

# ANALYSIS OF HETEROGENEOUS PERSPECTIVES ON SUSTAINABLE PRACTICES AMONG JAPANESE CONCRETE INDUSTRY STAKEHOLDERS

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## 1. INTRODUCTION

Sustainable concrete implementation faces many challenges. It is important to understand the stakeholders' perceptions of practices on performance aspects and sustainable development aspects so sustainable concrete can be developed and applied. Besides understand these perceptions, the collected information also should be analyzed to accurately reflect the respondent's opinion. From that, this research has as a goal to compare the perceptions of stakeholders of the concrete industry when in homogeneous groups and groups separated by agglomerative clustering analyze based on similarities. So, it would improve the reliability of the data set and it could be used to help to implement sustainable measures in Concrete Industry.

## 2. METHODOLOGY

The research is based on the data collected by [1]. The questionnaire was conducted by making a bottom-up investigation survey with professionals related to the concrete industry in Japan. A total of 210 responses were analyzed by this research with four groups of stakeholders named as Academic, Owners, Contractors, and Material. The questionnaire evaluated the stakeholders' perception and asked them to attribute importance levels to concrete performance aspects and sustainable development aspects for sustainable practices in the concrete industry in Japan. The main evaluation was composed of nine questions, divided into two subjects, one about the concrete performance parameters (JSCE) and the other from the sustainable indicators (United Nation). The answers were separated on a scale that expressed how important the respondent understood each aspect. The scale was divided in

"no importance = 1", "little importance= 2", "some importance = 3", and "high importance= 4". This information was analyzed by stakeholders' groups and by using Agglomerative Hierarchical Clustering (AHC) analysis to form groups with similar characteristics using the software R [2]. So, the results of each analysis were compared to verify the nuances between the homogeneous stakeholders' groups and software-formed clusters. Therefore, the heterogeneous group profile was traced by analysis of the cluster group respondent's opinions about sustainable development knowledge in Japanese society and sustainable practices of the Japanese concrete industry.

## 3. RESULTS AND DISCUSSION

### 3.1 Clustering Formation

The cluster investigation resulted in three groups that presented an affinity of answers, independent of the stakeholders' category (Figure 1). Group C1 was formed by 16 stakeholder respondents, group C2 by 134, and C3 by 60. The distribution of stakeholders' by clusters can be seen in Figure 2. Group C1 was mainly formed by Contractors. The groups C2 and C3 had a very similar composition in percentage with a higher population of Owners.

### 3.2 Perceptions of Concrete Performance and Sustainable Development Aspects

After building the groups of clusters (C1, C2, and C3) by the AHC, the average of the perceptions of importance from all aspects were recalculated for each new group. These values were so compared with the average importance levels from the homogeneous stakeholders' groups (100% Owners, 100% Contractors, 100% Academic and 100% Material).

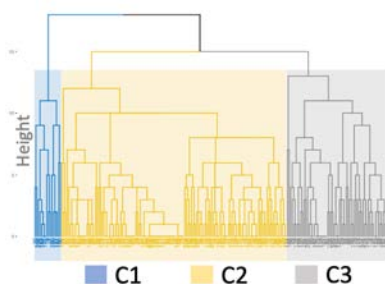


Fig. 1 Clustering division in 3 groups (C1, C2, and C3)

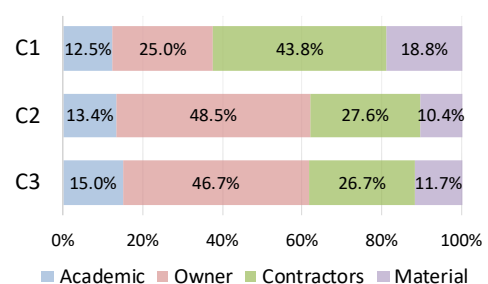


Fig. 2 Distribution of stakeholders by cluster

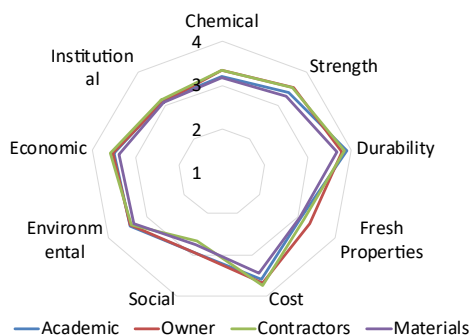


Fig. 3 Importance levels by stakeholder group

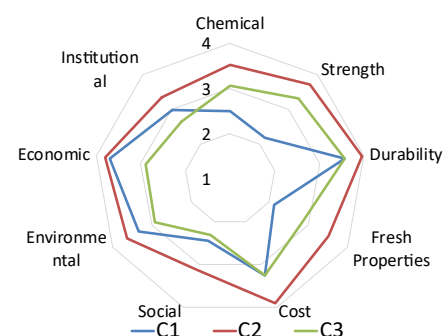


Fig. 4 Importance levels by cluster analysis

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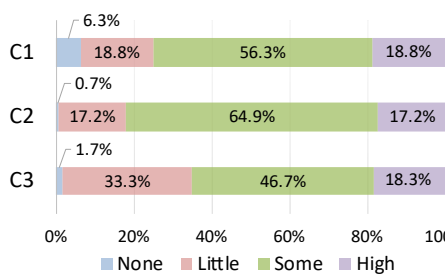


