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Investigation of Social Concerns Regarding a Sustainable Cement

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ABSTRACT

This work investigates individual and social concerns regarding the integral sustainability of an alternative low-carbon cement. The framework of Integral Philosophy was used for the investigation. Social surveys were conducted in Australian, American, and Sri Lankan contexts. The data was collected through both closed-ended and open-ended questions in a questionnaire. Analysis of responses was carried out using fuzzy techniques and grounded theory techniques. Results indicate that individuals and societies in all three countries are more concerned about market price, quality standards, sustainability issues, and recommendations from professionals when selecting a new cement. In all three contexts, they also indicate that there is generally high support among individuals and societies for accepting low-carbon cement as an integrally sustainable cement. Combining the top-down Integral Theory approach with the bottom-up Grounded Theory is a valuable tool for social science research.

Keywords: Fuzzy techniques, Grounded theory, Integral theory, Social concerns, Sustainable cement

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التحقيق في التحديات الاجتماعية المرتبطة بالإسمنت المستدام

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الخلاصة

هذه الورقة البحثية تقدم تحقيقًا في المخاوف الفردية والاجتماعية فيما يتعلق بالاستدامة الشاملة لأسمنت بديل منخفض الكربون. تم استخدام إطار الفلسفة التكاملية للتحقيق. تم إجراء استبيانات اجتماعية في سياقات أسترالية وأمريكية وسريلانكية. تم جمع البيانات من خلال أسئلة مغلقة ومفتوحة في الاستبيان. تم إجراء تحليل الاستجابات باستخدام تقنيات ضبابية وتقنيات البحث النوعية. تشير النتائج إلى أن الأفراد والمجتمعات في جميع البلدان الثلاثة أكثر اهتمامًا بسعر السوق ومعايير الجودة وقضايا الاستدامة وتوصيات المتخصصين عند اختيار أسمنت جديد. كما أنها تشير ، في جميع السياقات الثلاثة ، إلى وجود دعم كبير بشكل عام للأفراد والمجتمعات لقبول الأسمنت المختار منخفض الكربون كنوع من الأسمنت المستدام بشكل متكامل. ان الجمع بين التطبيق الهيكلي لنظرية التكامل و المنهج الاستقرائي التطوري ستقدم كأداة مفيدة للبحوث الاجتماعية.

الكلمات المفتاحية: التحليل الضبابي، بناء النظريات القائم على البيانات، النموذج الشامل للواقع، التحديات والتطلعات المجتمعية، الإسمنت الصديق للبيئة.

1. INTRODUCTION

This work presents the application of integral philosophy to investigate social concerns regarding sustainable cement. In the context of this research, the term ‘sustainability’ refers to ‘ecological sustainability’ and ‘integral sustainability’, which can be described as a concept that integrates many sustainability aspects, such as ecological, economic, social, and technological ones. As such, this research can be defined as integrating technological and philosophical investigations.

Over time, the discourse on ‘sustainability’ has been influenced by modernism, post-modernism, and now 'post-postmodernism'. According to modernism, there is only one reality, which is external, objective, and tangible **(Lincoln and Guba, 1985)**. Therefore, within the modern paradigm, the discourse and research on sustainability focus mainly on the consumption and production of physical and quantifiable entities such as resources, energy, products and waste, which are external, objective, and material. As a reaction to the modern movement, post-modernism emerged in the latter part of the last century and rejected all fundamental principles of modernism **(Huckle and Martin, 2001)**. Accordingly, it rejected the grand narrative or the modern worldview of a single objective reality and recognized multiple realities. As a result, the discourse on sustainability, which was limited to ‘objective reality’ within the modern movement, has migrated to many other realities. The concerns regarding broad ecological and social systems could result from that. However, the stand of ‘rejecting the grand narrative’ might have prevented the integration of multi-narratives to form a meaningful whole. In this background, ‘Integral Philosophy’ or ‘Integral Theory’ developed by **(Wilber 1995; 1996)** is one of the most significant philosophical paradigms that emerged at the dawn of the new millennium. Integral theory recognises multiple realities and integrates them **(Esbjörn-Hargens, 2009)**. According to Integral

Theory, any issue can be linked to the four fundamental realities, which are subjective, inter-subjective, objective, and inter-objective. These realities are assigned to the upper left (UL), lower left (LL), upper right (UR) and lower right (LR) quadrants, respectively, of a tetra-quadrant framework **(Esbjörn-Hargens, 2009; Wilber, 1996)**, as graphically depicted in **Fig. 1**.

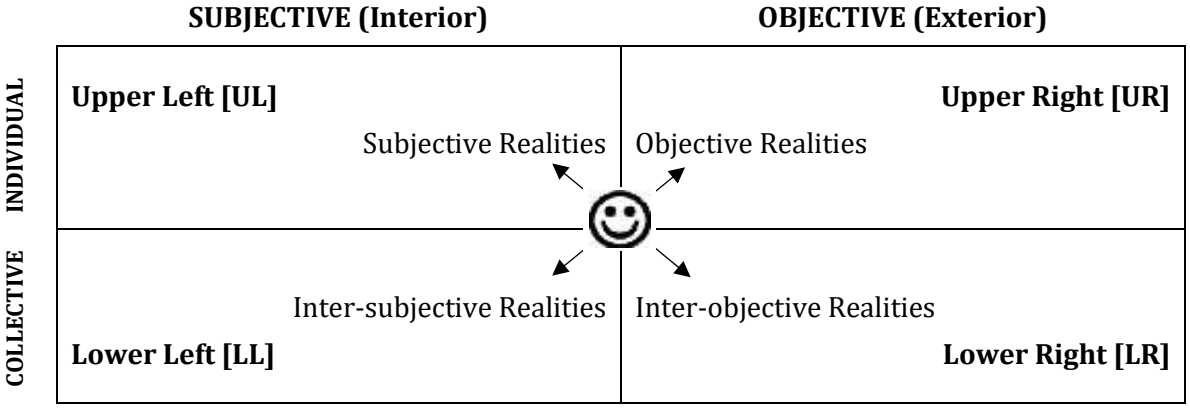

Figure 1. Tetra-quadrant Framework

Integral sustainability is a concept derived from Integral Philosophy **(Brown, 2005; De Kay, 2006; De Kay, 2011)**. It implies the integration of various dimensions of sustainability. For example, when applying the concept to a product, not only should the product be (objectively) sustainable, but it should also be (subjectively) perceived as such by both individuals and society. Suppose the acceptance of a product is to be considered. In that case, it should be based on considerations of the aspects related to the four quadrants of the Integral Sustainability Framework developed by **(Esbjörn-Hargens, 2009)**, based on what is called the 'quadratic approach', see **Fig. 2**. Note that the 'quadratic framework' is the standard way of presenting information within the discourse of Integral Philosophy.

Conventional cement, commonly known as Ordinary Portland Cement (OPC), is one of the most widely used materials in building construction. Approximately 1.7 tonnes of non-fuel, non-renewable raw materials and 3.3 to 6.3 GJ of energy are required to produce 1 tonne of OPC. Furthermore, during the production of 1 tonne of OPC, around 1 tonne of carbon dioxide, a greenhouse gas that contributes to global warming, is released into the atmosphere **(Van Oss and Padovani, 2002; 2003)**. The carbon dioxide released from the cement industry is over 5% of the total anthropogenic carbon dioxide emissions **(Hendriks et al., 1998)**. Therefore, OPC can be seen as a threat to the sustainability of the planet, and the challenge ahead in the cement industry is to develop alternative cement using alternative materials **(Schneider et al., 2011; Bediako et al., 2016; Afrin et al., 2021)**.

