"Multi-Criteria Analysis of the Design Decisions In Architectural Design Process during the Pre-Design Stage"

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Abstract - Design studio in architectural education is a traditional process, based on the methodology related to the aims and objectives of those respective studio curriculum, and the experience and expectation of the faculty members as what they wants the students to learn, and expected to synthesis their knowledge gained from other sources and previous studio experiences. One of the weaknesses of the traditional studio practice is that the design exercises were given so much attention to the compositional aspects of design rather than attempting to study complex and multi-criteria approach for those decisions.

To understand the importance of rational decision method over the intuitive decisions, an architectural studio project was explored with the design brief as to develop a morphological variation to create the alternatives as design solutions. All those design alternatives have been evaluated by different stakeholders namely the fellow students, faculty members, and post graduate students who are mainly the architects. The objective of the evaluation is to develop an empirical analysis and evaluation of framework for assessing the Architectural Design to check is there a correlation between the different value judgment for intuitive method of decision making and rational method of decision making, of the pre design alternatives.

Key words: Design Decision, Intuitive Decision, Morphology, Pre-Design Stage, and Rational Method.

I INTRODUCTION

"Architectural design studios are educational environments that professional education are premised on a particular kind of pedagogy defined as "learning by doing" in the design studio" (Cikis and Cil, 2009[12], Kurt, 2009) [13]. Traditionally, the practice of architectural design is also similar to a project-based "studio" approach. In studio, designers express and explore ideas, generate and evaluate alternatives, and ultimately make decisions and take action (Luen and Gross, 1997) [14]. Several concepts enter into design decisions during the early stage of design, such as size, scale, proportion, configuration, morphology, and emphasis on context. Morphology, the study of pattern and form, is crucial to design because it constitutes an essential part of its corpus of coherent knowledge (Julienne Hanson, (2001) [1]. But they are not consciously aware of the influence of that on the design of those spaces and other performance factors.

The British architect, Bryan Lawson (Bryan Lawson 2005) [21], findings about design methodology as " Design problems cannot be comprehensively stated. Both objectives and priorities are quite likely to change during the design process as the solution implications begin to emerge". William M. Peña Steven A (2001) [22] states that the design process is the combination and balancing of Analysis and synthesis.

Design can be seen as a multi-criteria decision making (MCDM) process. (Harputlugil T, 2011) [15]. Architectural design is a process influenced by many, namely design variables, Performance variables and contextual variables (Laseau (2000) [16] and many stakeholders, like clients, designers, consultants and project managers etc. Each of which has impact on decision quality. Each variable and stakeholder might have different criteria and weightings depending on the objective and goal and role they play on that project. (Harputlugil T, 2011)[15].

Krzysztof Zima and Edyta Plebankiewicz (2012) [2] concluded in their research by Analysing the building shape erected in Krakow and its impact on construction costs that "Designing buildings having costs in mind, which translates into constructing buildings simpler in shape to decrease the costs of construction".

MCDM can be defined as the evaluation of the alternatives for the purpose of selection or ranking, using a number of qualitative and/or quantitative criteria that have different measurement units (Özcan et al., 2011) [3].

Keeping the above aspects in mind, the core concern of this paper has been worked out to minimise the influence of traditional architectural design process by making intuitive design decision and aim at increasing the quality of design by practising a rational method of design decision.

II BACKGROUND OF THE STUDY

A. Shape and Compactness

Depecker, Menezo et al. (2001) [4] discovered, in a simulation study of 14 different building shapes in two different French climates, that the colder the climate (>250 heating degree days, which corresponds to Paris) the stronger the correlation between shape and energy consumption. He also state that Building compactness (C) is generally defined as surface-to-volume ratio, $C=S/V$, where S is the envelope surface [m²] and V is the internal volume of the building [m³]. The size of the geometry has a great effect on the surface-to-volume ratio where a large size gives a small surface-to-volume ratio. Therefore, building compactness is sometimes expressed as the relative compactness (RC) which is the ratio between the compactness of an ideal reference building with the same volume (for orthogonal buildings a cube) (Ourghi, Al-Anzi et al. 2007) [5]. (Pessenlehner and Mahdavi 2003) [17] State that Preferable to reduce surface area that the most compact building has a relative compactness close to 1.0 and different shapes with the same volume can vary between 0.6 and 1.0. Also examined whether the simple correlation between compactness and heating load is reliable regardless of building shape (self-shading aspect), glazing amount and building orientation.

B. Compactness and Cost Related Studies

The simpler the building plan shape, the lower will be its unit construction cost. (Seely, 1996) [18]. The choice of a particular architectural solution when designing a building considerably influences the costs of its construction (Ferry and Brandon, 2007) [19]. Ibrahim (2004) [6] results confirmed the predictive powers of existing plan shape indices and that of using some of the building parameters. (The building perimeter [EWA] and floor area [FA]). E.Bostancioglu, (2010) [7] states that the increase in the change of shape that is the EWA/FA / ratio causes the biggest increase in energy costs, construction costs and increased LCC.

C. The Importance of Exploring Design Alternatives

Traditional architectural design processes, lack the rational approach, and designers typically explore only a very small number of alternatives in their work. As a result, most design processes are focused only on a relatively narrow range of possibilities. There may be various reasons like restrictions of time and other limitations.(J. Wang, (2002) [8], as well as by cognitive limits. R. Woodbury, A.L. Burrow, (2006) [9] emphasizes that, un- like in other disciplines; early in the architectural design process the architect tends to identify a strong preferred design direction, with limited design objectives and a clear concept, a so called primary generator (J. Darke, 1984) [10]. The importance of exploring different design alternatives is commonly recognized as a major characteristic of the conceptual design process (Y.C. Liu, T. Blight, A. Chakrabarti, (2003) [11]; Okudan and Tauhid, 2008) [24] providing key advantages, which could be more beneficial to architectural design processes than what current limitations allow. As stated by Wang (2002) [8], conceptual design proceeds as an incremental learning process, in which it is impossible to develop a proper solution in one shot. Instead, phases of divergence generate design alternatives; and phases of convergence select the most promising solutions (Y.C. Liu, T. Blight, A. Chakrabarti (2003). [11]

III METHODOLOGY.