Fig. 5 Level of knowledge on sustainable development in terms of Japanese society by cluster

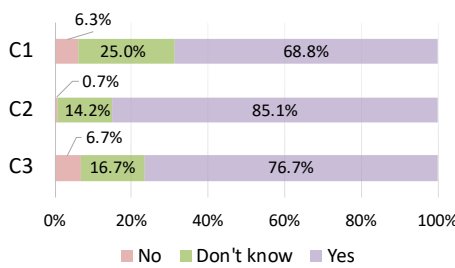


Fig. 6 Necessity of change practices in Japanese concrete industry to consider sustainable development by cluster

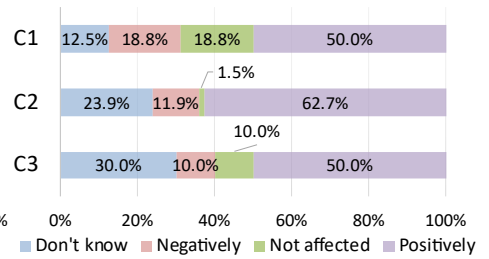


Fig. 7 Effects of changes for the organizations due to sustainable development by cluster

The homogeneous stakeholders' groups' perception by each aspect can be seen in Figure 3 and the new clusters groups in Figure 4. As seen in Figure 3, the importance attributed by each stakeholder to the different aspects was very similar in general. The highest importance attributed by all groups of respondents were durability and cost. The social aspect received the smallest importance rate from all groups.

However, when separated by the groups' built-in clustering analyses from affinities, the results became divergent in the attribution of importance and it can be seen in Figure 4. The group C1 shows higher values of importance attributed to Economic aspects followed by Durability. The C2 presented more importance to Durability, Cost, and Economic. Group C3 considered more important Durability and Strength. Group C1 is mostly formed by Contractors and, Group C2 and C3 by owners. So, this can indicate that the opinion of the professionals can vary when it comes to concrete aspects perceptions. Therefore, the observation of homogeneous groups alone can hide particularities of perceptions that are important to implement a sustainable concrete in the concrete industry. Hence, other factors aside from the stakeholders' category, have to be considered to investigate the real understanding and perceptions of concrete related to sustainable aspects.

### 3.3 Clusters Sustainable Development Knowledge and Practices in the Japanese Concrete Industry

As the clustering analytical process formed new heterogeneous stakeholders' groups (C1, C2, and C3), other factors related to the perceptions of the respondents had also to be verified. Therefore, this section intended to provide more information about the formed clusters groups by investigate the respondent answers about the sustainable development knowledge in Japanese society and also sustainable practices of the Japanese concrete industry. The knowledge of the groups on the sustainable development of Japanese society can be seen in Figure 5. The majority of all three group members described themselves as having "some" or "High" knowledge about sustainable development. Figures 6 and 7 show the answers of the cluster groups about the sustainable practices of the Japanese concrete industry. Figure 6 shows the opinion of the respondents about if the Japanese concrete industry has to change practices to consider sustainable development. The majority of the three groups answered that the industry has to change its practices. Figure 7 shows the answers of how the organizations will be affected by the changes in the Japanese Concrete Industry due to Sustainable development. The three cluster groups of respondents agree that the organizations will be affected positively. When analyzing the groups' answers, it can be observed that clusters C2 and C3 have a closer distribution

of stakeholders highlighted in Figure 4, however, they have different perceptions concerning answers in Figures 5, 6, and 7. The C2 group presented more respondents claiming to have "Some" knowledge of sustainable development (Figure 5), as well as they, think that changes are necessary in the Japanese concrete industry (Figure 6), considering more sustainable approaches. These groups also showed more enthusiasm in predicting positive changes that sustainable development can bring to the construction industry organizations (Figure 7). On the other hand, group C3 showed more respondents with "Little" knowledge of sustainable development (Figure 5), and, aside from having a high percentage of members that thinks that is necessary to have changes in the concrete industry (Figure 6), 50% of the stakeholders' in the cluster believe that these changes will "not affect", "don't know" or affects "negatively" the organizations in Japanese concrete industry (Figure 7). The clusters analyzed also present an interesting connection with the importance levels of the aspects assigned in Figure 4 and their opinion about sustainable practices (Figures 6 and 7). Group C2 presented more importance to all aspects when compared to group C3. Therefore, the heterogeneous groups formed by clustering analyzes can highlight divergences within homogeneous stakeholder groups, helping to understand better their perspectives tendencies.

## 4. CONCLUSIONS

In order to be more accurate, the criteria to investigate the perception of the stakeholders inside the concrete industry must consider different aspects by similarity analyzes such as clustering. The characteristics that bring the group of respondents together have to be considered to see if other aspects of their profile culminate in the same conclusions and opinions. The comparison of homogeneous stakeholders' groups and clusters formed by similarities demonstrated that the methodology of analysis can play an important role in the identification of the perception of importance for concrete performance aspects and sustainable concrete aspects. So, the agglomerative hierarchical clustering analyzes showed more potential to describe the stakeholder's perspectives of important aspects and it can contribute to the understanding and implementation of sustainable concrete.

## REFERENCES

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