PLAYERS IN ARCHITECTURAL PROJECT PROCESS FLOW TOWARDS SUSTAINABILE BUILDINGS: CASE STUDIES BASED OUTLINE

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ABSTRACT**:** On the hand of amplifying the current comprehension on a sustainable performance of a building, based on the management of project architectural process flow, the discussion of this paper is the reorganization of significant information about pre-selected outstanding sustainable buildings case studies, part of the master research titled "Management of Project towards Less Unsustainable Architecture", in order to configure the best practices of each case, unfolded to future architectural constructions. On this way, the methodology is supported on interview of one key person involved to each pre-selected project, crap of the up mentioned research, based on the further stages: 1) the quantification and pre-identification of green solutions used in the buildings; 2) the pick of the involved team members that worked for the solutions and the communication type in between; 3) the pre-identification and qualification of outstanding project challenges of some specific green solutions; 4) the definition of communication on the process flow of the selected architectural projects, considering the team members into the activities; 5) the points of the project where the sustainable solutions were taken into the plan. 6) the construction, afterwards, of an overlapping between the results of the selected case studies, toward on detecting the best practices during the flow that confers sustainability to the buildings. Finally, based on a typical architectural process flow, the overlapping of the obtained information during the interviews over the comprehension of the case studies will clarify significant points in what it is possible to input extra attention and effort to guarantee sustainability to the buildings, considering the entire flow, but focusing into the planning phase of the project. The resulted process map will be able to configure an important management of project tool for future architectural projects process flow, supporting significantly the construction professionals on guiding their works, warranting less unsustainable performing of the general results of the buildings.

KEYWORDS: sustainability, architectural project process flow, involved team members

1. INTRODUCTION

In order to get important information to a comparison related to the project process flow and the type of communication between the members of extraordinary cases of sustainable performance of buildings, it was judged necessary to select buildings from what it would be possible to get essential information for the sustainability. Subsequently, it was judged necessary to make interviews to key person into each selected case that joined an important position on the project process to clarify the comprehension of the real characteristics of a less unsustainable architectural project.

On this way, three cases were selected toward establish a comparison between the buildings, evaluating some strategic points of the sustainable architectural project process flow, communication and the actions when facing significant challenges.

The interview of one key person of each case study towards recognizes expressive points about the selected buildings that made difference on the final outcome sustainable performance, configuring the three of case studies for this research. The interface related to the sustainability can be described in further key points: green solutions; involved team members; roles of them; communication between the team; management of the challenges faced by the project; project process flow; activities of the process; and predecessor activities.

2. METHODOLOGY

The methodology of this paper was based on: 1) the quantification and pre-reorganization of green solutions used into the selected buildings; 2) the involved team members that worked for the solutions and the communication type in between; 3) the identification and qualification of outstanding project challenges of some green solutions; 4) the process flow of the selected architectural project, considering the team members into the activities. On the collecting the data about the case studies, the outcomes of the interview aims to make, afterwards, an overlapping between the results of the three selected case studies, toward detect the players during the flow that conferring more sustainability to the buildings, mainly during the process flow of the project, when the core decisions are taken and define the performance of it, during its lifecycle. The result will be presented in graphics and tables to allow the comparison as the outcome of it.

The further list of possible involved members into the green solutions on the project will be used to referring about the cases on next sections. It was created according to the collected available information related to the selected buildings and increased by the case information on the interviews:

A) Client as an Active Role	B) Manager of the Project
C) Mechanical Engineer	D) Structural Engineer
E) Structural Engineer	F) Electrical Engineer
G) Facilities Engineer	H) Landscape Engineer
I) General Contractor	J) Geotechnical Engineer
K) Interior Designer	L) Lighting Specialists
M) Authorities	N) Research & Development
O) Site Manager	P) General Contractor Engineer
Q) Environment Engineer	R) Green Design Specialist
S) Cost Consultant	T) Suppliers
U) Environmental Consultant	V) Hydraulic Engineer
	W) Sub Contractor

The considered phases of the project are taken in order to separate the group of activities to give more efficiency for the project. It was adopted a typical model of a Japanese general contractor, as in the table below.