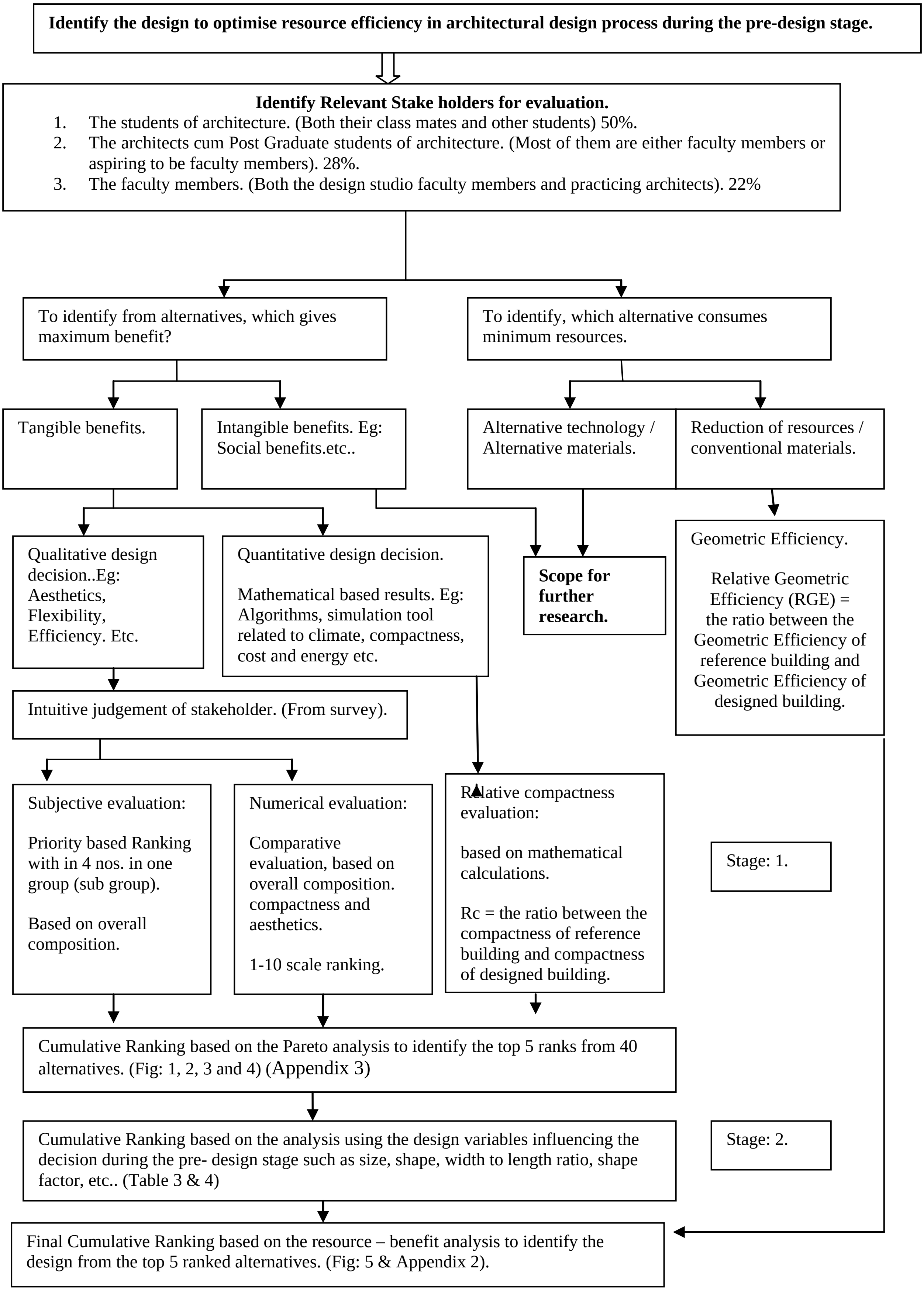
A. Aim

The main aim of the research is “the architecture students must learn to see and experience spaces and forms in a way that will enable them to understand not only the visual but also eco sensitiveness aspects of the built environment they create” (Schon, 1989) [20]. The empirical analysis has two stages to identify the best alternatives. In stage one, the students were asked to explore and capture the essential qualities required for the special buildings (DCR, CMDA: 2005) [25] with the typology as design of an apartment building. Each student has developed minimum of four (4) alternatives based on the manipulation of design variables (Laseau (2000) [16] with interplay and linking of solids and voids to create an interesting compositions by treating those voids as interstitial spaces such as terraces, protruding terraces and introverted spaces, courtyard spaces, and self shading spaces to create the dynamic composition with improving their spatial quality. And also the emphasis was to reduce the possible surface area for the given volume with respect to relative compactness (Rc). Based on their intuitive judgement of those alternatives, finally each student has submitted their best possible solution for the stage one submission.

TABLE I.
The Summary of Brief to Generate Morphological Variation as Design Alternatives for the Proposed Research.

Description.	For All The 40 Nos. Of Alternatives.
Objective.	The brief of the design is to develop a volumetric variation using the size of sample mentioned below as constant to create the morphological variance based on the Design variables (Laseau (2000) [16] to generate various design alternatives.
Building typology and building regulations.	Multi unit Residential Building typology, with Special Building category (Regulation for special buildings p.no.32- 40, Volume II ,Development Regulations no.27., (2008), CMDA) [25]. • Min. Plot Extent = 660 sq.m. (Min area for multifamily residential development as per CMDA: 2005) [25]. • Max. Height = G+3 or Stilt+4 subject to a max. of 15.25m • Max. FSI = 2 (including premium FSI).
Size of the sample analyzed.	• A modular geometry was derived based on an elementary cube (3.0x 3.0x3.0 m). • (The module referred as the minimum standards for a habitable room: Requirements of parts or buildings – NBC 2005) [26]. • Volume: (660 x 2x 3) = 3960 m^3. (Which is together of roughly 146 cubes and a total surface area of 1535 sq.m. as reference building).
Climatic Condition (Context variables)	• The geographical context for this study is Chennai city, a region in the south of India. The climate is Hot and humid: Chennai (13°04’ N; 80°17' E), which characterizes a hot and humid climatic condition. Annual T_o (outside air temperature) ranges from 21° to 42°C and RH (relative humidity) ranges from 23 to 98%. And primary wind directions predominate from the south and south-east directions.

B. Research Methodology



Flow chart 1: The process to develop the framework has been explained below.

The students have used the physical model as well as 3D visualisation models using sketch up or 3Dmax or any tool which they are comfortable with, to explore their ideas as to enable them to understand better to take the decisions. Now we have the best 40 alternative design out of 160 (40*4) alternatives these entire 40 best alternatives have been identified (appendix 1) as their best possible alternatives based on their intuitiveness and level of design judgement.

During the second stage submission the multi criteria method of evaluation has followed, with a survey from 59 samples consisting of students, faculty members and P.G. Students. All those best alternatives from each of the students were randomly grouped as four in one group. Those were numbered as 1A, 1B, 1C, 1D.....10A, 10B, 10C, 10D. For the purpose of evaluation process.

Those design alternatives were evaluated based on subjective evaluation within each sub-group of 4 alternatives as the priority of ranking, numerical evaluation method to assign value based on 1 – 10 scale based and relative compactness measured from their drawing by comparing its surface area with the reference building for a given volume (Mahdavi, A., Gurtekin, B (2002) [23].

IV Results

The analysis of results has been done on a two stages.

The first stage, the analysis has to be used for evaluation of data from the survey through the survey questionnaire and mathematical calculations taken from the stake holders as mentioned above. The Pareto analysis tool was used to sort the least preferred alternatives to identify the top 5 alternatives for each type of evaluations. And the cumulative ranking based on the design decision (Appendix 3) of Subjective evaluation, Numerical Evaluation and Relative Compactness.