The research of **(Kulasuriya et al., 2014b; 2019; 2020; 2021)** was intended to study the application of Integral Philosophy in developing an alternative eco-friendly cement. For this purpose, Alkali Pozzolan Cement (APC) was selected as an example. Details regarding the mode of alkalinity and justifications for being environmentally friendly can be found in the references above. However, APC was used only as an example to keep the study as general as possible, so that findings can be extended towards developing any other eco-friendly cement. Hence, specific information about APC was not presented to the respondents when conducting social surveys. Instead, APC was introduced as an eco-friendly cement that causes less adverse impacts on the earth's sustainability since the quantities of natural resources used and carbon dioxide released for its production are relatively less than in the

case of OPC. The two primary constituent materials of APC are lime and fly ash, which are alkali and pozzolanic materials. The combination of alkali and pozzolan materials generates a cementitious mixture.

The objective engineering properties of this cement would be the basis of the two (objective) right-hand quadrants of the Integral Sustainability Framework. However, to investigate 'Alkali Pozzolan Cement' (APC) for integral sustainability, data related to individual and social perceptions (the left-hand quadrants) regarding APC must also be included. Only then can the Integral Sustainability Framework for APC **(Kulasuriya et al., 2014a)** be fleshed out.

(Mishra and Sharestha, 2019) identify quality, price, influence by others, advertising, packaging, and convenience as factors that influence consumer perception regarding a cement brand. They found that consumers are more concerned about the quality and brand than the market price. Furthermore, they found that consumers get confirmations of quality through consultants, friends, and relatives. **(Mishra, 2019)** found that advertising is the key strategy used by cement companies; and that consumers' preferences can be influenced through promotional tools such as bonus coupons and credit periods - this is related to financial aspects.

The above relatively sparse literature related to individual or social concerns about the 'four-quadrant aspects' of cement is supplemented below with that related to other products. **(Ur Rahman et al., 2023)** investigated cross-cultural perspectives on sustainable consumption. Consumers have different perspectives such as self-expression, self-reliance, social responsibility, social norms and benefits to society. They can be grouped into a 'feel good factor' and 'society's eco-values' and pertain to left-hand side quadrants. **(Syadzwina and Astuti, 2021)** reveals that manufacturers' exaggerated claims about 'eco-friendliness' or green products create scepticism among consumers and reduce their intentions to purchase green products. This implies that confirmation of eco-friendliness by a reliable authority is paramount - i.e., professionals' recommendations would help convince a potential customer. **(Grundey, 2008)** contrasted traditional marketing with the new concept of 'experiential marketing'. In traditional marketing, consumers are considered to be rational decision-makers. In contrast, in experiential marketing, consumers are regarded as not only logical but also emotional beings connected with pleasurable experiences, namely, sensory experiences (SENSE), affective experiences (FEEL), creative cognitive experiences (THINK), physical experiences, behaviours and lifestyles (ACT) and social-identity experiences (RELATE). These are directly related to the individual's subjective perceptions; and hence, to the upper left quadrant of **Fig. 2**. When applied to cement, the 'pleasurable experience' may be the 'feel good factor' arising from using sustainable cement. **(Karabiyik and Elgun, 2022)** explore the differences between modern and postmodern consumer behaviours. Instead of the simplicity of modern consumption, post-modern consumption has many dimensions, such as symbolic consumption, experiential consuming and shopping-focused behaviour, which are individual and social constructions related to the left-hand quadrants. **(Ali and Amir, 2016)** based on their research in Pakistan concluded that there is a significant correlation between the general environmental beliefs of the consumer and their confidence in green products, but no such correlation between their ecological beliefs and their behaviour. This portrays individual and social concerns relative to the given context; they may differ in another context. **(Yeniyurt and Townsend, 2003)** concluded that there is a significant association between cultural aspects and diffusion rates of new products in general; and also confirmed that the culture associated with the acceptance of new products

is affected by the context's economic, educational, and urbanization structures. Culture relates to the lower left quadrant of the Integral Sustainability Framework.

(Pickett-Baker and Ozaki, 2008) found that most consumers were likely to trust a well-known branded product rather than a lesser-known environmentally friendly one. Therefore, even a non-familiar product can be acceptable if introduced under a familiar brand name. This suggests that the majority is concerned (subjectively) about the aspects in the upper left quadrant rather than those (objectively) in the upper right quadrant. They also found that consumers 'feel good' when purchasing brands that cause less environmental damage.

(Ograh et al., 2021) conducted a systematic literature review on supplier selection by identifying the drivers for integrating Environmental Sustainability (ES) into supplier selection. They identified a variety of 31 drivers, both subjective and objective. For example, drivers such as level of awareness, high level of green knowledge, desire for a high green image reputation, desire to do the right thing, and trust building in suppliers are related to subjective aspects. In contrast, those such as financial efficiency, inclusion of green activities in performance and promotion reviews, compatibility of technology, availability of green criteria and specifications, availability of credible standards and ecolabels, access to tools that measure life cycle cost, mandatory sustainable procurement rules/legislation, formulation of policy/goals/action plans for becoming 'green', and constant monitoring, evaluation and enforcement of green procurement policies are related to objective ones. They classified these drivers into five broad categories: strong policy direction, high level of commitment, desire for high reputation, robust technology, and availability of green products. It is clear that the category 'desire for high reputation' falls into the left-hand side quadrants of the integral sustainable framework, while categories such as robust technology, availability of green products, and strong policy direction fall into the right-hand side quadrants. Where the category 'high level of commitment' is considered, its constituent drivers relating to subjective and objective aspects would fit into left-hand and right-hand side quadrants, respectively. **(Zhang and Dong, 2020)** conducted a systematic literature review on green marketing and green purchases. They classified green purchase behaviour factors into individual, product, marketing and social factors. Individual and social factors can be seen as relating to subjective aspects of the integral sustainability framework and product factors to objective aspects of the framework.

In summary, it is seen that acceptance of a new green product depends on many factors such as market price, quality, familiarity, brand name, cultural trends, environmental concerns, and confirmation of qualities, all of which are related to different quadrants of the Integral Sustainability Framework. This background knowledge was used to decide the aspects to be focused on in terms of the individual and social concerns related to the four quadrants of the framework. It is also seen from the literature that the integration of quantitative and qualitative paradigms would help understand individual and social concerns.

However, there is only limited literature on individual and social concerns regarding the acceptance of a new cement. In addition, where all products (but especially cement) are concerned, little if any work has been done to assess the concept of integral sustainability, although the notion of Integral Theory is well known in some quarters **(Wilber, 1995; Wilber, 1996; Brown, 2005; De Kay, 2006; Esbjörn -Hargens, 2009; De Kay, 2011)**. The main aim of this paper is to fill the above gaps – i.e. to investigate the individual and social concerns regarding the acceptance of new cement and to assess the integral sustainability of new cement.

The significance of the research is also twofold and related to the gaps. First, sustainability is perhaps the most crucial global challenge in the 21st century, given the current issues of global warming and climate change. Most solutions for such complex problems demand a systems approach that integrates various aspects and techniques. Since Integral Theory appears to hold promise regarding such systems thinking, applying the theory to sustainability would be an essential aim. In the process, the top-down approach of Integral Theory and the bottom-up approach of Grounded Theory are combined in a novel way. Second, concrete (of which cement is the key ingredient) is a highly consumed material globally, surpassed only by water; and also causes environmental stress via mining processes, energy consumption, and carbon emissions. Any improvement to the integral sustainability of green cements would, therefore be highly beneficial towards reducing global energy and carbon costs. This paper uses Alkali Pozzolanic Cement (APC) **(Kulasuriya et al., 2014a)** as an example of a green cement.