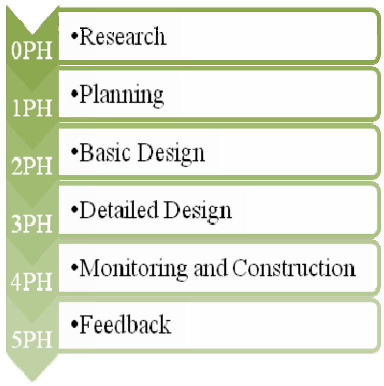

Figure 1: Typical Architecture process flow in Japan

3. CASE STUDY SELECTED BUILDINGS

The selection of the cases to be studied was taken based on the extraordinary sustainable performance of the building during its lifecycle or the performance forecasted during the project phase. On this hand, three buildings were selected, all of them located in Japan, as shown in the Table 1.

Table 1 Selected Case Studies

Name of the case	Image of the building
Case A: Hokkaido Toyako IMC [METI, 2008]	
Case B: Daito Bunka University Itabashi Campus	
Case C: IGES [Japan sustainable database]	

3.1 Case study A: Hokkaido Toyako Summit International Media Centre (IMC)

The Hokkaido Toyako Summit IMC, the main, is a temporary construction, facility that supported the summit press center during the G8 meeting in 2008. This building is result of an architectural competition and took place in Hokkaido. The building lifecycle was short, just during the summit, the time for its preparation and dismounting. However, the concepts of the construction justified the investment on it. The first concept was supported at the 3R (reduce, reuse and recycle) in 95% of the used material for the construction. The other concept was "the severe winter environment of Hokkaido is applied to create a comfortable summer environment". The last concept was a significant reduction of Life Cycle CO2 (LLCO2) compared to general buildings. [Takenaka report, 2009]

Table 2 Building overview [BE n.2, 2009]

Description	Unique block for the use of the summit press center, containing "zero emission house" showcase
Type	New, temporary
Use	Summit press center
Site	Izumikawa, Rusutsumura, Abuta-gun, Hokkaido
Floor area	10,692 m2
Stories	2 above, 1 below ground
Structure	Steel
Budget	276,936 JPY/m2
Population	4000 users / day
Conclusion	2008
Architectural designer	Nihonsekkei, selected by a competition
Manager of the Project	the clients – Hokkaido Regional Development Bureau; Ministry of Economy, Trade and Industry
Environmental support	Takenaka Corporation
Construction Company	1) Takenaka; 2) Iwatachizaki; 3) Itou Special Construction JV
Sponsors	Hokkaido Regional Development Bureau; Ministry of Economy, Trade and Industry (METI)
Stakeholders	1) Constructors; 2) Ministry of Economy, Trade and Industry (METI); 3) G-81; 4) Hokkaido Regional Development Bureau
Assessment tool	CASBEE (S - 5 stars) for temporary buildings
Performance	Reduction in 50% of CO2 emission

3.1.1 Interviewee

This case interviewee was an essential member into the project process flow, an involved member at one of the construction companies.

3.1.2 Sustainability

The building evaluation by the CASBEE, conquest the highest score in sustainability of a temporary building, category updated to new version during the construction of this specific building. The green solutions presented by the IMC building are listed below, considering the involved professional correspondent letters codes, pre-established before the interview. The complexity of IMC building presented diverse combined solutions to generate the sustainable performance in target. It can be understood based on the following schematic images at Figure 2, aiming the reduction on CO2 emission, using less energy for operation, the action plan into the 3R concept and the eco-wall, capable to confer a pleasant indoor environment.

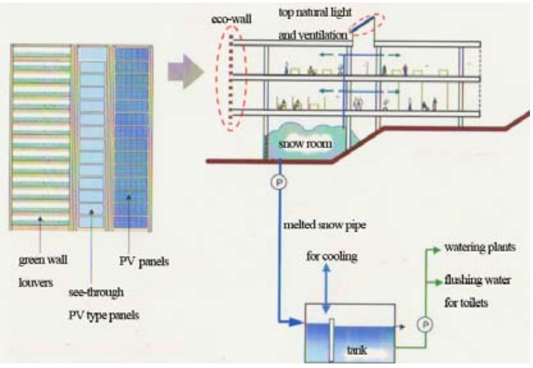

Figure 2 Schematic section [METI, 2008]

Table 3 Green solutions (codes on methodology)

