation. This is also linked to the consequences of the behaviour (recommending RC), which can be more or less accentuated depending on the visibility of the use of the innovation.

Appendix B.

Table A1. Details of the 16 interviews held.

ID	Date	Gender	Age Group	Experience (years)	Language	Modality
1	03.07.2019	Male	30–40	5–10	French	In person
2	08.08.2019	Male	30–40	10–15	Italian	In person
3	09.08.2019	Male	50–60	15–20	Italian	Phone

Table A1. *Cont.*

ID	Date	Gender	Age Group	Experience (years)	Language	Modality
4	12.08.2019	Male	30–40	5–10	French	In person
5	23.08.2019	Male	40–50	10–15	Italian	Skype
6	23.08.2019	Male	40–50	5–10	English	Skype
7	26.08.2019	Male	50–60	25–30	Italian	Phone
8	27.08.2019	Male	70–80	50–60	Italian	Phone
9	27.08.2019	Male	50–60	10–15	English	In person
10	29.08.2019	Female	40–50	20–25	English	In person
11	02.09.2019	Male	40–50	10–15	French	In person
12	02.09.2019	Male	50–60	30–35	English	In person
13	04.09.2019	Male	50–60	20–25	Italian	Phone
14	04.09.2019	Male	40–50	15–20	French	In person
15	23.09.2019	Male	40–50	15–20	Italian	Phone
16	26.09.2019	Male	30–40	5–10	French	Skype

Appendix C.

Table A2. Framework components and extracted quotes from the interviews. The # code refers to the interview transcript.

Framework Component	Quotes
Contextual factors	• *"We used RC for Minergie label. The client wanted it"* #10 • *"I don't even know if RC is proposed. I haven't seen it on brochures. I don't know the sites that are able to offer the RC"* #07
Subjective culture	• *"The architect has a fundamental role in proposing new things or things that can improve life in the built environment"* #05 • *"A good architect is someone that manages to produce a product that is ok for everyone"* #02
Habit	• *"Actually, now we have the policy that we use RC for all our projects"* #09 • *"Whenever there is the possibility is kind of normal to use RC"* #10 • *"We did all the projects with RC"* #11
Perceived behavioural control	• *"I find that in the construction sector today the engineers have more weight than architects"* #08 • *"But it's so difficult to make a decision. You need so many hours to make your decision"* #10 • *"Let's say that it's 80% the architect that decides the material and 20% the client"* #16
Attitude	• *"I've never been told that there was any problem with the use of RC. [. . .] Not even logistic problems"* #11 • *"I followed a workshop [. . .]. I could touch it, see many pictures, and go in depth on the theory of the application of this material"* #15 • *"The advantage or RC is really that it has the same quality"* #09 • *"Systematically, if there is no request from the client, we say that we do like that. And a lot of times the client says ok, that's not more complicated"* #11 • *"The difference between a recycled concrete and a conventional concrete is none"* #13
Social networks	• *"I think the opinion of all actors involved is fundamental"* #13 • *"There is a lot of discussion in the office and with the colleagues, about the project"* #10
Consequences	• *"We didn't have any major backlashes. It worked out pretty well"* #09 • *"We acquired know-how for being able to reuse it"* #14

Appendix D.

Table A3. Wilcoxon rank-sum test results to identify continuous variables whose values significantly differ between the group of architects that recommended RC at least once, and the group of architects that have recommended RC. Significance levels *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$. For scales, see Table 1 in the manuscript. In bold, the variables with significant p-values (at least $p < 0.05$).