During the second stage, the evaluation has been done for the top 5 alternatives based on the variables affecting the compactness and morphology of any buildings which are directly beneficial to the resources used in a project. The variables are, the relative compactness, proportion of building (width to length ratio), and total height of the building, characteristic length and external wall area to floor area. Using these parameters the alternatives have been compared with the impact of those variables to the design decision to identify the optimum design by conducting the resource benefit analysis. (Appendix 2).

A. *Stage 1: The first case: Effect of Subjective Evaluation on Morphological Variation Results*

The stack holders have been asked to rank their priorities from priority no 1 to 4 through a randomly selected sub groups containing 4 options in each sub-group. The above values identified as frequencies have been tabulated as an average score from the survey format and Final cumulative value for each alternative has been assigned and sorted using the Pareto-analysis.

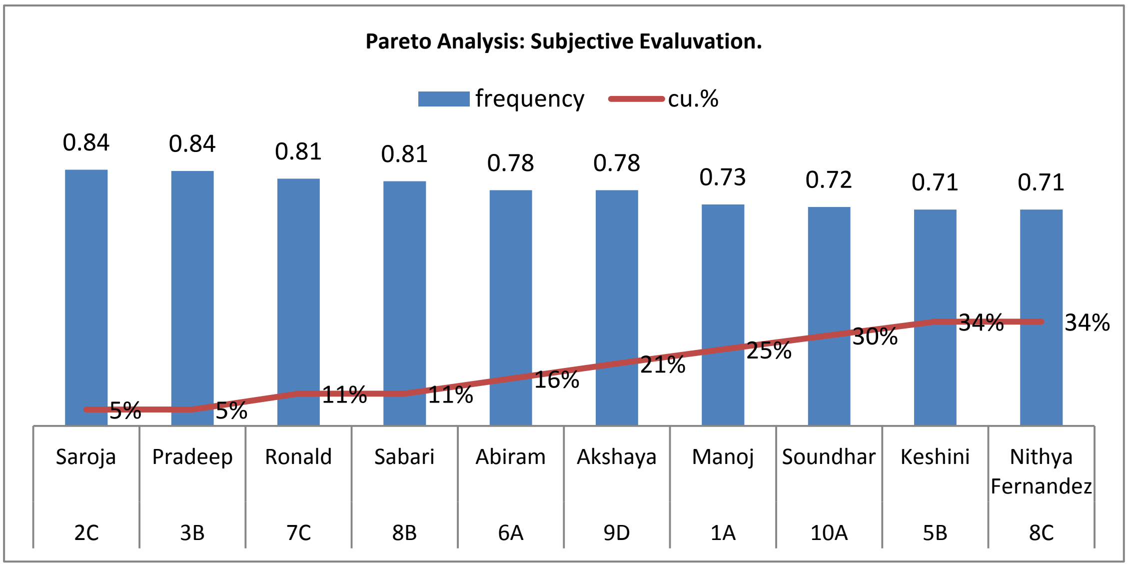


Figure 1: Effect of Subjective evaluation on Morphological variation Results

B. *Stage 1: The Second Case: Effect of Numeric Evaluation on Morphological Variation.*

The stack holders have been asked to assign weighted scale of 1 to 10 (1 as their lowest score to 1 and highest as 10). The above values identified as frequencies have been tabulated as an average score from the survey of all the 59 samples. Final cumulative value for each alternative has been assigned and sorted using the Pareto-analysis.

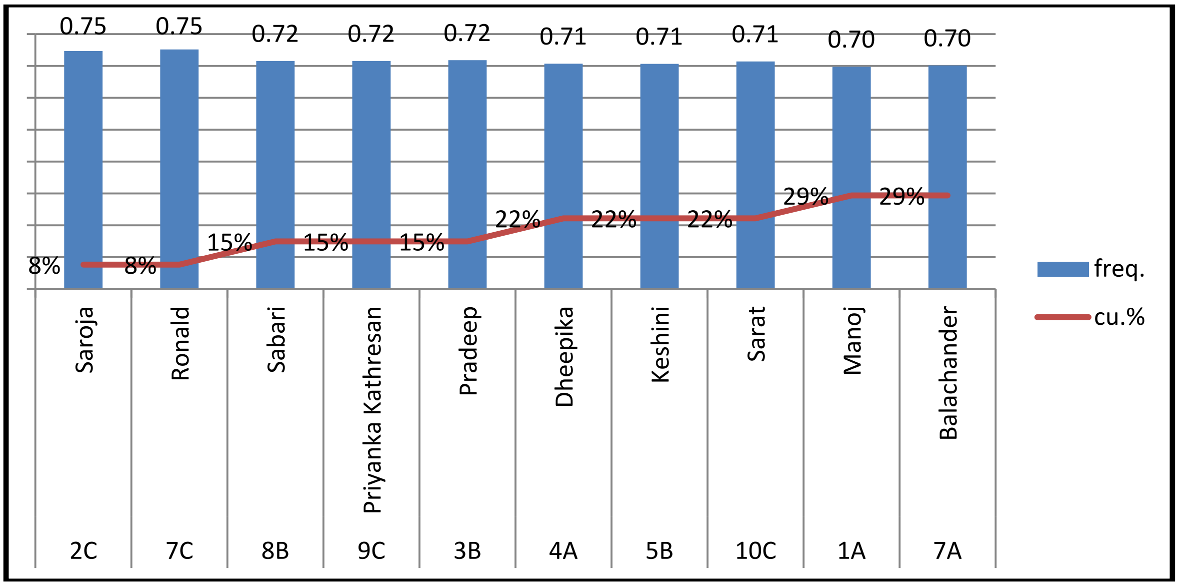


Figure 2: Effect of Numeric evaluation on Morphological variation Results.

C. *Stage 1: The Third Case: Effect of Relative Compactness Evaluation on Morphological Variation.*

Based on mathematical calculations i.e. Rc = the ratio between the compactness of reference building (and compactness of designed building. i.e. (R.C. = surface area of designed object / surface area of reference block (1535).