Green solutions	members
1. Snow air conditioned system	A C D E M N O P U W
2. PV, see-trough type	A C F L P T U W
3. Eco-wall, bringing nature to indoor	A C E H N R W
4. LED and HF as artificial lighting	A C F K L
5. Low flow toilets	D N T
6. High-efficiency transformer	F P T W
7. Localized A.C.	C D E F P
8. Use of rainwater	C D N P
9. Natural ventilation;	C D E F H N P
10. Green roof	A C D E F H N R T
11. Natural lighting from the roof;	A C E F K L
12. Sunshade elements (louvers)	A C E H K L
13. 40% usage of Recycling materials	A C M O P S T U W
14. 55% usage of Reused materials	A C M O P S T U W
15. Cardboard pipes for the air conditioned	C D K P T W
16. Reuse high amount of materials	A B C K M O P S T U W

3.1.3 Challenges on the project

3.1.3.1: Challenge 1

The usage of the snow into this architectural temporary project was an initial requirement form the client side and it was transformed in the very extraordinary solution of this project. For the snow to be used at the air conditioned system, it was considered that the timing of the snow storage matching to the days of the summit became a big challenge. Consequently, this issue was managed according to fundamental information provided by the manager of the site, who was capable to evaluate the condition of the snow in areas close to the site to be picked and used for the various systems related to the snow into the building. The communication between the design team members and the site team members was essential to face this challenge and guarantee success on the issue. On this way, the limitations on the solution of this challenge were the time, the technology, the logistic and the weather conditions.

The involved professionals on this sustainable solution became the client as an active role (A), the site manager (O), the mechanical engineer (D), the manager of the project (B), research & development (N) and the electrical engineer (F). The risks related to this challenge, timing of the snow storage, was forecasted during the planning phase and the involved team members elaborated a plan for the mitigation.

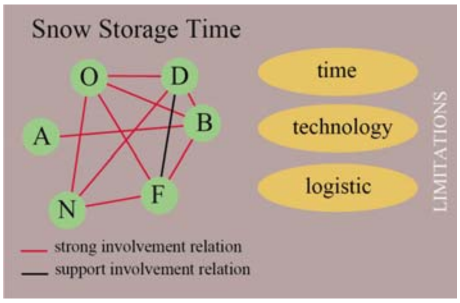

Figure 3 Involvement relation of the team

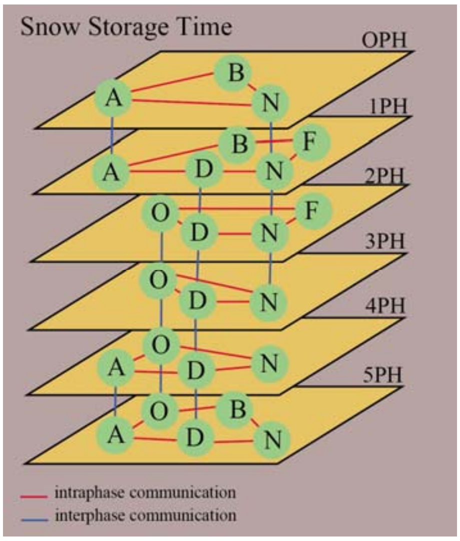

Figure 4 Team Communication between phases

3.1.2.1: Challenge 2

Another headlined challenge was related to the obtaining of the construction materials that based into the significant rate of 95% of the used materials fitting into the 3R concept. Since the Hokkaido Toyako Summit IMC was a temporary construction, the management of the choice of the materials to be relocated after the use of this building was considered an important challenge that required a strategic plan, mainly in what refers to the logistic of the procedures. On this comprehension, the project was designed in order to use materials capable to fit on this concept and be dissembled in the shortest possible time, with the destinations defined to receive the materials to be reused in other constructions. It is important to headline that it was used bio-combustible for the vehicles used on the transportation of the material to and from the site after the disablement, which was associated to the reduction of carbon dioxide emission during the lifecycle, starting with the building construction.