This work aims to investigate the application of Integral Philosophy to determine individual and social concerns regarding sustainable cement. The following were identified as specific objectives for achieving the above aim.

1. To identify aspects relevant to the four quadrants of the Integral Sustainability Framework for accepting APC (i.e. the alternative eco-friendly cement considered).
2. To investigate the individual and social concerns regarding selected aspects.
3. To analyze the social perception of APC's integral sustainability, including how individual and social concerns could vary based on social context.

2. METHODOLOGY

According to integral philosophy, individual and social concerns about an issue may not be 'out there' to collect via research. Instead, they may be grounded in the social context to be unearthed or generated using suitable methods. The following mix of methods were used.

1. The literature and an informal pilot survey were adopted to identify aspects relevant to the four quadrants of the Integral Sustainability Framework for accepting APC, as described below in the Identification of Integral Sustainability Aspects of APC.
2. A formal social survey was adopted to investigate the individual and social concerns regarding the selected aspects described below in the Investigation of Integral Sustainability Aspects of APC.
3. Two methods were adopted to analyze the social perception regarding the integral sustainability of APC. Fuzzy techniques were used to analyze the responses to closed-ended questions, and grounded theory techniques were used to analyze the responses to open-ended ones. They are described below in the Methods of Data Analysis.

2.1 Identification of Integral Sustainability Aspects of APC

The literature indicates that many factors are considered when selecting a product, including economic concerns, quality, environmental concerns, familiarity, trustworthiness, and cultural trends. It was also noted that related advertisements highlighted the price, quality, eco-friendliness, and recommendations of professionals. Brainstorming sessions also yielded further insights **(Kulasuriya, 2015)**. In summary, however, all these aspects could be subsumed under eight aspects, two for each quadrant, as seen in **Fig. 2**.

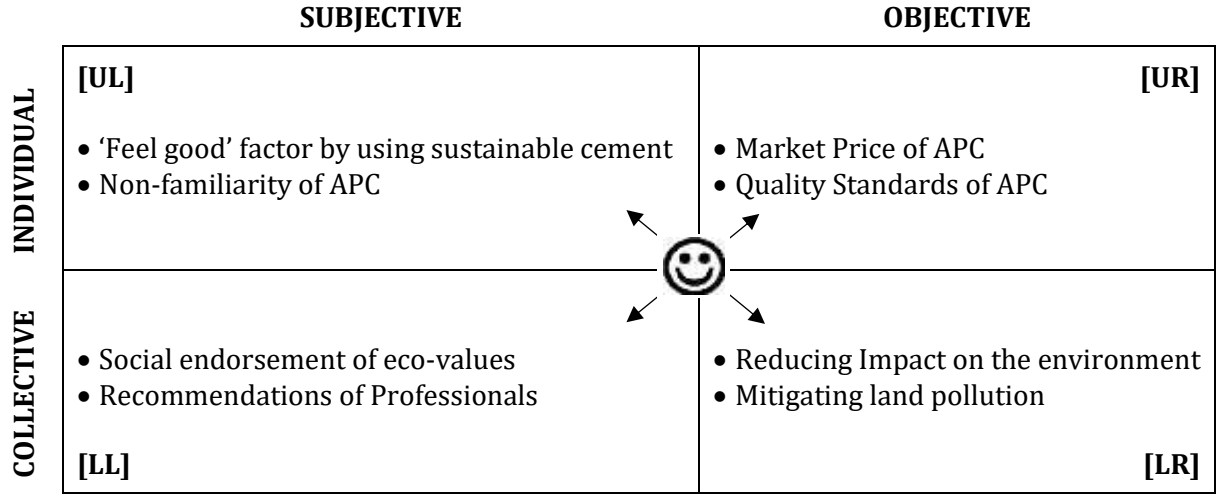

Figure 2. Individual concerns about APC: Quadratic view

2.2 Investigation of Integral Sustainability Aspects of APC

In this research, there was a need to determine both individual and social concerns regarding the aspects of the integral sustainability of APC. It should be noted that these (subjective) concerns cover both subjective and objective elements – that is an embodiment of the 'quadratic' approach of Integral Theory where the 'individual' is placed at the center (**Fig. 2**). On the other hand, if the entity under investigation (i.e. APC) is placed at the center of the quadratic framework, and the framework populated with both its subjective aspects (described in the Introduction above) and its objective aspects - already presented in the literature **(Kulasuriya et al., 2019; Kulasuriya et al., 2020; Kulasuriya et al., 2021)** – such an approach would be called a 'quadrivial' one **(Kulasuriya et al., 2014a)**. This latter approach is not covered in this paper.

It should be appreciated that social concerns cannot be determined as directly as individual ones. Moreover, this research recognised the difference between 'collections' and 'collectives' **(Kulasuriya et al., 2014a)**. Hence, a mere 'collection of individuals' cannot be considered a 'collective'. Therefore, a collection of 'concerns of individuals' cannot be considered a 'concern of the society'. It is only a 'collective concern' that can be considered the 'concern of the society'. The 'collective view' of a small focus group about a particular issue can be generated at a focus group discussion, with participants being asked to discuss an issue until a common view emerges. However, this method is inappropriate for a larger group or society. Hence, an indirect method had to be developed to obtain the 'social view'. In this method, individuals were asked about their 'individual view' regarding 'their society's view' concerning an issue. The views of separate individuals about their society's view concerning an issue would enable the construction of a 'society's view' about the issue.

Individual and social concerns may be contextual as well as universal. Hence, to ascertain such contextual variations, participants were selected from three different contexts that are directly related to the study area, namely: (i) Participants at the Concrete 2013 Conference in Australia (termed 'Australian Technologists'); (ii) Participants at the Integral Theory Conference 2013 in the USA (termed 'American Integralists'); (iii) Participants of a Green Building Workshop held in Colombo Sri Lanka in 2013 (termed 'Sri Lankan Environmentalists').

Participants at the Concrete 2013 Conference were technologists who had been associated with the construction industry in Australia, and residing five or more years in Australia. Participants at the Integral Theory Conference 2013 were either integral practitioners (who adopt integral philosophy in their professional work) or those interested in 'integral theory'; and residing in the USA for five or more years. Participants at the Green Building Workshop 2013 were those interested in 'green buildings' and 'sustainable construction materials' residing in Sri Lanka for five or more years. Hence, it could be posited that Australian Technologists, American Integralists and Sri Lankan Environmentalists were interested and knowledgeable in three specific areas related to this study: cement, integral sustainability and the environment. The data generation had to be carried out in the context of 1 to 3-day conferences. Conducting interviews with a sizable number of participants within these minimal durations was impractical. Hence, it was decided to use a questionnaire for data collection.

The purpose of the questionnaire was to determine the individual and social concerns regarding certain aspects relevant to the integral sustainability of APC and, in the process, to generate data that was unique or specific to different contexts. Closed-ended questions allow the participants to express various degrees of concern regarding the given aspects. On the other hand, open-ended questions can generate new information. Hence, both types of questions were included in the questionnaire. The complete questionnaire can be found in related literature (**Kulasuriya, 2015**). A summary of the questions in the survey instrument (i.e. questionnaire) is given in **Table 1** below.