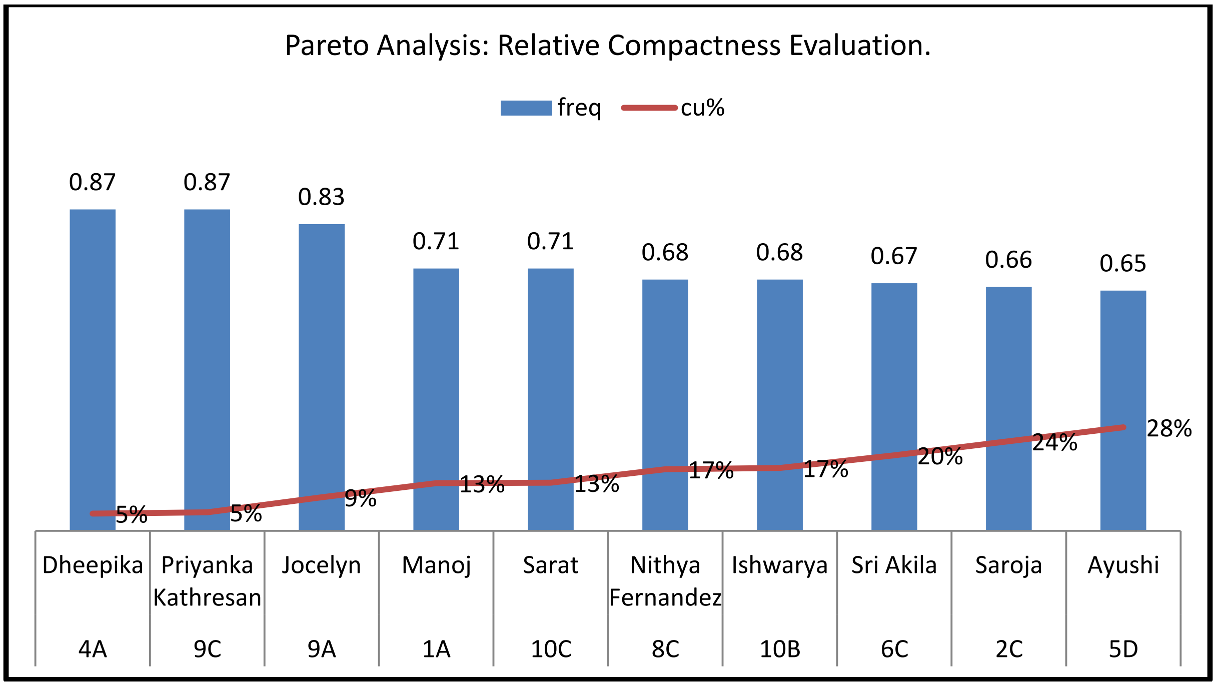


Figure 3: Effect of Relative Compactness evaluation on Morphological variation Results.

D. Stage 1: The Final Case: Effect of Overall Evaluation on Morphological Variation

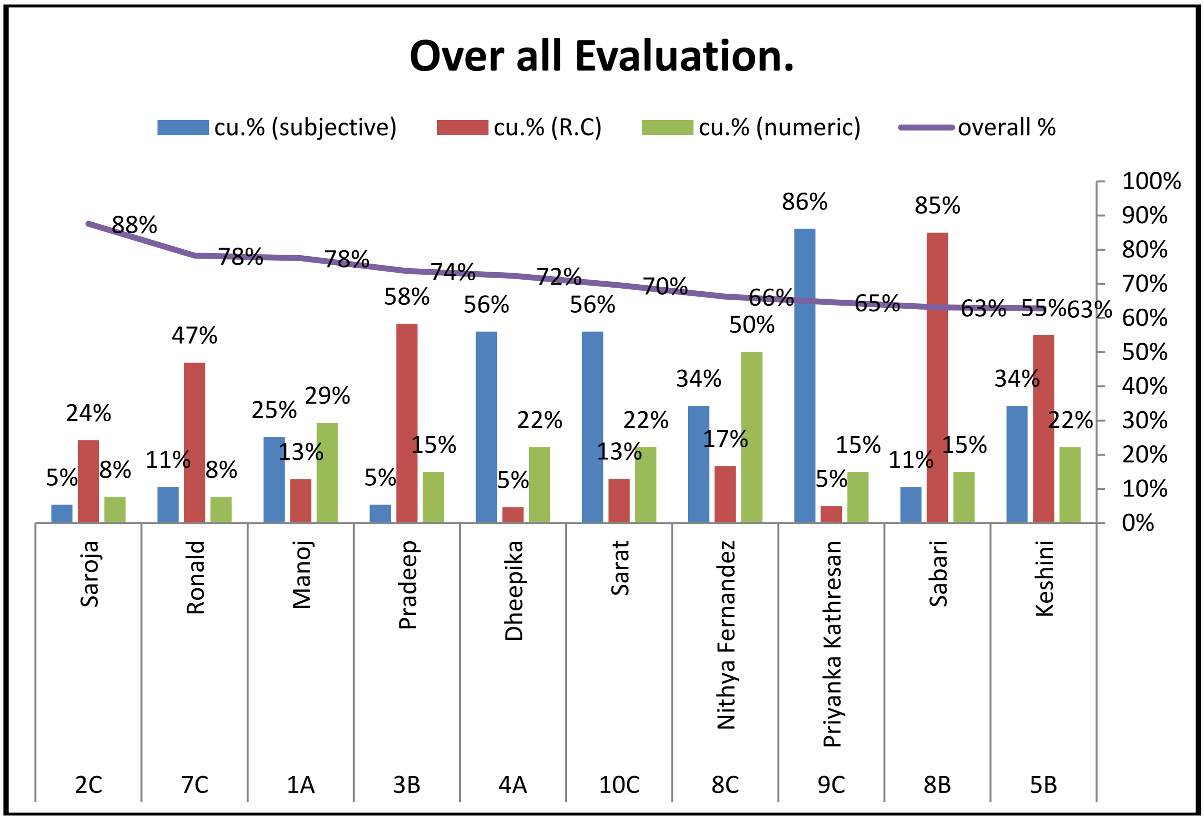


Figure 4: Effect of Overall evaluation on Morphological variation Results to identify top 10 ranks.

TABLE II.
Pareto analysis: Results to identify top 5 ranking. (Appendix 3)

S.no.	Shape no	Name of the student.	Cu.% (subjective)	Cu.% (Rc)	Cu.% (numeric)	Overall deviation	Overall value %
1	2C	Saroja	5%	24%	8%	12%	88%
2	7C	Ronald	11%	47%	8%	22%	78%
3	1A	Manoj	25%	13%	29%	22%	78%
4	3B	Pradeep	5%	58%	15%	26%	74%
5	4A	Dheepika	56%	5%	22%	28%	72%
6	10C	Sarat	56%	13%	22%	30%	70%
7	8C	Nithya Fernandez	34%	17%	50%	34%	66%
8	9C	Priyanka Kathresan	86%	5%	15%	35%	65%
9	8B	Sabari	11%	85%	15%	37%	63%
10	5B	Keshini	34%	55%	22%	37%	63%

E. Stage 2: The Final Case: Effect of Overall evaluation on Morphological variation Results to identify top 5 ranking.

TABLE III.
Compression of Variables affecting the Compactness and Morphology for top 5 ranking models.

S.No.	Variables affecting the Compactness and Morphology	SAROJA (2C)	PRADEEP (3B)	RONALD (7C)	MANOJ (1A)	DHEEPICA (4A)	Reference building.
1	W/L	1	1.21	1	1	1	1.2
2	R.C.	0.665	0.487	0.517	0.710	0.870	1.000
3	Characteristic Length (L.C.)	1.706	1.250	1.329	2.024	2.235	2.570
4	Wall to floor ratio: (P/ S)	1.150	1.393	1.661	0.980	0.914	0.750
5	Shape Factor or G.E (Building) (A/S)	1.750	2.389	2.248	2.916	1.336	1.162
6	R.G.E	1.505	2.054	1.933	1.410	1.149	1.000

TABLE IV.
Compression of Values for the Variables affecting the Compactness and Morphology for top 5 ranking models.