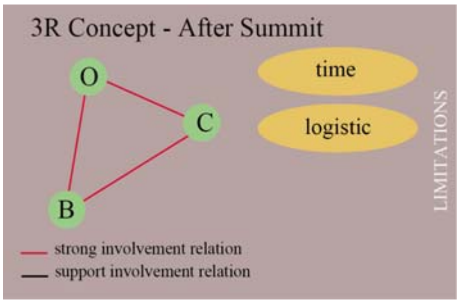

Figure 5 Involvement relation of the team

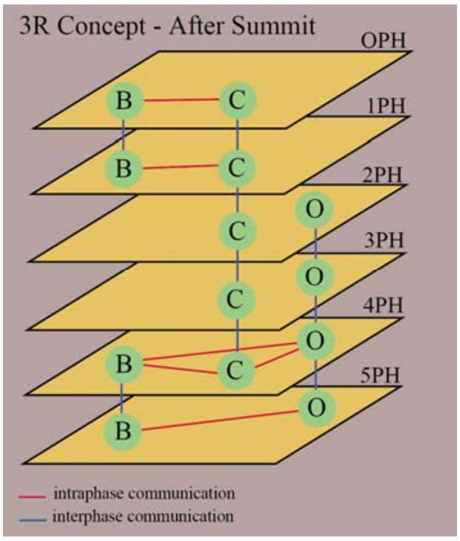

Figure 6 Team Communication between phases

The limitations faced by this challenge were the time and the logistic for the destinations, because it was necessary to match the other site ready to receive the material in the necessary time. The key involved members to equate this challenge became the manager of the project (B), the architect (C) and the site manager (O). The interaction between these professionals became essential on the discussion of the action plans related to this challenge. This issue was forecasted during the planning phase and accomplished perfectly on the execution.

The communication between the team members occurred into the mix of hierarchic model to the open communication model. That means that the members were working based on the command of the client, the manager of this project and the discussion on the solutions and plan of the project was managed as an open exchange of ideas, research and knowledge toward the adequate solutions.

3.2 Case study B: Daito Bunka University Itabashi Campus

A limited budget architectural project, this case study was supported by the concepts of being a building capable to develop new values by communal spaces for the students. The redevelopment project of the campus was following the usage of integrated techniques synthesized with architectural design, utility design, and facility management systems.

The sustainable solution brought a special plus that could answer the main concepts on the response to the needs of the new generation. The plan solution was based on the creation of medium-rise buildings surrounding courtyards, areas to stimulate the communication and exchange between the students.

Table 4 Building overview [NAKAMURA, 2005]

Description	Central Library; 2nd Building (gymnasium); 3rd Building (lectures); Courtyards
Type	Refurbishment
Use	Educational
Site	Itabashi-ku, Tokyo, Japan
Floor area	21,058 m2
Stories	5 above, 1 below ground
Structure	Reinforced Concrete / Steel
Budget	250,000 JPY / m^2
Population	6000 users / day
Conclusion	2003 (1st phase: library, lecture halls), 2004 (2nd phase: gymnasium, student plaza), 2006 (3rd phase: community plaza, meditation green space)
Architectural designer	Ben Nakamura, Keisuke Yamamoto, Keiji Hori, selected by a competition
Manager of the Project	Ben Nakamura
Environmental support	The architect researches
Construction Company	Obayashigumi (stage 1); Toda Kensetsu Construction (stage 2/3); Taisei Kensetsu (stage 2/3)
Sponsors	Daito Bunka University
Stakeholders	Daito Bunka University; students; teachers
Assessment tool	CASBEE A class; could get the highest score (the evaluation also considered the pre-existent buildings that were not efficient)
Performance	25.7% of energy saving, 50% of water saving

3.2.1 Interviewee

The interviewee for this case was the Professor Ben Nakamura, an essential member of this project that joined the core team as the main Architect, also the Manager of the project role.

3.2.2 Sustainability

The sustainability conferred to this project was a suggestion of several actions proposed by the architect during the competition time. At the beginning 30 solutions were considered to be included. However, the budget destined for the project could cover 27 of them after long discussion and negotiating between the architects, the design team and the client – the sponsor of the project.