The preliminary questions are intended to collect demographic data about the participants. Following this, Section 1 of the questionnaire contained closed-ended questions to generate data related to the eight aspects of APC presented in **Fig. 2**. Section 2 of the questionnaire also contained a closed-ended question to determine the overall view concerning APC. In contrast, Section 3 of the questionnaire had one open-ended question inviting participants to express opinions on the selection of cement.

Questions in sections 1 and 2 of the questionnaire had the same format - an 'introductory statement' and two sub-sections: Part (a) and Part (b). Both in Parts (a) and (b), a spectrum of linguistic labels from Very Low (VL) through Low (L), Medium (M), and High (H) to Very High (VH) were given to indicate the responses. The category 'medium' was divided into 'medium-low' (ML) and 'medium-high' (MH) to avoid the 'central tendency' **(Dias, 1999)**. Participants were made aware that the size of the ranges for ML and MH is half that of ranges of other linguistic labels. Thus, participants could choose one of 6 labels: VL, L, ML, MH, H, and VH.

2.3 Methods of Data Analysis

The data generated through sections 1 and 2 of the questionnaire concern specific aspects related to APC, while the data generated through Section 3 have no such focus and can be seen as having emerged freely. Hence, two different methods were used to analyze the data. Responses to closed-ended questions were given using linguistic labels (e.g. 'very low' to 'very high'). In reality, human preferences are expressed in terms that do not have clear-cut boundaries. Their boundaries are fuzzy, with 'overlapping areas' between them. Hence, a 'step scale' may not be the best way to represent these responses; instead, they are converted to a fuzzy scale, as described later.

Table 1. A Summary of Questions in the Survey Instrument

Qn No.	The Aspect Inquired by the Question	Part (a)	(Part b)
		What degree of importance would you assign to this aspect in selecting the new cement over conventional cement if you were to build your own house?	In your view, what degree of importance do you think the society you presently live in would assign to this aspect in selecting the new cement over conventional cement to build houses?
Section 1			
Q1	Market Price of the new cement	VL/L/ ML/MH/H/VH	VL/L/ ML/MH/H/VH
Q2	Quality Standards of the New Cement	VL/L/ ML/MH/H/VH	VL/L/ ML/MH/H/VH
Q3	Reducing the Impact on the environment of cement	VL/L/ ML/MH/H/VH	VL/L/ ML/MH/H/VH
Q4	Contribution to mitigating land pollution by new cement	VL/L/ ML/MH/H/VH	VL/L/ ML/MH/H/VH
Q5	Non-familiarity of the new cement	VL/L/ ML/MH/H/VH	VL/L/ ML/MH/H/VH
Q6	'Feel good' factor by using sustainable cement	VL/L/ ML/MH/H/VH	VL/L/ ML/MH/H/VH
Q7	Social endorsement of eco-values of new cement	VL/L/ ML/MH/H/VH	VL/L/ ML/MH/H/VH
Q8	Recommendations of Professionals for new cement	VL/L/ ML/MH/H/VH	VL/L/ ML/MH/H/VH
Section 2			
Q9	Overall acceptability	VL/L/ ML/MH/H/VH	VL/L/ ML/MH/H/VH
Section 3			
Q10	Open-ended questions to express any other views/ideas of the participants.		

Part (a) & Part (b) of Questions:
In Part (a), the participants were asked to indicate the degree of importance they would assign to the given aspect when selecting the new cement over the conventional cement if they were to build their own house, using linguistic labels.
In Part (b), the participants were asked to indicate the degree of importance they thought that 'the society they presently live in' would assign to the given aspect in selecting the new cement over conventional cement to build houses, using linguistic labels.

Linguistic Labels used to indicate 'Degree of Importance':
VL-Very Low; **L**- Low; **ML**- Medium Low; **MH**- Medium High; **H**-High; **VH**-Very High

In Section 3 of the questionnaire, the open-ended question provided a platform to generate data grounded in various contexts freely. Hence, such data are analyzed using grounded theory techniques. Compared with the dominant positivist research methodology developed by Auguste Comte (1798–1857), Grounded Theory is a relatively new research methodology developed in the social sciences **(Glaser and Strauss, 1967)**. It is a research methodology that can be employed to arrive at theory (or overarching concepts) by analyzing the

'grounded' data. Even though it was developed in social sciences, grounded theory techniques have been successfully applied in many other fields **(Haig, 1995)**.
Further, they have been combined with other analytical techniques and applied to develop theories and identify phenomena. For example, **(Chandratilake and Dias, 2004)** used grounded theory techniques to study the vulnerability of buildings to blast events. Another example is that **(Pidgeon et al., 1991)** used grounded theory to conceptualise information gained through knowledge elicitation regarding engineering hazards. The application of grounded theory techniques is described in detail later.
The questionnaire surveys were conducted in the three contexts described earlier. To ensure that the participants had a reasonable understanding of their context (i.e. the society they lived in), only the responses of participants residing for over five years in the given context were considered for analysis. The respondents to the questionnaire in Australia, America, and Sri Lanka were 80, 83 and 39, respectively; however, the numbers filtered based on the above residency criterion were 51, 40 and 37, respectively.

3. RESULTS AND DISCUSSION

3.1 Analysis of Responses to Closed-Ended Questions

The fuzzy set theoretical framework suggested by **(Dias, 1999)** was adopted to analyse the responses to closed-ended questions. First, the responses to closed-ended questions, which were in the form of linguistic labels (e.g. 'very low' to 'very high'), were arranged along the X–axis, and the degree of support (0 to 1) for the responses was indicated on the y–axis as shown in **Fig. 3**. The area covered by each fuzzy set in **Fig. 3** is 0.2, except that of ML and MH, which cover an area of 0.1 each.
The responses obtained from participants in three different contexts were grouped and analyzed separately to investigate the contextual differences in views regarding the issues. First, reactions to a particular question were selected from a specific context. Then, each of those responses was converted to its fuzzy curve representation. Next, the individual fuzzy curves were added and averaged to obtain a cumulative curve. The mean response to that question was found by dividing the area covered by the cumulative curve by the total number of responses to that particular question.

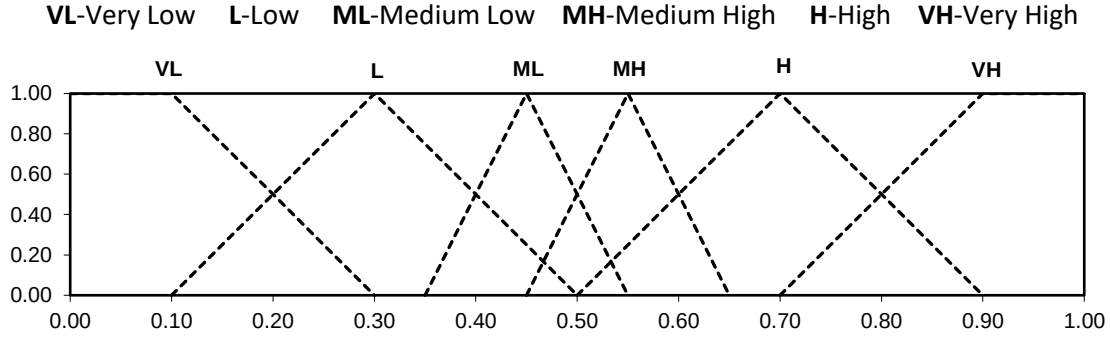

Figure 3. Fuzzy set definitions

The above procedure is expressed mathematically below. The following general equation defines the complete fuzzy set F,

$$F = [x_i, \mu F(x_i)) \mid x_i = x_1 \ldots x_n] \quad (1)$$

Here, $\mu F(x_i)$ is the support allocated to x_i in F, which indicates the degree to which x_i belongs to F.