S.No.	Variables affecting the Compactness and Morphology	SAROJA (2C)	PRADEEP (3B)	RONALD (7C)	MANOJ (1A)	DHEEPICA (4A)
1	W/L ratio	83.33333	100.8333	83.33333	83.33333	83.333333
2	R.C.	66.450	48.684	51.736	71.000	87.018
3	Charectristic Length (L.C.)	66.401	48.647	51.697	78.761	86.953
4	Wall to floor ratio: (P/ S)	65.217	53.834	45.144	76.531	82.090
5	Shape Factor or G.E (Building) (A/S)	66.400	48.647	51.697	39.850	86.952
	Total	69.042	58.221	55.890	70.066	85.27
	Ranking	3	4	5	2	1

From the below analysis we can identify the shape no 4A (Deepika) has got the benefits of 85.27 % and the deviation from the reference building as 14.90 (Relative Geometric Efficiency) stands first amongst the five alternatives (Appendix 2).

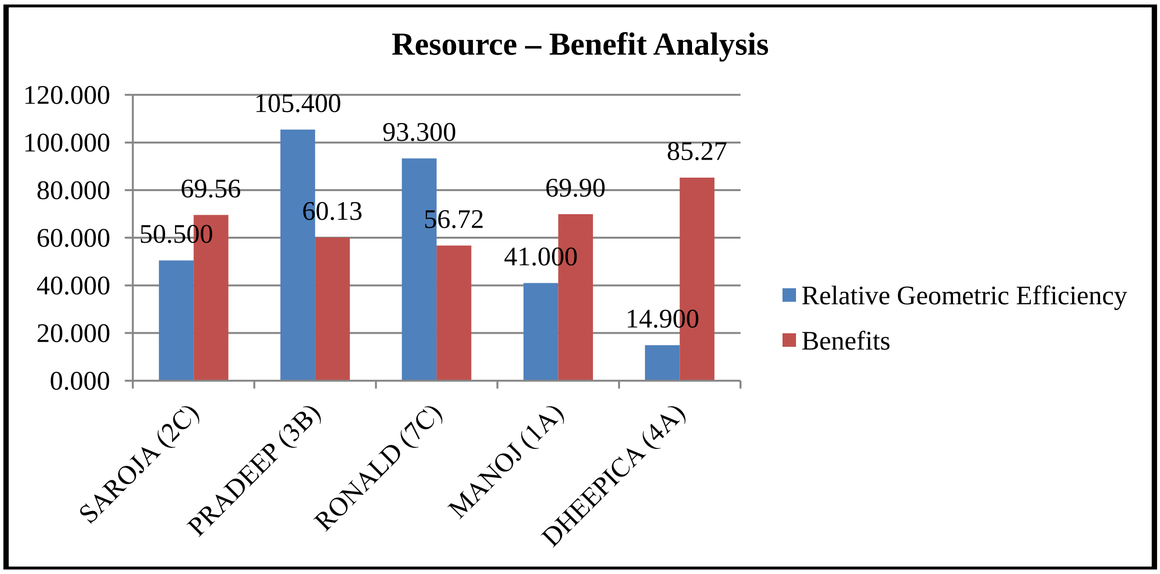


Figure 5: Effect of Overall evaluation on Resource and Benefit.

V DISCUSSIONS

A. The Correlation Coefficient Analysis.

The correlation coefficient analysis has been conducted between the subjective decision ranking (intuitive), Numeric decision ranking (intuitive) and relative compactness ranking (mathematical model) with overall ranking between the students, faculty members and architects group participated in the survey.