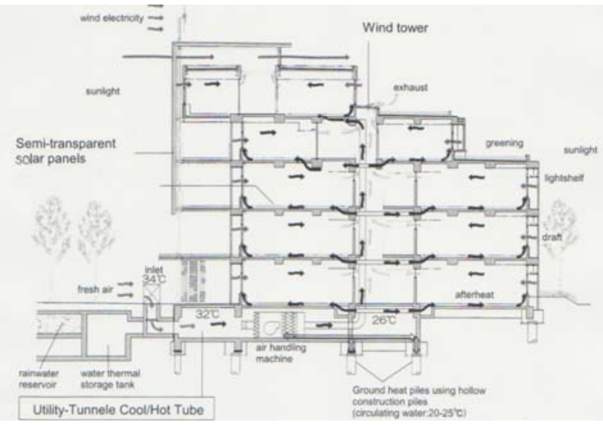

Figure 7 Schematic section [NAKAMURA, 2005**]**

Table 5 Green solutions (codes on methodology)

Green solutions	members
1. Participation process	A B C D E F G
2. Long life structure and repairable equipment system	C E F D
3. Greening on the roofs, two inner courtyard greens	C H
4. Rain water reservoir using underground floor spade of existing building	C D E H S P
5. Limited air conditioning area and maximum use of half in and outer space	A B C H
6. Natural air flow conducted by wind tower	C D
7. Natural air ventilation control system	C D
8. Cool / hot tube using multipurpose tunnel	C D E F G
9. High heat insulation and high air tightness	C W
10. Outer insulation for the outer wall with timber finishing	C W T
11. Heat storage into the concrete body	C W
12. Deep eave and vertical louver	C W T
13. Ground source energy by using construction hollow pile	C D
14. South elevation by see-through type solar energy	C F H W T
15. Wind power generator	C D F
16. Using rain water to the toilet flush	C D
17. Light shelf and curved ceiling	C
18. Light sensor zoning	C F
19. Woody space	C
20. Using waste concrete in the basement	C D E P S
21. Eco-material	C W T
22. Dehumidifying air conditioned system	C D
23. Co-generator power plant	C D F
24. Heat storage water tank by using waste energy	C D F
25. Hot air circulation system for gymnasium	C D
26. High efficiency equipment use	C D F
27. Building management system	C D F G

3.2.3 Challenges on the project

3.1.3.1: Challenge 1

The first considered challenge is the management of the space and the huge infrastructure for the underground rainwater storage, crossed to the timing of the construction, considering the conflict of the activities at the university. In fact, the interviewee related that not just the construction of the underground rainwater storage, but, since the beginning, the conflict with the regular activities of the university and the three stages of construction on the jobsite had to be carefully managed in order to guarantee the safety of the users. The big and necessary intervention on the existing site required a large construction period, a big challenge that demanded extra budget to construct pathways to the users to avoid accidents during the construction.

The urgent first change was removing from the center of the site the existing bus terminal that was occurring mixed to the circulation of 6000 students per day. The limited site area crossed to a bus terminal activity was bothering the flow and the communication of the users inside the central area. The further interventions also had to be managed in the target to allow the flow between the buildings. For this reason, on the up levels of the buildings, it was created many alternative safe paths for the students and bridges which were favorable to the benefic horizontal connection within the floors, avoiding the circulation on the ground level.

After that, and many other big interventions also occurred. For example, it was necessary to manage the demolition of the library and the lecture hall to be reconstructed in another position that would stimulate a future communication between the users of the university at the opened space interconnected to the semi indoor areas of the lecture hall building. For sure it was a highlighted challenge and the risks and the mitigation related to this challenge was a constant of the execution. After the conclusion of the first stage of the project execution, just the basic activities of the university could be occur, bringing the necessity of create alternative safe paths to users.

The limitations of this challenge, in order of importance, were defined by the logistic, the site conditions, the time, the budget and the stakeholders. The involved professionals into the solutions demanded on it were the architect (C), the general contractor (I), the facilities manager (G) and the construction engineer (P). The challenge was forecasted during the planning phase.