Six fuzzy sets have been defined to cover the linguistic range VL to VH. A particular curve can be denoted F_r. Then the 'Degree of Identity' (DoI) of the mean response (M) with a selected fuzzy curve F_r is based on the intersection of the two curves and defined as,

$$DoI(M, F_r) = |M \cap F_r| / |F_r| \quad (2)$$

Here,

$$M \cap F_r = [x_i, \ min(\mu F(x_i), \ \mu M(x_i))] \quad (3)$$

$$|F_r| = \sum \mu F(x_i), \ x_i = x_1 \ldots x_n \quad (4)$$

$$|M \cap F_r| = \sum min[\mu F(x_i), \ \mu M(x_i)], \ x_i = x_1 \ldots x_n \quad (5)$$

Here, the operator | | represents the relevant area of the fuzzy set.

In all cases, it can be said that $0 \leq DoI(M, F_r) \leq 1$

A cut-off level (α) is introduced for DoIs, and those falling at or above this level are termed 'significant DoIs'. The most significant or largest DoI represents the 'mode' of the responses, defined as the reaction captured by a particular linguistic label most often; or the most predominant view.
In the fuzzy sets shown in **Fig. 4**, x_i varies from 0 to 1 in discrete steps of 0.05. For example, the linguistic label 'High' or 'H' is defined for xi values of 0.55, 0.60, 0.65, 0.70, 0.75, 0.80 and 0.85 with supports $\mu F(x_i)$ of 0.25, 0.50, 0.75, 1.00, 0.75, 0.50 and 0.25 respectively. The mean response of participants in the Australian Technologists group for a single question has been superimposed on the range of fuzzy sets.

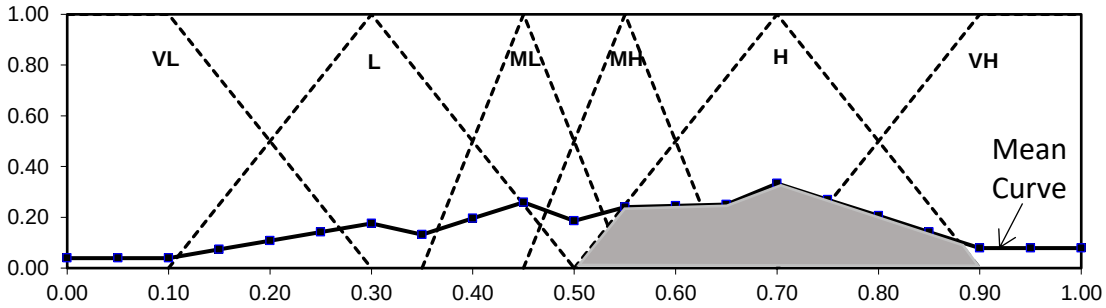

Figure 4. Mean responses for Question 5, Part (a) of Australian participants

The mean response is represented by the area under the mean curve (*M)*. Then, the entity $|M \cap F_r|$ represents the area of intersection of the mean curve M and the fuzzy curve F_r. The entity |Fr| represents the area under the fuzzy curve 'F_r'. The ratio of the former to the latter gives the Degree of Identity (DoI) of the mean response with the fuzzy curve F_r. In **Fig. 4**, the

fuzzy curve considered for illustration (F_r) is the curve that represents the linguistic label 'high' or H. The intersection of the mean curve and the fuzzy curve H is highlighted. Then, the DoI for H can be computed by dividing this area by the area under the fuzzy curve H - more details are found in **(Kulasuriya, 2015)**.

The entity DoI(M, F_r), which is the 'degree of identity of mean responses' (M) with a given fuzzy curve (F_r), indicates the extent to which a given linguistic label has been assigned as the response to a particular question. Hence, if the value of the DoI for a particular fuzzy curve (say H) is relatively large, it can be said that the concerns are 'high'. However, the fuzzy curve M would inevitably intersect with other F_r curves. The DoIs for those curves will reflect the spread in levels of concern.

The DoIs for all the fuzzy curves corresponding to the linguistic labels were computed and tabulated for the responses obtained from Australian Technologists (**Table 2**), American Integralists (**Table 3**), and Sri Lankan Environmentalists (**Table 4**). In these tables, the rows from Q1 to Q9 represent aspects of integral sustainability for APC. The key to the aspects **(Table 1)** is as follows: Q1 - Market price; Q2 - Quality standards; Q3 - Impact on the sustainability of the Earth; Q4 - Mitigating land pollution; Q5 - Non-familiarity; Q6 - 'Feel good' factor; Q7 - Social trends; Q8 - Recommendations of professionals; Q9 - Overall acceptability.

It should be noted that Questions 1 to 8 are intended to ascertain the degree of importance of different aspects that are considered when selecting APC. Question 9 queries the degree of overall acceptance of APC. Part (a) in the Table represents the DoIs related to individuals, while Part (b) those related to society. Part (a) and Part (b) contain the spectrum of linguistic labels from VL to VH.

Somewhat arbitrarily and guided by the results, DoIs falling at or above a 0.33 cut-off level were interpreted as 'significant DoIs', while those above 0.55 were deemed 'highly significant DoIs'. DoIs below 0.33 are omitted in **Tables 2** to **4** for clarity. The maximum DoI for each question, which reflects the 'mode' for the response, is indicated in bold font. For a particular question, if significant DoIs are generally on the right-hand side (RHS) of the spectrum of linguistic labels, then it can be said that the aspect considered is essential. Similarly, the element is considered less critical if significant DoIs fall on the spectrum's left-hand side (LHS).

Table 2. DoIs for 'Australian technologists'

Section	Q	Part (a) - Individuals						Part (b) - Society					
		VL	L	ML	MH	H	VH	VL	L	ML	MH	H	VH
Sec I	**Q1**				0.45	**0.58**					0.38	**0.67**	0.38
	Q2					**0.61**	0.51				0.42	**0.49**	0.33
	Q3				0.52	**0.56**	0.33				0.46	**0.50**	
	Q4				0.48	**0.56**	0.33				0.43	**0.53**	
	Q5			0.38	0.40	**0.43**					0.40	**0.55**	
	Q6			0.39	**0.45**	0.43				0.35	0.48	**0.50**	
	Q7			0.38	**0.39**	0.37					0.45	**0.55**	
	Q8				0.43	**0.61**	0.40				0.42	**0.63**	0.40
Sec II	**Q9**				0.45	**0.69**					0.53	**0.55**	

Table 3. DoIs for 'American integralists'

Section	Q	Part (a) - Individuals						Part (b) - Society					
		VL	L	ML	MH	H	VH	VL	L	ML	MH	H	VH
Sec I	**Q1**				**0.53**	0.50						0.34	**0.62**
	Q2					0.50	**0.57**				0.39	0.45	**0.46**
	Q3					0.55	**0.61**			0.43	**0.53**	0.36	
	Q4				0.36	0.50	**0.52**			**0.46**	0.44		
	Q5		**0.50**	0.44							**0.52**	0.48	
	Q6				0.39	**0.61**	0.46		0.33	0.45	**0.46**		
	Q7			0.39	**0.47**	0.33				0.32	**0.56**	0.47	
	Q8				0.33	**0.57**	0.54				0.49	**0.56**	0.40
Sec II	**Q9**					0.55	**0.63**				**0.52**	0.44	