	Distribution of Full Sample		Distribution of Subsamples				Wilcoxon Rank-Sum (df = 1)
			RC Recommended		RC Not Recommended		
	Mean	SD	Mean	SD	Mean	SD	
Age	**50.8**	**10.64**	**51.65**	**10.12**	**49.57**	**11.30**	**z = −2.420, *p* < 0.05 ***
Perceived role—client's demand	2.50	1.11	2.45	1.08	2.47	1.16	z = −0.030, *p* = 0.976

Table A3. *Cont.*

	Distribution of Full Sample		Distribution of Subsamples				Wilcoxon Rank-Sum (df = 1)
			RC Recommended		RC Not Recommended		
	Mean	SD	Mean	SD	Mean	SD	
Perceived role—environment	**4.55**	**0.77**	**4.63**	**0.74**	**4.44**	**0.80**	**z = −3.563, $p < 0.001$ *****
Perceived role—minimal requirements	**3.76**	**1.20**	**3.88**	**1.12**	**3.577**	**1.28**	**z = −2.536, $p < 0.05$ ***
Environment as an important value	4.67	0.61	4.68	0.61	4.66	0.62	z = −0.404, $p = 0.686$
Concern about the environment	**4.46**	**0.84**	**4.56**	**0.77**	**4.31**	**0.92**	**z = −3.327, $p < 0.001$ *****
Social norm, RC recommendation	**3.18**	**1.04**	**3.29**	**1.01**	**2.97**	**1.06**	**z = −3.026, $p < 0.01$ ****
Social norm, SIA norms	**3.58**	**1.14**	**3.48**	**1.17**	**3.74**	**1.06**	**z = 2.372, $p < 0.05$ ***
Prescriptive social influence, Architects	**16.43**	**24.38**	**22.37**	**26.64**	**7.45**	**16.98**	**z = −7.653, $p < 0.001$ *****
Prescriptive social influence, Building engineers	**26.25**	**30.56**	**34.87**	**31.19**	**13.22**	**24.44**	**z = −8.958, $p < 0.001$ *****
Prescriptive social influence, Construction companies	**10.44**	**21.55**	**14.17**	**24.60**	**4.81**	**14.15**	**z = −5.099, $p < 0.001$ *****
Prescriptive social influence, Policy makers	**12.64**	**24.89**	**1.31**	**28.47**	**4.09**	**14.58**	**z = −7.237, $p < 0.001$ *****
Prescriptive social influence, Researchers	**12.79**	**27.19**	**15.84**	**30.01**	**8.17**	**21.55**	**z = −2.836, $p < 0.01$ ****
Prescriptive social influence, Suppliers	**6.34**	**18.08**	**7.77**	**19.40**	**4.35**	**15.90**	**z = −2.418, $p < 0.05$ ***
Prescriptive social influence, Clients	**9.58**	**20.47**	**14.25**	**24.35**	**2.52**	**8.67**	**z = −6.804, $p < 0.001$ *****
Descriptive social influence—influence of other architects' behaviour	2.91	1.11	2.83	1.10	3.01	1.10	z = 1.853, $p = 0.064$
Descriptive social influence—Behaviour of other architects	**28.87**	**24.25**	**35.91**	**24.91**	**14.09**	**14.19**	**z = −6.956, $p < 0.001$ *****
Risk propensity—New materials	3.64	0.98	3.70	0.99	3.54	0.97	z = −1.812, $p = 0.070$
Risk propensity—Client's request	4.13	0.88	4.14	0.88	4.13	0.88	z = −0.196, $p = 0.844$
Belief environmental impact	**3.86**	**1.15**	**3.93**	**1.18**	**3.73**	**1.09**	**z = −2.599, $p < 0.01$ ****
Belief company benefit	3.14	1.00	3.13	1.06	3.16	0.89	z = 0.421, $p = 0.674$
Belief durability properties	2.83	0.54	2.84	0.55	2.82	0.53	z = −0.644, $p = 0.520$
Belief delays	**3.91**	**0.90**	**4.00**	**0.92**	**3.76**	**0.86**	**z = −3.045, $p < 0.01$ ****
Belief cost	3.20	1.08	3.24	1.12	3.11	1.01	z = −1.183, $p = 0.237$
Belief impact aesthetics	3.84	0.95	3.86	0.98	3.81	0.88	z = −0.914, $p = 0.361$
Knowledge of Minergie	**2.61**	**1.17**	**3.34**	**0.82**	**1.50**	**0.61**	**z = −17.907, $p < 0.001$ *****
Self-assessed knowledge	**2.12**	**0.33**	**2.18**	**0.39**	**2.03**	**0.18**	**z = −5.113, $p < 0.001$ *****
Perceived behavioural control—Difficulty of the task	**3.21**	**1.04**	**3.34**	**1.06**	**3.00**	**0.98**	**z = −3.640, $p < 0.001$ *****
Perceived behavioural control—Need for external approval	1.84	0.96	1.89	1.00	1.75	0.89	z = −1.341, $p = 0.180$

Table A4. Chi2 test results to identify categorical variables whose values significantly differ between the group of archiTable 0. **: $p < 0.01$; ***: $p < 0.001$. In bold, the variables with significant p-values (at least $p < 0.05$).