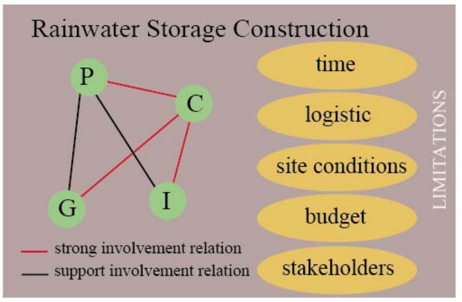

Figure 8 Involvement relation of the team

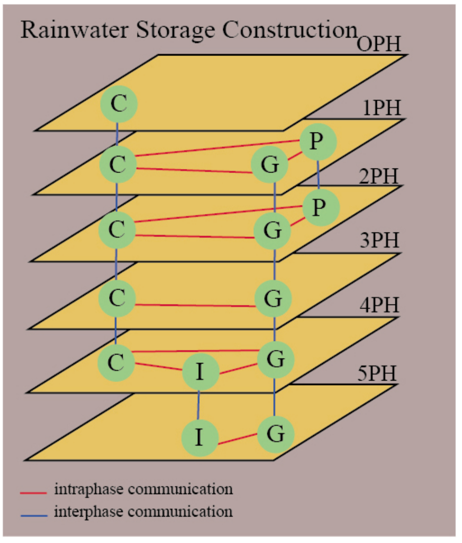

Figure 9 Team Communication between phases

3.1.3.2: Challenge 2

Another big challenge of the project was the necessity of decrease the demand of the energy consumption from the users and from the building, also transforms the energy to be consumed in renewable energy. At the beginning, taking the building as a conventional one, the 8000 m2 area of the lecture hall would demand 2000 kW.

By design, the architect transformed 50% of the space to be in-out transition spaces, in where it was not necessary to conditioning the air. Just this design decision reduced by the half the requirement of energy. Using the refresh air solution, the demand could be reduced to around 450 kW. On this way, the renewable energy generated by the solar panels system, by the ground heater, by the heat pipe and by the waste heat storage, could generate around 220 kW of renewable energy. Other actions on the reduction of the demand could be managed on the insulation of the building, the lighting plan, the economic equipments or the shadowing elements on the building envelope. Consequently, the final demand of the building could reduce the necessity of conventional energy by over 50%.

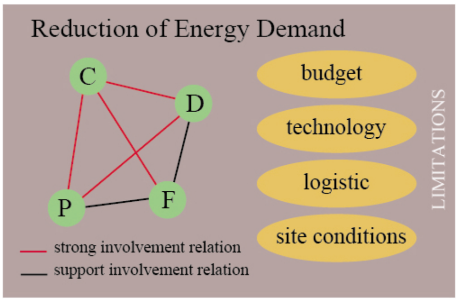

Figure 10: Involvement relation of the team

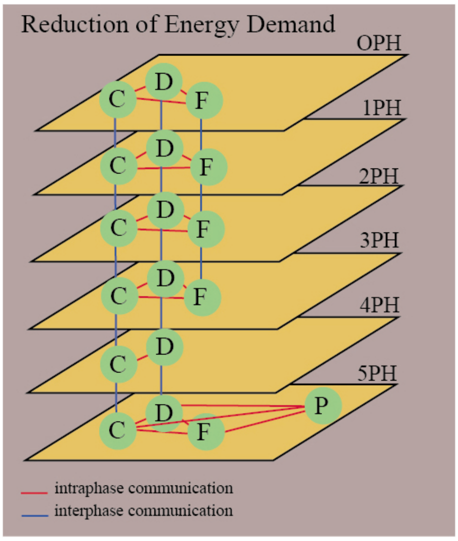

Figure 11 Team Communication between phases

These challenge limitations were the budget and the technology. The professionals involved on the solution of this green solution were the architect (C), the mechanical engineer (D), the electrical engineer (F) and the general contractor engineer (P). The challenge and the solutions could be forecasted during the planning phase.

3.3 Case study C: Institute for Global Environmental Strategies - IGES

The Institute for Global Environmental Strategies is a building in which architectural concepts were based on the requirement to be a practical and comfortable research environment, providing flexible support for long-term researches and to be a prototype environmentally friendly building, taking advantage of surrounding environment appropriating the relation to content of research activities.