Table 4. DoIs for 'Sri Lankan environmentalists'

Section	Q	Part (a) - Individuals						Part (b) - Society					
		VL	L	ML	MH	H	VH	VL	L	ML	MH	H	VH
Sec I	**Q1**				0.44	**0.65**						**0.57**	
	Q2				0.33	**0.58**	0.48			0.33	0.36	**0.45**	
	Q3					**0.62**	0.58				0.38	**0.52**	
	Q4				0.33	**0.60**	0.49				0.38	**0.45**	
	Q5		0.33	0.37	**0.42**	0.33			**0.50**	0.39			
	Q6				0.36	**0.58**	0.53				0.42	**0.49**	
	Q7				0.43	**0.57**	0.33				0.48	**0.58**	0.33
	Q8				0.33	**0.67**	0.50				0.36	**0.51**	0.44
Sec II	**Q9**				0.42	**0.68**	0.43			0.32	0.47	**0.51**	

3.2 Discussion on Responses to Closed-Ended Questions

Significant DoIs tend towards the RHS for Parts (a) and (b) in Australia and Sri Lanka but are scattered over the whole range in America. This implies that Australian Technologists and Sri Lankan Environmentalists and their societies generally consider as important the aspects they were queried on; and are also positive about using APC. The position of most modes is H in Parts (a) and (b) in Australia and Sri Lanka, implying an agreement of predominant views between individuals and societies. The modes from America are mostly VH in Part (a) but MH in Part (b). The predominant views of American Integralists indicate that aspects related to the integral sustainability of APC, such as quality standards (Q2) and sustainability issues (Q3), are very important. However, external variable factors such as non-familiarity (Q5) and social trends (Q7) are not. There is also no agreement on predominant views between individuals (American Integralists) and their society (American society). The reason could be that the holistic opinions held by American Integralists differ from their society.

Significant DoIs for Q1 (market price) and Q2 (quality standard) are located within the RHS in Parts (a) and (b) for all three countries. This indicates that individuals and societies in all three countries consider the objective aspects of market price and quality standards very important. The reason is that contemporary societies are very concerned about the primary expectation of cement, that is, its quality; at the same time, they are concerned about the money they spend. Significant DoIs for Q3 (impact on the sustainability of earth) and Q4 (mitigating land pollution) are spread over the RHS in Parts (a) and (b) in all three countries, except in Part (b) for America. This implies that individuals and societies generally consider ecological issues as necessary. It could be that the current discourse on sustainability has made them aware of environmental problems; American society may be an exception.

Q2 is about the 'quality standards', and Q8 is about the 'recommendation of professionals'. Significant DoIs for Q2 and Q8 are spread over the RHS in Parts (a) and (b) in all three countries. This implies that individuals and societies of all three countries consider 'quality standards' necessary; further, they need professional confirmation or assurance. Contemporary societies are very concerned about the performance of a product they select. Also, the establishment of professionalism in contemporary society has caused it to seek and trust professional recommendations.

The spread of significant DoIs for Q5 and Q6 shows a somewhat reciprocal pattern (i.e. spread in opposite directions) in both Parts (a) and (b), with Australia perhaps an exception. That implies that the acceptance of non-familiar products is inversely related to the 'feel good' factor through using sustainable products. The reason may be that individuals and societies have realistic views about the issue; i.e., they accept that a new product is always non-familiar. Hence, those who want to feel good by selecting eco-friendly cement are prepared to forego 'familiarity'. On the other hand, those who wish to adhere to 'familiarity' are willing to sacrifice the 'feel good' factor.

For Q9 (overall acceptability), the values of modes for Part (a) are always more significant than those of Part (b). The position of the mode is H in Parts (a) and (b) in Australia and Sri Lanka, but VH in Part (a) and MH in Part (b) of America. This implies that the 'overall acceptability of APC' is generally high for societies and much higher for individuals in all three countries. In particular, acceptance by American Integralists is very high, reflected by a high mode (DoI = 0.63) positioned in VH.

When country-wise comparisons are made, the most noticeable difference is that in Sri Lanka, in Parts (a) and (b) for Q7 (social trends), significant DoIs tend towards the far RHS end, but not so much in Australia and America. This suggests that for Sri Lankan Environmentalists as well as Sri Lankan society, 'social trends' play an essential role in the selection of cement. The reason may be attributed to the 'collective, dependent, eastern culture' in Sri Lanka, compared to the 'individualistic, independent, western culture' in Australia and America.

When society-wise comparisons are made, an evident difference is that in America, for Part (b) of Q6 ('feel good' factor), significant DoIs tend towards the far LHS, but not so in Australia and Sri Lanka. This indicates that American society does not consider the 'feel good' factor in selecting eco-friendly cement as important. Another notable feature is that for Part (b) of Q5 (non-familiarity) in Sri Lanka, significant DoIs tend towards the far LHS, not Australia and America. This suggests that for Sri Lankan society, non-familiarity is not an issue. The reason may be that the 'big store' and 'branded name' concepts are firmly established in Australia and America when purchasing most products, but not so much in Sri Lanka.

When individual-wise comparisons are made, a marked difference is that in America and Sri Lanka, for Q5 (non-familiarity) of Part (a), significant DoIs are spread towards the far LHS,

but not so in Australia. This implies that non-familiarity is not an issue for American Integralists and Sri Lankan Environmentalists.

Table 5 presents all aspects with DoIs greater than 0.55; they are also the maximum DoIs for each aspect, and hence 'modes'. Part (a) of **Table 5** has more entries in all three countries than in Part (b). This implies that views among Australian Technologists, American Integralists, and Sri Lankan Environmentalists are more focused than their societies. The reason could be that their common specific knowledge may have guided their thinking. Apart from one mode at an MH level and three at a VH level, all others are at level H.

In general, among individuals and societies of all three countries, there is a predominant view that market price is important. Among all three groups of focused individuals, there are strong views that quality standards and professional recommendations are important. Even though there is no such strong view about quality standards among societies, there is such a view about professional recommendations (implying that confirmation of quality standards is important). All three groups of individuals strongly expressed the view that consideration of 'impact on sustainability' is important.

The position of most modes in Section 1 of the questionnaire (Q1 to Q8), related to individual aspects, and that of the mode of Q9 in Section 2, related to overall acceptability, are the same in all three tables for both Parts (a) and (b). Hence, the good fit between the positions of modes in Sections 1 and 2 of **Tables 2 to 4** yields some internal validation of the questionnaire responses and analyses.

3.3 Analysis and Discussion of Responses to Open-Ended Questions

Section 3 of the questionnaire contained an open-ended question, the responses to which were analyzed using 'Grounded Theory'. It involves four stages, as depicted below:

CODES ⇨ CONCEPTS ⇨ CATEGORIES ⇨ THEORY

Table 5. The most prominent concerns of individuals and societies

CONTEXT	Part (a) – Individuals	Part (b) - Society
Australia	Quality standards: H(0.61) Prof. recommendations: H(0.61) Market price: H(0.58) Impact on sustainability: H(0.56) Mitigating land pollution: H(0.56)	Market price: H(0.67) Prof. recommendation: H(0.63)
America	Impact on sustainability: VH(0.61) 'Feel good' factor: H(0.61) Quality standards: VH(0.57) Prof. recommendations: H(0.57)	Market price: VH(0.62) Social trends: MH(0.56) Prof. recommendations: H(0.56)
Sri Lanka	Prof. recommendations: H(0.67) Market price: H(0.65) Impact on sustainability: H(0.62) Mitigating land pollution: H(0.60) Quality standards: H(0.58) 'Feel good' factor: H(0.58) Social trends: H(0.57)	Social trends: H(0.58) Market price: H(0.57)

In the first stage, the data are analyzed, and the key points are identified and coded. In the second stage, the codes are compared, similar codes are grouped, and concepts are allowed to emerge. In the third stage, the concepts are compared, identical ideas are grouped, and broad categories are formed. In the fourth and final stage, the categories are linked, leading to the emergence of theory. Since the theory emerges from the live data, the need for separate 'testing of the theory' does not arise **(Allan, 2003)**.