1. CASE 1: Correlation between subjective decision (intuitive) and overall ranking.

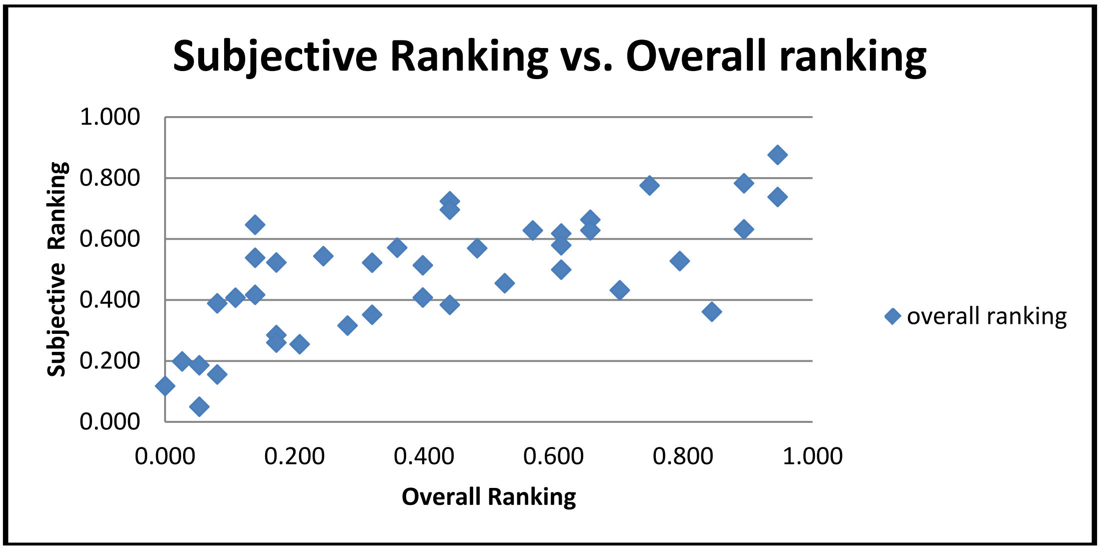


Figure 6: The correlation coefficient is 0.709985828

2. CASE 2: Correlation of Relative compactness ranking and overall ranking.

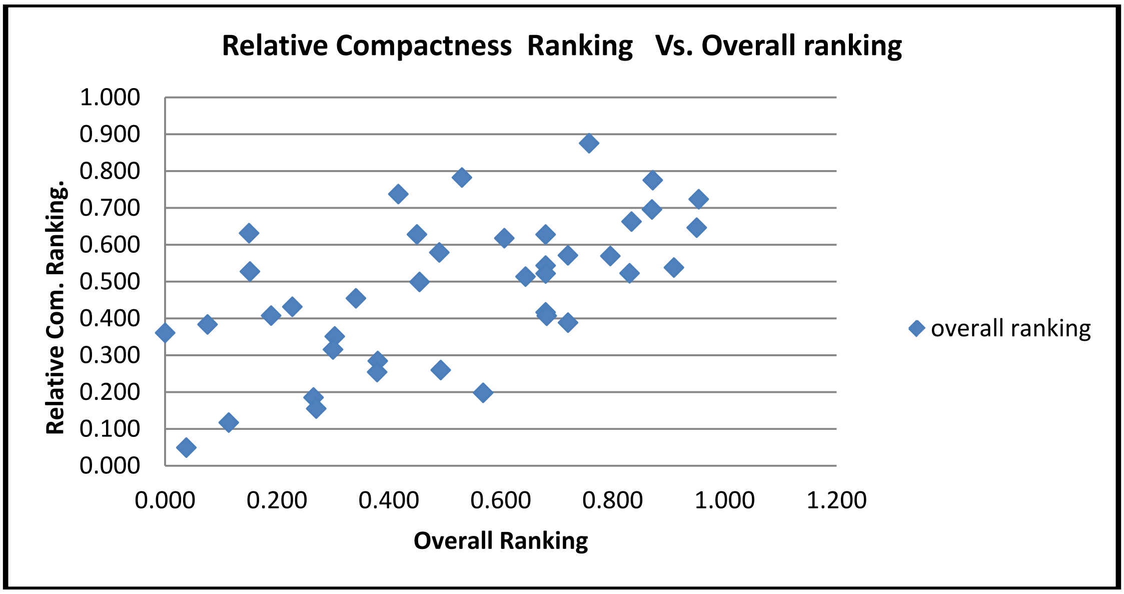


Figure 7: The Correlation Coefficient is 0.596167

3. *CASE 3: Equal value in Numeric value weightage with difference in other weightage and overall ranking. (Table 10).*

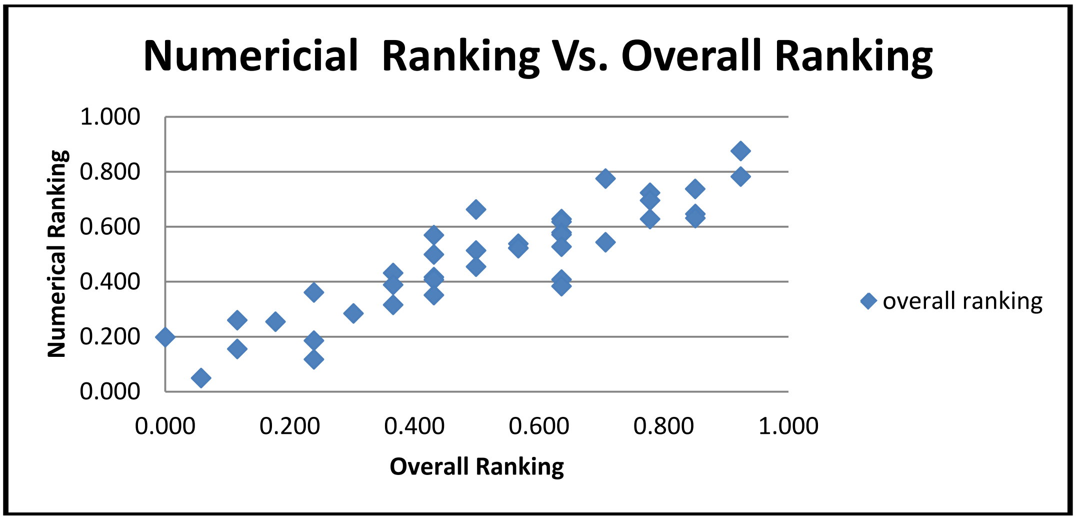


Figure 8: the correlation coefficient is 0.90402.

From the above correlation coefficient there is a strong correlation between the Numeric decision ranking (intuitive) and overall ranking (0.90402) (fig.10). There is the correlation coefficient is 0.709985828 (fig 8) between the subjective decision ranking (intuitive) with overall ranking which shows there is a moderate relation. However the correlation coefficient shows that relatively lower correlation between the Relative compactness ranking (mathematical model) with overall ranking (0.596167) (fig 9).

1. The intuitive judgement and single objective decision alone cannot be used to judge the alternative to predict the best possible design with the possible minimum information by any designer which can be accessible during the pre-design stage. This has proved the requirement of multi-criteria tool with a rational approach to predict the optimum design solution during the pre-design stage.

2. This is evident that the results of intuitive judgements as listed in table 1 and results of multi-criteria as listed in table no 4 gives different opinion.

VI Limitations And Scope For Further Improvement:

From the research the following are identified as the limitation and scope for further research:

1. The constraints of the site and other geographical influences were not considered for this design development but those factors could impact the development of design.
2. Only a morphological variation alone considered for the evaluation. But in practice the major factors could majorly influence the design decision such as the internal arrangement, performance or qualitative aspects like, day lighting; natural ventilation, thermal performance etc are not considered as the criteria for evaluation.
3. If any further research could add the above mentioned tangible benefits or intangible benefits (eg: social, economical, cultural etc.) they can add to the framework in such a way that it can be a continuous research process so that at the end we will have a comprehensive rational tool to evaluate the design decisions during the pre- design stage. This will be available as a very useful tool to the architects, clients and promoters to reduce the negative impact they possibly create on the built environment.
4. There is also possibility of change in result may be possible, based on the typology of building and relative importance of the architects during their design process.