	Distribution of Full Sample	Distribution of Subsamples		Chi^2 Test (df = 1)
		RC Recommended	RC Not Recommended	
Gender				Chi^2 = 3.07611, $p = 0.079$
Male	436 (84.5%)	269 (86.8%)	167 (81.1%)	
Female	80 (15.5%)	41 (13.2%)	39 (18.9%)	
Company size				**Chi^2 = 15.6203, $p < 0.001$ *****
≤10	**312 (59.8%)**	**166 (52.9%)**	**146 (70.2%)**	
>10	**210 (40.2%)**	**148 (47.1%)**	**62 (29.8%)**	

Table A4. *Cont.*

	Distribution of Full Sample	Distribution of Subsamples		Chi^2 Test (df = 1)
		RC Recommended	RC Not Recommended	
Country of study				$Chi^2 = 1.0806$, $p = 0.0.299$
Switzerland	435 (83.3%)	266 (84.7%)	169 (81.3%)	
Other	87 (16.7%)	48 (15.3%)	39 (18.7%)	
Job position				**$Chi^2 = 10.1060$, $p < 0.01$ ****
Senior position	**374 (71.7%)**	**241 (76.8%)**	**133 (63.9%)**	
Other	**148 (28.3%)**	**73 (23.2%)**	**75 (36.1%)**	
Years of experience				**$Chi^2 = 15.6203$, $p < 0.001$ *****
≤20 years	**231 (44.3%)**	**117 (37.3%)**	**114 (54.8%)**	
>20 years	**291 (55.7%)**	**197 (62.7%)**	**94 (45.2%)**	
Number of projects/year				**$Chi^2 = 5.2193$, $p < 0.05$ ***
≤5	**297 (56.9%)**	**166 (52.9%)**	**131 (63.0%)**	
>5	**225 (43.1%)**	**148 (47.1%)**	**77 (37.0%)**	
Visual knowledge				**$Chi^2 = 187.5710$, $p < 0.001$ *****
Never seen RC	**332 (63.6%)**	**126 (40.1%)**	**206 (99.0%)**	
RC seen at least once	**190 (36.4%)**	**188 (59.9%)**	**2 (1.0%)**	
RC-related events				$Chi^2 = 3.7077$, $p = 0.054$
≤1	320 (61.3%)	182 (58.0%)	138 (66.4%)	
>1	202 (38.7%)	132 (42.0%)	70 (33.6%)	

Appendix E.

Table A5. Contextual factors profiles of projects in which RC was or was not recommended. Significance levels ***: $p < 0.001$.

	Distribution of Full Sample	Distribution of Subsamples		Chi^2 Test (df = 1)
		RC Recommended	RC Not Recommended	
Building typology				$Chi^2 = 23.82$, $p < 0.001$ ***
Residential	370 (50.5%)	115 (40.0%)	255 (57.3%)	
Other	370 (50.5%)	180 (60.0%)	190 (42.7%)	
Awarding authority				$Chi^2 = 24.77$, $p < 0.001$ ***
Public	239 (39.6%)	142 (50.2%)	97 (30.3%)	
Private	364 (60.3%)	141 (49.8%)	223 (69.7%)	
Cost project				$Chi^2 = 16.03$, $p < 0.001$ ***
≤1 Million CHF	73 (10.7%)	14 (5.0%)	59 (14.8%)	
>1 Million CHF	613 (89.3%)	267 (95.0%)	346 (85.2%)	
Consideration of environmental labels				$Chi^2 = 72.08$, $p < 0.001$ ***
Yes	159 (24.3%)	113 (41.0%)	46 (12.1%)	
No	496 (75.7%)	163 (59.0%)	333 (87.9%)	
Suppliers				$Chi^2 = 1.75$, $p = 0.186$
1	112 (42.4%)	63 (46.3%)	49 (38.3%)	
>1	152 (57.6%)	73 (53.7%)	79 (61.7%)	

Appendix F.