In this research, the purpose of employing grounded theory techniques is not to develop theory but to uncover the concepts grounded in the selected contexts and assign them to one of the four categories of the Integral Sustainability Framework. Therefore, a bottom-up approach was adopted to develop the concepts. At the same time, a top-down one was applied to assign the concepts to the relevant categories of the Integral Sustainability Framework.

Concepts, categories, and theories discovered by grounded theory techniques are context-dependent. Grounded theory techniques are commonly applied to a raw data set related to a particular context, and then the concepts, categories, and theories related to that context are discovered. In this research, the most extensive data came from Sri Lankan participants; note that although most of the participants were from Australia and America, most of the responses to the open-ended questions were from Sri Lankan participants. Hence, the data set generated from Sri Lanka was selected for analysis.

In the first stage, each transcript was read, and codes (expressions arising from data) were identified and numbered. In the second stage, the related coded data were grouped, and concepts began to emerge. In other words, a bottom-up approach was adopted to unearth the concepts grounded in the data. The 28 ideas that emerged from the data are presented in **Table 6.** One of them is demonstrated below:

Coded Data Group 2

SL5/6 - Inside everyone, there is an environmentalist
SL5/7 - Important to educate people about green products
SL5/8 - People would accept APC if they were educated (about eco-friendly products)
SL22/1 - Society will accept APC if they are made aware of environmental issues.

Emerged CONCEPT

Environmental awareness/education (Related to individuals as well as to society)

Rather than generating categories from concepts in the usual grounded theory approach, the ideas that emerged were placed in the pre-defined Integral Theory framework of categories (UL, LL, UR, and LR), as given in **Table 6.** Therefore, a mixed bottom-up and top-down approach is used in this research.

Once a set of concerns, such as in **Table 6,** is available, appropriate context-based strategies can be used to tackle them **(Kulasuriya, 2015)**. For example, some of the concerns raised are (i) the long-term effect on the properties of APC, (ii) assurances given about APC, and (iii) health/risk-related issues for the user. The relevant strategies could be (i) specifications for durability, (ii) arriving at guarantee periods, and (iii) safety data sheets, respectively, all of which can be combined with professional certification. **Table 6.** relates to the Sri Lankan context. Similar tables can be generated for the other two contexts explored. Strategies can be targeted to these contextual peculiarities. Conversely, if a more general or global view of concepts is desired, the concepts from contexts can be compared and combined within the Integral Theory categories.

Table 6. Emerged concepts placed within the four quadrant categories

[UL]	**[UR]**
Emotions, Beliefs, Self-identity: I: Individual's nature-loving attitude I: Individual's sustainability /environmental concerns I: Individual's optimistic attitude I: Individual's pessimistic attitude I: Individual's readiness to re-consider with more information I: Individual's hesitation about new materials I: Individual belief & self-identity	**Price, Physical Properties:** I & S: Concern about market price I & S: Specific qualities related to engineering properties I & S: General qualities related to engineering properties I: Long-term effect (durable properties) I: Type of structure/type of application I: Health/risk related Issues
Philosophical, Ethical, Religious Worldviews: S: Culture of loving nature S: Ethical considerations S: Acceptance of professional recommendations S: Social trends I & S: Trends/culture of accepting a product S: Culture of resistance to change S: Culture of readiness to change S: Culture of adaptability	**Environmental, Ecological, Educational, Economic, Legal Aspects:** I & S: Overall economic gains I & S: Confirmation of quality I & S: Proof I & S: Environmental awareness/education I: Guarantee/assurance I: Consideration of environment and ecological systems I: Consideration of the combined effect
[LL]	**[LR]**
KEY: The concepts related to 'Individuals' and 'Society' are indicated by the letters 'I' and 'S'.	

4. CONCLUSIONS & RECOMMENDATIONS

The main aim of the research was to investigate the application of Integral Philosophy to determine individual and social concerns regarding selected aspects related to the integral sustainability of Alkali Pozzolan Cement (APC) and to discover any other major concerns of individuals and societies related to the four quadrants of the Integral Sustainability Framework.

The aspects selected for investigation were the 'feel good' factor by using APC, non-familiarity with APC, social endorsement of eco values of APC, recommendations for APC by professionals, market price of APC, quality standards of APC, reduction of environmental impact through the use of APC, and mitigation of land pollution through using industrial waste in APC. As described before, of course, APC can be seen as a proxy for any eco-friendly cement. The participants selected for the social survey, from Australia, the USA, and Sri Lanka, can be considered interested and knowledgeable persons in three areas related to this study: cement, integral sustainability, and environment.

The following conclusions can be made:

1. Individuals and societies of the three countries attach high degrees of importance to market price and quality standards (directly or through professional recommendations). Individuals also attach a high degree of importance to impacts on environmental sustainability. Such aspects are favourable for the integral sustainability of APC. Aspects unfavourable to APC, such as non-familiarity, have not been given high importance by individuals, but societies have been seen as doing so. However, when overall acceptability

is considered, it is seen that there is a high degree of acceptance of APC as an integral sustainable cement in all three countries.
2. There are apparent contextual differences in assigning importance to different aspects. For example, 'social trends' were considered important in Sri Lanka but not Australia and America. Also, while the views of focused individuals matched those of their societies in Australia and Sri Lanka, it was not so in America - with 'American Integralists' demonstrating very high acceptance of APC, while their society was seen as accepting it with only medium-high support.
3. Some new concerns were identified through the responses to the open-ended question. The most important among them were the long-term effects on the properties of APC, assurances that could be given about APC, and health/risk-related issues for the user.
4. Complementing the bottom-up approach inherent in Grounded Theory with the top-down identification of categories in Integral Theory can be seen as a novel contribution towards social science research methodology.

The following recommendations can be identified from this study for introducing sustainability-promoting cement such as APC: (i) Obtaining the endorsement of professionals; (ii) Accounting for contextual difference; (iii) Carrying out awareness campaigns; and (iv) Providing assurances concerning perceived areas of concern.

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Declaration of Competing Interest

The authors declare that they have no financial or other substantive conflicts of interest that may be construed to influence the results or interpretation of their manuscript.

REFERENCES

Afrin, H., Huda, N., and Abbasi, R., 2021. An Overview of Eco-Friendly Alternatives as the Replacement of Cement in Concrete. *IOP Conference Series: Materials Science and Engineering, 1200 (1), P. 012003*. Doi:10.1088/1757-899X/1200/1/012003.

Ali, M., and Amir, M., 2016. Pro-environmental products: Marketing influence on consumer purchase decision. *Arabian Journal of Business and Management Review (OMAN Chapter)*, 5(6). pp. 1-15 https://www.arabianjbmr.com/pdfs/OM_VOL_5_(6)/R1.pdf

Allan, G.W., 2003. The use of grounded theory as a research method. *Proceedings of the 2nd European Conference on Research Methodology for Business and Management Studies*, pp. 9-19.