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REFERENCE

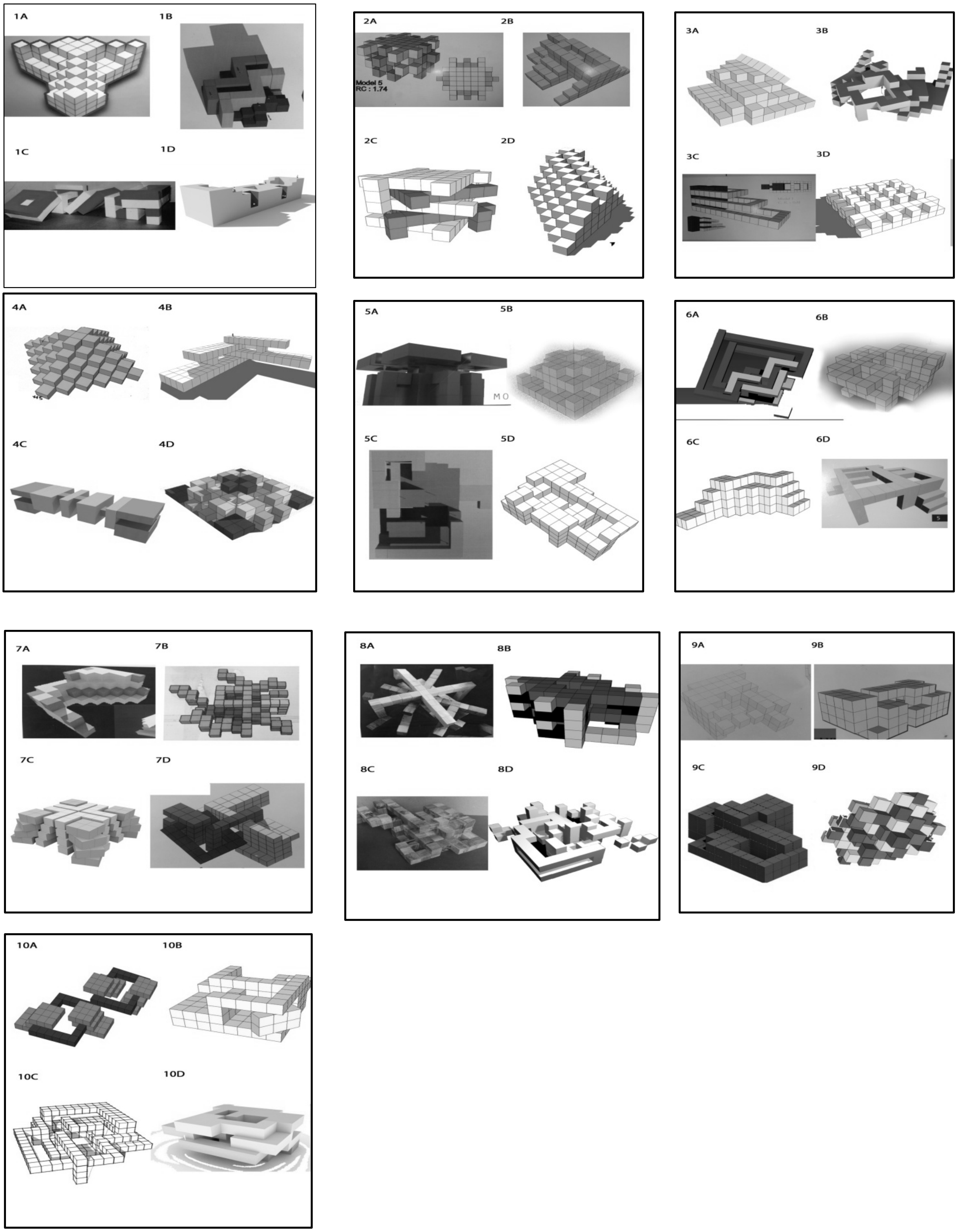
A. Refereed journals

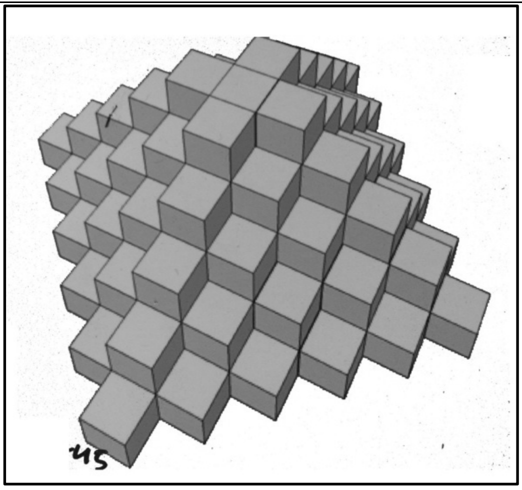
[1] Julienne Hanson, Morphology and Design. Reconciling intellect, intuition, and ethics in the reflective practice of architecture. Proceedings. 3rd International Space Syntax Symposium Atlanta (2001).
[2] Krzysztof Zima and Edyta Plebankiewicz, “Analysis of the building shape erected in Krakow and its impact on construction costs”. organization, technology and management in construction · an international journal 4(1) (2012) pp 411- 419.
[3] Özcan, T., Çelebi, N., Esnaf, Ş., Comparative Analysis Of Multi-Criteria Decision Making Methodologies And Implementation Of A Warehouse Location Selection Problem. Expert Systems with Applications, (2011).
[4] P. Depecker, C. Menezo, J. Virgone, S. Lepers, “Design of buildings shape and energetic consumption”. Building and Environment 36 (2001) 627–635.
[5] Ourghi, R.; Al-Anzi, A.; Krarti, M. A simplified analysis method to predict the impact of shape on annual energy use for office buildings, Energy Conversion and Management 48(1) (2007) : pp.300–305.
[6] Ahmed doko Ibrahim, Effect of changes in layout shape on unit construction cost of residential building –samaru journal of information studies, vol.7 (2007). Pp.24-31.
[7] E.Bostancioglu, “Effect of building shape on a residential buildings construction cost, energy and life cycle costs.” Architectural Science review, 53:4, (2010), pp.441- 467.
[8] J. Wang, Improved engineering design concept selection using fuzzy sets, International Journal of Computer Integrated Manufacturing 15 (1) (2002) pp.18–27.
[9] Woodbury, R.F., & Burrow, A.L., “Whither Design space?” AIEDAM (2006), 20(02), pp. 63-82.
[10] Darke, J., “The Primary Generator and the Design Process”, Developments in Design Methodology, Nigel Cross, Open University, John Wiley & Sons, (1984) pp.175-188.
[11] Y.C. Liu, T. Blight, A. Chakrabarti, “Towards an ‘ideal’ approach for concept generation, Design Studies” 24 (4) (2003) 341–355.

B. Books and Proceedings of Conferences.

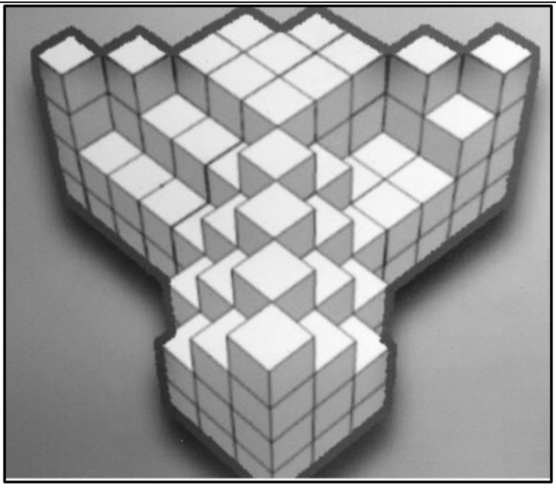
[12] Çıkış, Ş., & Çil, E. . Problematization of assessment in the architectural design education: First year as a case study. Procedia Social and Behavioural Sciences, 1, (2009), pp.2103–2110.
[13] Kurt, S. An analytic study on the traditional studio environments and the use of the constructivist studio in the architectural design education. Procedia Social and Behavioural Sciences, 1, (2009) pp. 401–408.
[14] Ellen Yi-Luen Do, Mark D. Gross, The Design Studio Approach: Learning Design in Architecture Education, In Design Education Workshop, J. Kolodner & M. Guzdial (eds.) EduTech/NSF, College of Computing, Georgia Institute of Technology, September 8 -9, (1997) Atlanta.
[15] Harputlugil T.,Gültekin A.T., Matthijs Prins, Conceptual Framework For Potential Implementations Of Multi Criteria Decision Making (MCDM) Methods For Design Quality Assessment, Management and Innovation for a Sustainable Built Environment, (20 – 23 June 2011), Amsterdam, The Netherlands.
[16] Laseau, P. Graphic Thinking for Architects & Designers. (2000), USA.
[17] Werner Pessenlehner and Ardeshir Mahdavi, “Building Morphology, Transparency, and Energy Performance”, (2003) Eighth International IBPSA Conference, Eindhoven, Netherlands.
[18] Seeley, I.H. Building Economics. Macmillan, (1996). London.
[19] Ferry, D. and Brandon, P. Cost Planning of Buildings. Granada, (1991) London.
[20] Schon D.A., “ Educating the reflective Practioner, Jossey – Bass, (1989) Sanfrancisco.
[21] Bryan Lawson, “How Designers Think, The Design Process Demystified”, Fourth Edition, Architectural press, (2005) Oxford.
[22] William M. Peña Steven A. Parshall, “Problem Seeking - An Architectural Programming Primer”. (2001) HOK Team, 4th Edition.
[23] Mahdavi, A., Gurtekin, B., “Shapes, Numbers, and Perception: Aspects and Dimensions of the Design Performance Space”. Proceedings of the 6th International Conference: Design and Decision Support Systems in Architecture, the Netherlands, ISBN 90-6814-141-4. (2002) pp 291-300.
[24] Okudan, G. E. and Tauhid, S.:, Concept selection methods – a literature review from 1980 to 2008, Int. Journal of Design Engineering, 1(3), (2008), 243–277.
[25] Regulation for special buildings p.no.32- 40, Volume II, Development Regulations no.27. (2008), CMDA.
[26] National Building code of India, Bureau of Indian Standards, (2005) New Delhi, India.