Table 6 Building Overview [Shinkenchiku, 2002]

Description	Unique block for the research center
Type	New construction
Use	Research facility
Site	Kanagawa prefecture, Japan
Floor area	7,408 m2
Stories	2 above, 1 below ground
Structure	Reinforced Concrete, steel
Budget	382,700 JPY / m^2
Population	170 users / day
Conclusion	2002
Architectural designer	Nikken Sekkei Ltd. by a competition
Manager of the Project	Nikken Sekkei Ltd.
Environmental support	Ikaga Laboratory, Keio University
Construction Company	Kajima; Mitsui Construction; Kobai Kensetsu JV
Sponsors	Kanagawa Prefecture
Stakeholders	international institutions; governments; local autonomous bodies; enterprises; nonprofit organizations; citizens
Assessment	CASBEE (S - 5 stars)

tool	
Performance	50% of energy saving; reduction in 40% of CO2 emission

3.3.1 Interviewee

This case interviewee was an essential member into the project process flow, the Professor Toshiharu Ikaga from Keio University, mechanical and environmental engineer.

3.3.2 Sustainability

The IGES building presents the excellence in green solutions of its performance. Since the beginning many simulations supported the results of the building behave facing to sustainability. The client demanded the project to receive the installations of the center of sustainable studies and it was strongly required the highest level of sustainability on it, highlighting future activities inside the building.

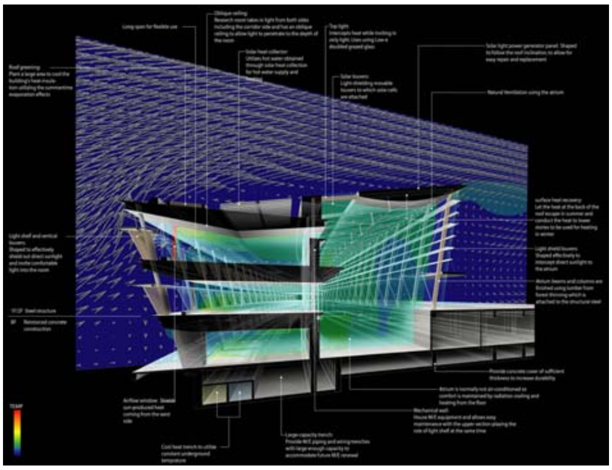

Figure 12 Schematic section [KODAMA]

Table 7 Green solutions (codes on methodology)

Green solutions	members
1. Natural Ventilation	A D C
2. Photovoltaic Panels	A F C
3. Sunshade Elements	D C
4. Wind power generation	A F C
5. Rainwater storage	AD C
6. Gray water treatment	D
7. Solar heat accumulation	A D
8. Natural light from the roof	D C
9. Recycling materials	A D C
10. Reused materials	A D C
11. Countermeasures	D F
12. Natural lighting	A D C
13. Greenbelt on the site	A D H C
14. Passive acclimatization	D
15. Landscape relationship	A C
16. Soil large permeability	M
17. Micro gas turbine	D F
18. Composting of waste	A D
19. Ice-heat storage	D
20. Cool heat trench	A D F

3.3.3 Challenges on the project

3.3.3.1 Challenge 1

The first big challenge became the quality on the atrium environment. Since this area to be treated is located facing the east façade and the natural tendency is to become very cold during the winter. The big sized volume to be treated on this space required careful efforts on it. On this way, many simulations were made in order to guarantee the best indoor environment to forecasting good behave of it.

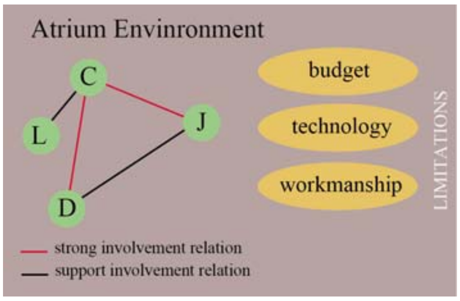

Figure 13 Involvement relation of the team

The communication between the involved team members on this challenge happened in order to overpass the barriers of this. On this hand, the players on the solutions were the architect (C), the mechanical engineer (D), the geotechnical engineer

(J) and lighting consultant (L), who dealt with the air quality, the illumination, the influence from the ground temperature and the design solution for it.