Bediako, M., Adobor, C.D., Amankwah, E.O., Nyako, K., and Kankam, C.K., 2016. Maximizing the sustainability of cement utilization in building projects through the use of greener materials. *Journal of Engineering*, 2016. Doi:10.1155/2016/1375493.

Brown, B.C., 2005. Theory and practice of integral sustainable development – An overview: Part 1-Qudrants and the practitioner. *AQAL Journal of Integral Theory and Practice*, 1(2), pp. 351-386.

De Kay, M., 2011. *Integral Sustainable Design: Transformative Perspectives*. London: Earthscan.

De Kay, M., and Guzowski, M., 2006. A model for integral sustainable design explored through daylighting. *Proceedings of the 2006 American Solar Energy Society (ASES) Conference*, Boulder, Colorado.

Dias, W.P.S., 1999. Soft systems approaches for analysing proposed change and stakeholder response - A case study. *Civil Engineering and Environmental Systems*, 17(1), pp. 1-17. Doi:10.1080/02630259908970271.

Chandratilake, S.R., and Dias, W.P.S., 2004. Identifying vulnerability to blast loading using grounded theory. *Engineering Research Unit Symposium on Research for Industry*, University of Moratuwa, Sri Lanka. http://dl.lib.mrt.ac.lk/handle/123/9639.

Esbjorn-Hargens, S., 2009. An overview of integral theory: An all-inclusive framework for the 21st Century. *Integral Institute*, Resource Paper No. 1, pp. 1-24.

Glaser, B.G., and Strauss, A. L., 1967. *The Discovery of Grounded Theory. Strategies for Qualitative Research*. Aldine Publishing, Chicago.

Grundey, D., 2008. Experiential marketing vs. traditional marketing: Creating rational and emotional liaisons with consumers. *The Romanian Economic Journal*, 29(3), pp.133-151.

Haig, B.D., 1995. Grounded theory as scientific method. *Philosophy of education,* 28(1), pp. 1-11.

Hendriks, C.A, Worrell, E., De Jager, D., Blok, K., and Riemer, P., 1998. Emission reduction of greenhouse gases from the cement industry. *Proceedings of the Fourth International Conference on Greenhouse Gas Control Technologies*. Doi:10.1016/B978-008043018-8/50150-8.

Huckle, J., and Martin, A., 2001. *Environments in a changing world*. Routledge. London.

Karabiyik, H.C., and Elgun, M.N., 2022. A comparative theoretical discussion on the modern and postmodern consumer behaviors. *Optimum Ekonomi ve Yönetim Bilimleri Dergisi*, 9(2), pp. 229-242.

Kulasuriya, C., 2015. *Alkali Pozzolan Cement for Integral Sustainability*. PhD thesis submitted to Curtin University, Perth, 2015.

Kulasuriya, C., Dias, P., and Vimonsatit, V., 2014a. Integral sustainability of Alkali Pozzolan cement. An integral theory application in civil engineering. *Journal of Integral Theory & Practice*, 9(1), pp. 74-87.

Kulasuriya, C., Vimonsatit, V., Dias, W.P.S., and De Silva, P., 2014b. Design and development of alkali pozzolan cement (APC). *Construction and Building Materials*, 68, pp. 426-433. Doi:10.1016/j.conbuildmat.2014.06.095.

Kulasuriya, C., Dias, W.P.S., and Vimonsatit, V., 2019. Durability properties of Alkali Pozzolan Cement (APC). *Journal of the National Science Foundation of Sri Lanka*, 47(1), pp. 121–131. Doi:10.4038/jnsfsr.v47i1.8929.

Kulasuriya, C., Vimonsatit, V., and Dias, W.P.S., 2021. Performance-based energy, ecological and financial costs of a sustainable alternative cement. *Journal of Cleaner Production,* 287, P. 125035. Doi:10.1016/j.jclepro.2020.125035.

Kulasuriya, C., Dias, W.P.S., Vimonsatit, V., and De Silva, P., 2020. Mechanical and microstructural properties of Alkali Pozzolan Cement (APC). *International Journal of Civil Engineering*, 18, pp. 1281–1292. Doi:10.1007/s40999-020-00534-3.

Lincoln, Y.S., and Guba, E.G., 1985. *Naturalistic Inquiry*. SAGE Publications, Inc., Beverly Hills, Calif.

Mishra, A.K., and Sharestha, B., 2019. Assessment of consumer influencing factor in decision making for selecting cement brands. *South Asian Research Journal of Business and Management*, 1 (3), pp. 91-105. Doi:10.36346/sarjbm.2019.v01i03.002

Mishra, A.K., 2019. Influential marketing strategies adopted by the cement industries. *International Journal of Research-Granthaalayah*, 7(10), pp. 155-173. Doi:10.5281/zenodo.3522195.

Ograh, T., Ayarkwa, J., Osei-Asibey, D., Acheampong, A., and Amoah, P., 2021. Drivers of integration of green into supplier selections: a systematic literature review. *International Trade, Politics and Development*, 5(2), pp. 136-155. Doi:10.1108/ITPD-09-2021-0011.

Pickett-Baker, J., and Ozaki, R., 2008. Pro-environmental products: Marketing influence on consumer purchase decision. *Journal of Consumer Marketing*, 25(5), pp. 281-293. Doi:10.1108/07363760810890516.

Pidgeon, N. F., Turner, B. A., and Blockley, D. I., 1991. The use of grounded theory for conceptual analysis in knowledge elicitation. *International Journal of Man-machine Studies*, 35(2), pp. 151-173. Doi:10.1016/S0020-7373(05)80146-4.

Schneider, M.,Romer, M., Tschudin, M., and Bolio, H. 2011. Sustainable cement production—present and future. *Cement and Concrete Research*, 41(7), pp. 642–650. Doi:10.1016/j.cemconres.2011.03.019.

Syadzwina, M.N., and Astuti, R.D., 2021. Linking green skepticism to green purchase behavior on personal care products in Indonesia. *IOP Conference Series: Earth and Environmental Science* (Vol. 716, No. 1, p. 012045). IOP Publishing. Doi:10.1088/1755-1315/716/1/012045

Ur Rahman, S., Chwialkowska, A., Hussain, N., Bhatti, W.A., and Luomala, H., 2023. Cross-cultural perspective on sustainable consumption: Implications for consumer motivations and promotion. *Environment, Development and Sustainability*, 25(2), pp. 997-1016. Doi:10.1007/s10668-021-02059-8

Van Oss, H.G., and Padovani, A.C., 2002. Cement manufacture and the environment, Part I: Chemistry and Technology. *Journal of Industrial Ecology*, 6 (1), pp. 89-106. Doi:10.1162/108819802320971650.

Van Oss, H.G., and Padovani, A.C., 2003. Cement manufacture and the environment Part II: Environmental Challenges and Opportunities. *Journal of Industrial Ecology*, 7 (1), pp. 93-126. Doi:10.1162/108819803766729212.

Yeniyurt, S., and Townsend, J.D., 2003. Does culture explain the acceptance of new products in a country? An empirical investigation. *International Marketing Review*, 20(4), pp. 377-396. Doi:10.1108/02651330310485153.

Wilber, K., 1995. *Sex, ecology, spirituality: The spirit of evolution*. Shambhala Publications, Boston.

Wilber, K., 1996. *A brief history of everything*. Shambhala Publications, Boston.

Zhang, X., and Dong, F., 2020. Why do consumers make green purchase decisions? Insights from a systematic review. *International journal of environmental research and public health*, 17(18), No. 6607, pp. 1- 25. Doi:10.3390/ijerph17186607.