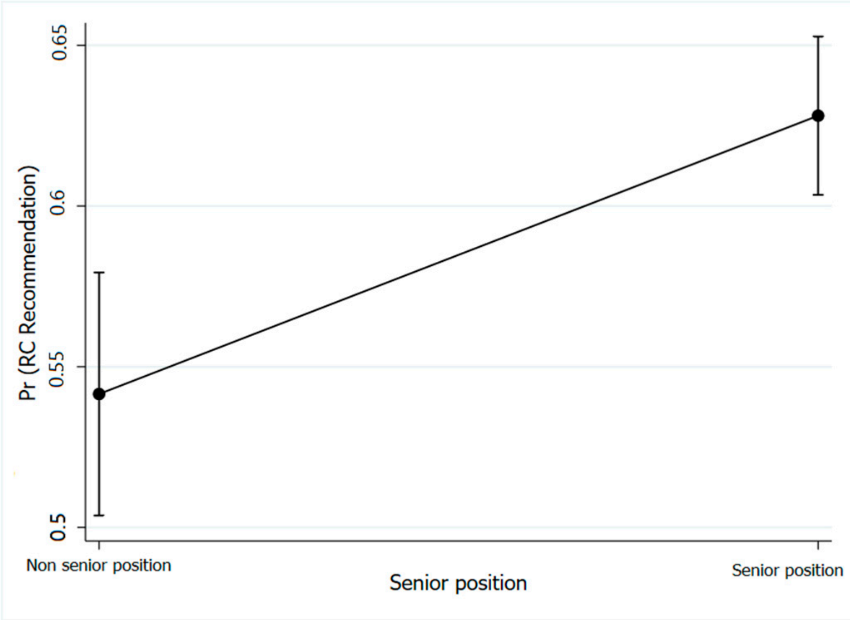

Figure A1. Predictive margins (Marginal means of outcome probabilities for levels of covariate) with 95% CIs associated to the variable "Senior position".

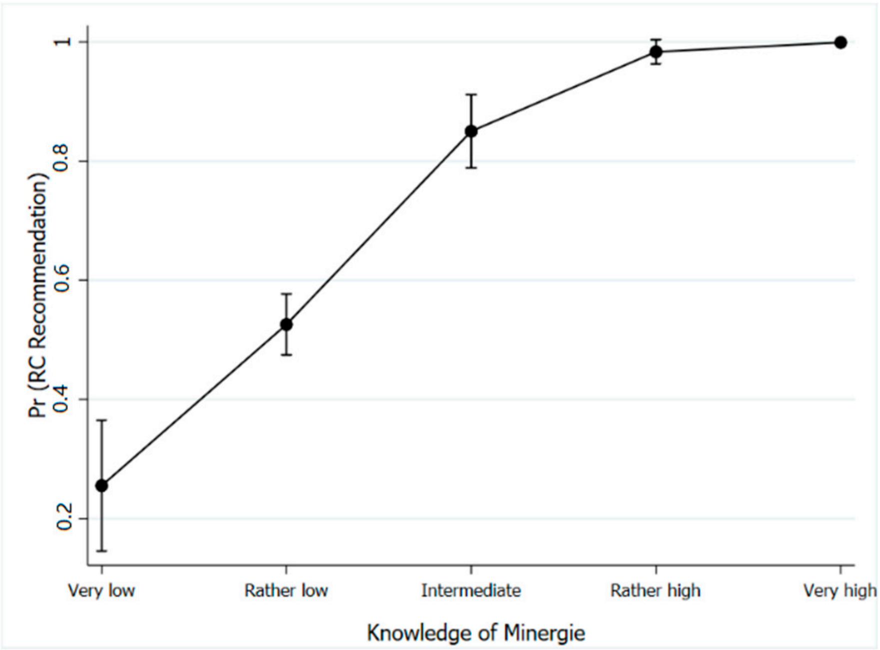

Figure A2. Predictive margins (Marginal means of outcome probabilities for levels of covariate) with 95% CIs associated to the variable "Knowledge of Minergie".