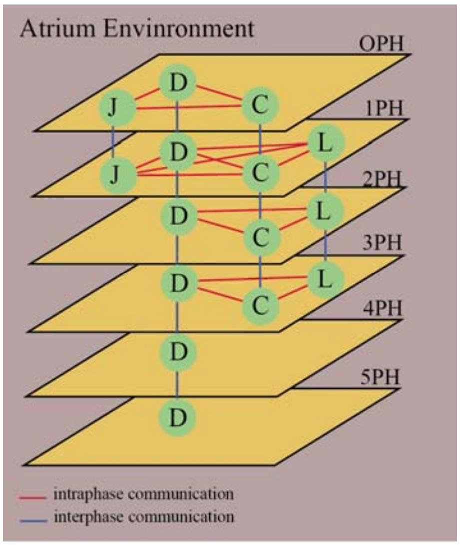

Figure 14 Team Communication between phases

The challenge was forecasted on the planning phase and could manage the main barriers related to the quality of the atrium environment. The considered limitations on the challenge were the budget, the technology and the workmanship.

3.3.3.2 Challenge 2

The other challenge related to the IGES building was considered the temperature distribution into the whole building, since the two main façades are in contact to extremes on the temperature. It was necessary to make a study of the temperature behave during the year to give responses on the problems related to it. The indoor area requires adequate temperature, mainly because of the research activities to be performed inside this building.

The communication between the team members became essential to give a good response into the challenge, mainly because the consumption of energy should not be high, that would conflict to the principles of the building. The players of the solution of this challenge became the architect (C), the mechanical engineer (D), the electrical engineer, the geotechnical engineer (J) and the research & development (N), who were dealt with issues related to the indoor temperature. The limitations related were the technology and the underground site conditions on the temperature to deal with.

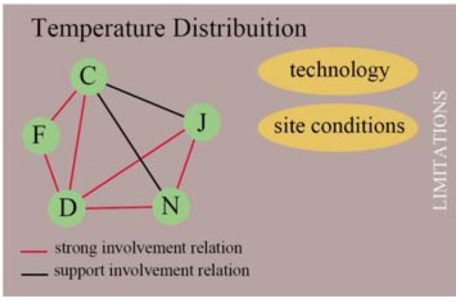

Figure 15 Involvement relation of the team

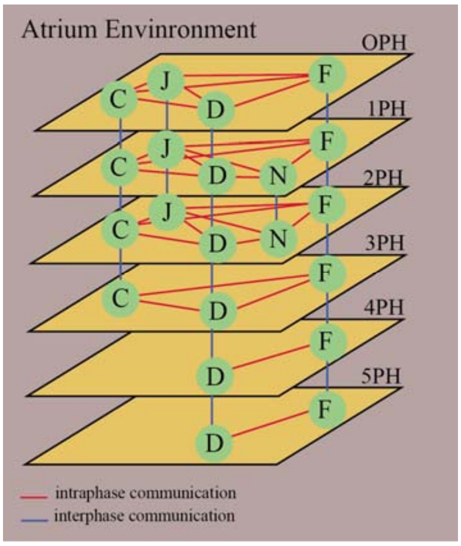

Figure 16: Team Communication between phases

3. OVERLAPPING AND CONCLUSIONS

The comparison detecting the main players on the green solutions (light green) challenges of the sustainable solutions (dark green) is displayed in the Table 8, from the initial list disposed at the methodology section at the beginning of this paper. The importance of the result is identifying the essential members on the architectural project process flow.

Table 8 Crossing the results

Involved team members	Cases A	Cases B	Cases C
A. Client as an activity role			
B. Manager of the project			
C. Architect			
D. Mechanical engineer			
E. Structural Engineer			
F. Electrical Engineer			
G. Facilities Engineer			
H. Landscape Architect			
I. General Contractor			
J. Geotechnical Engineer			
K. Interior Designer			
L. Lighting Specialists			
M. Authorities			
N. Research and development			
O. Manager of the site			
P. General Contractor Engineer			
Q. Environmental Engineer			
R. Green designer Specialist			
S. Cost Consultant			
T. Suppliers			
U. Environmental Consultant			
V. Hydraulic Engineer			
W. Sub Contractors			

Analyzing the table above, summarizing the players of the green solutions on the related cases, it is possible to recognize that the minimum core of the green solutions to compose a design team must be the architect, the mechanical engineer and the electrical engineer. Depending on the complexity and the size of the project, it is recommended and necessary to include other members related to the specific solutions. It is important to highlight that the found design involved team is basically related to the green solutions and this minimum core does not dispense other essential professionals to the project.

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