Appendix 1: images of all the models. (4 x 10 = 40 models) 1A, 1B, 1C and 1D.. 10A, 10B, 10C and 10D.

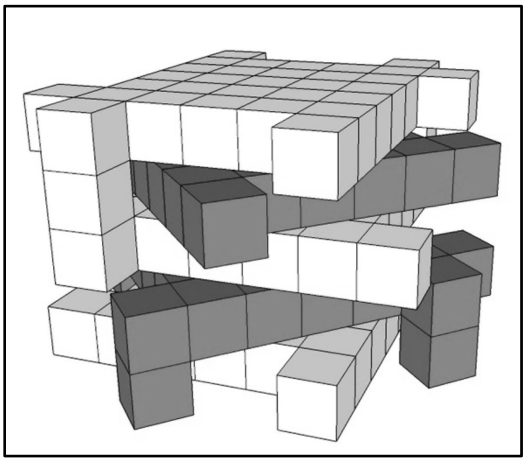




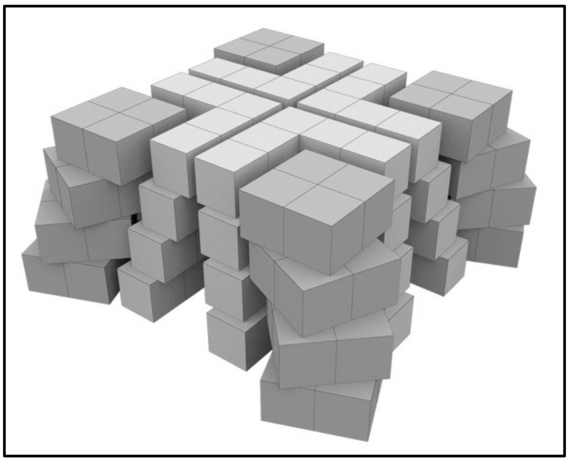
DHEEPICA (4A): First choice.



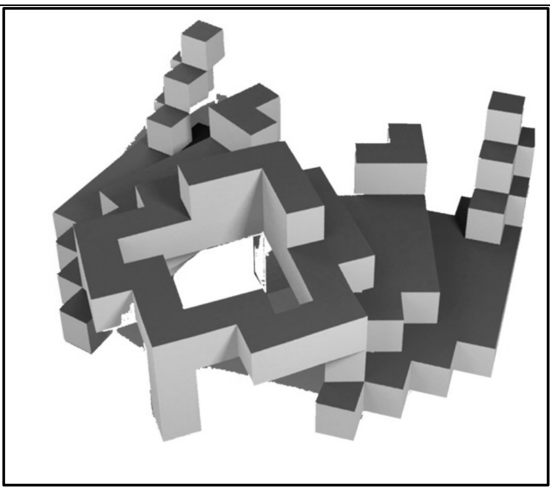
Manoj (1A) : Second choice'



Saroja (2C): Third Choice.



Ronald (7C): Fourth Choice.



Pradeep (3B): Fifth Choice.

Appendix 2: Final Ranking.

Appendix 3: Overall Ranking. (Pareto analysis)

Overall Ranking.						
S.no.	**Shape no**	**Name**	**cu.% (Subjective)**	**cu.% R.C. Frequency**	**cu.% Numeric frequency**	**overall %**
1	2C	Saroja	5%	24%	8%	88%
2	7C	Ronald	11%	47%	8%	78%
3	1A	Manoj	25%	13%	29%	78%
4	3B	Pradeep	5%	58%	15%	74%
5	4A	Dheepika	56%	5%	22%	72%
6	10C	Sarat	56%	13%	22%	70%
7	8C	Nithya Fernandez	34%	17%	50%	66%
8	9C	Priyanka Kathresan	86%	5%	15%	65%
9	8B	Sabari	11%	85%	15%	63%
10	5B	Keshini	34%	55%	22%	63%
11	9B	Sam	43%	32%	36%	63%
12	5A	Siddarth	39%	39%	36%	62%
13	4D	Aparna	39%	51%	36%	58%
14	2A	Sumithra	64%	28%	36%	57%
15	6C	Sri Akila	52%	20%	57%	57%
16	7A	Balachander	76%	32%	29%	54%
17	9A	Jocelyn	86%	9%	43%	54%
18	9D	Akshaya	21%	85%	36%	53%
19	10B	Ishwarya	83%	17%	43%	52%
20	1D	Vaikunth	68%	32%	43%	52%
21	5C	Vignesh	60%	36%	50%	51%
22	4B	Lalitha	39%	55%	57%	50%
23	3C	Nithya Reddy	48%	66%	50%	45%
24	10A	Soundhar	30%	77%	63%	43%
25	3A	Samyuktha	86%	32%	57%	42%
26	6B	Prithviraj	60%	81%	36%	41%
27	3D	Arthi	89%	32%	57%	41%
28	5D	Ayushi	92%	28%	63%	39%
29	7D	Preetika	56%	92%	36%	38%
30	6A	Abiram	16%	100%	76%	36%
31	2B	Vidyalakshmi	68%	70%	57%	35%
32	1B	Dhivya Dharshini	72%	70%	63%	32%
33	10D	Priyanka G	83%	62%	70%	28%
34	8D	G. Aiswarya P	83%	51%	88%	26%
35	1C	Abinaya	79%	62%	82%	25%
36	6D	Aysha	97%	43%	100%	20%
37	4C	Shobana	95%	73%	76%	19%
38	7B	Mohanapriya	92%	73%	88%	16%
39	8A	Surya	100%	89%	76%	12%
40	2D	Bhavana	95%	96%	94%	5%