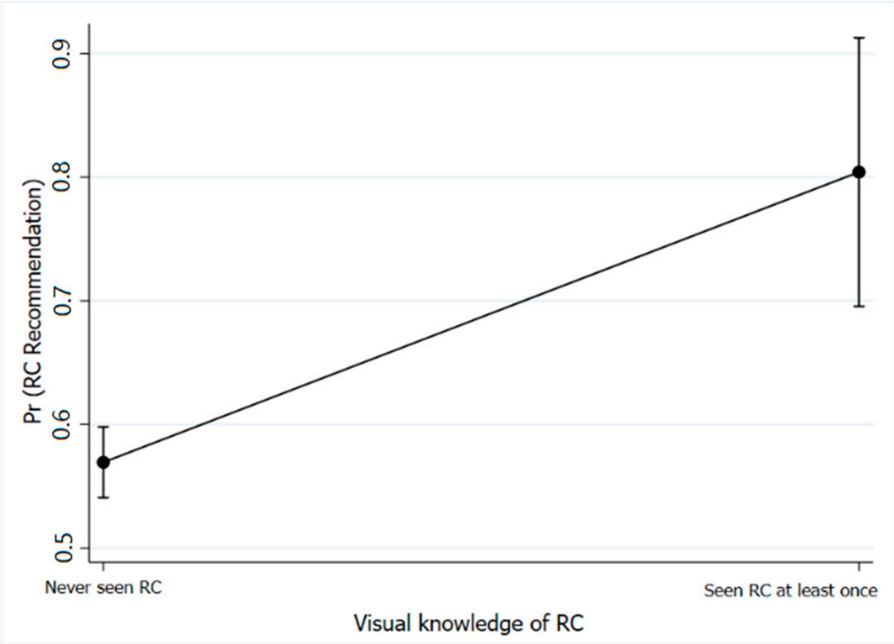

Figure A3. Predictive margins (Marginal means of outcome probabilities for levels of covariate) with 95% CIs associated to the variable "Visual knowledge".

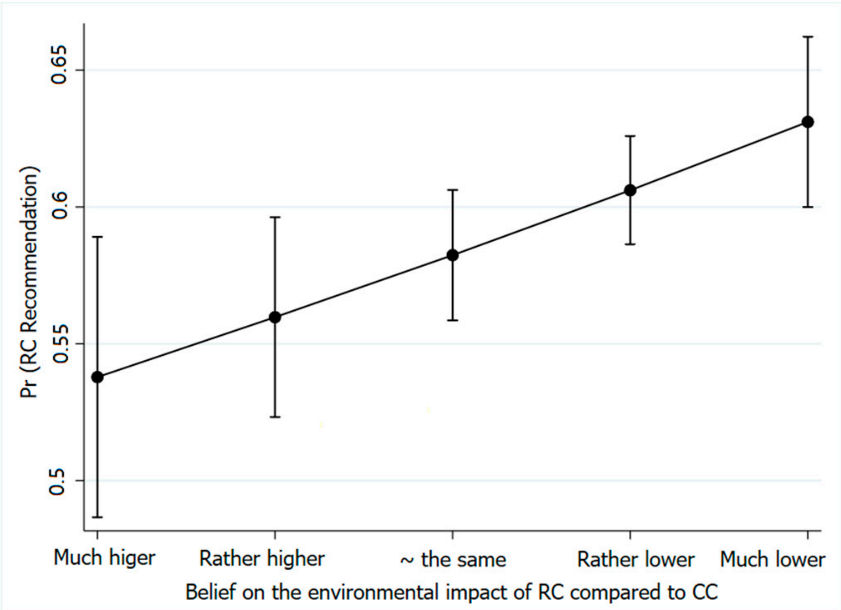

Figure A4. Predictive margins (Marginal means of outcome probabilities for levels of covariate) with 95% CIs associated to the variable "Belief on the environmental impact of recycled concrete compared to conventional concrete".

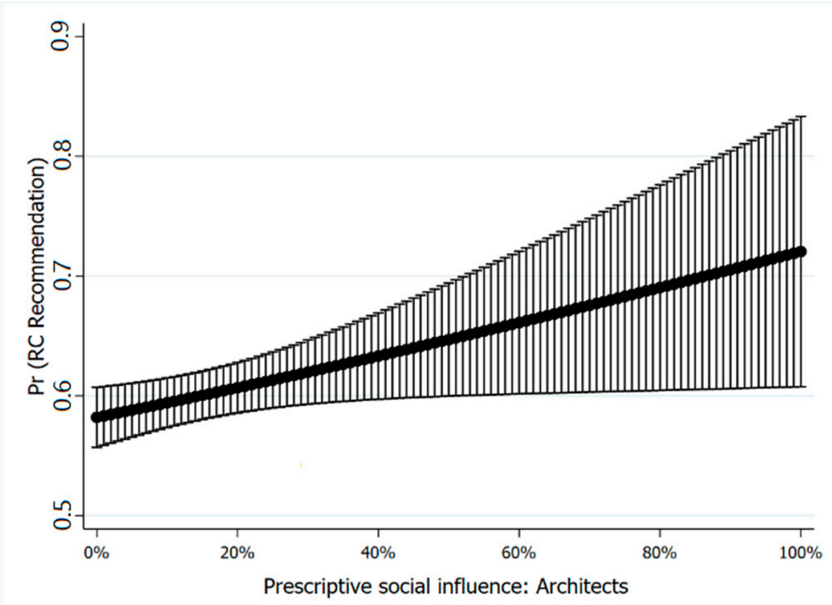

Figure A5. Predictive margins (Marginal means of outcome probabilities for levels of covariate) with 95% CIs associated to the variable "Prescriptive social influence: Architects", i.e., the percentage of other architects in the network of the architect that recommended him/her to recommend RC.

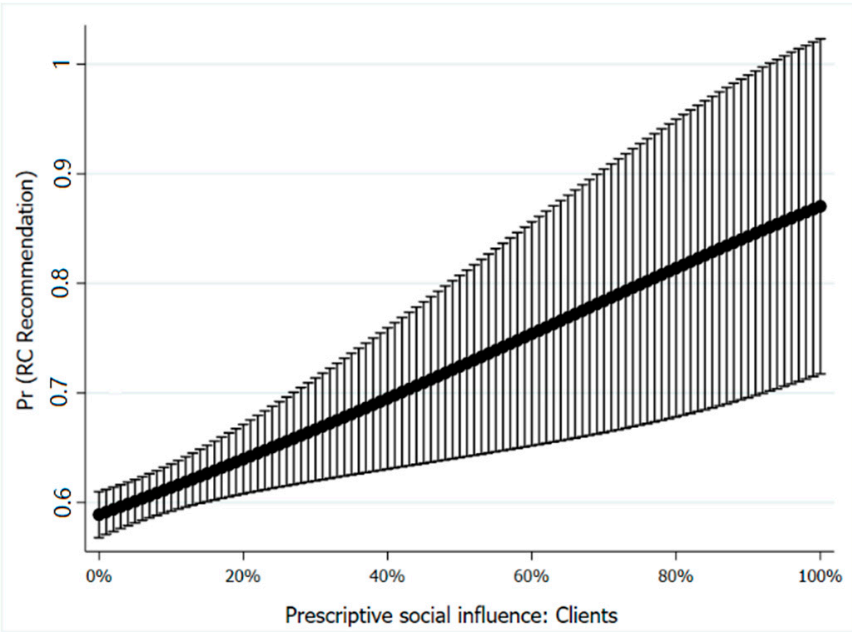

Figure A6. Predictive margins (Marginal means of outcome probabilities for levels of covariate) with 95% Cis associated to the variable "Prescriptive social influence: Clients", i.e., the percentage of clients in the network of the architect that recommended him/her to recommend RC.

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