

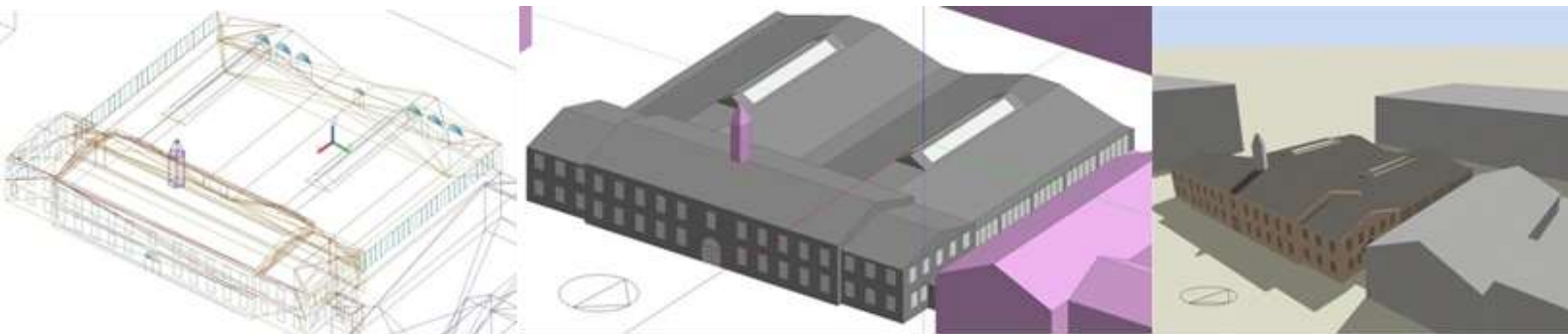


Greater Philadelphia Innovation Cluster
for Energy-Efficient Buildings
A U.S. DOE Energy Innovation Hub



Task 2.2.12 – CMU Report 01:
**Development of a Web-Based Survey Platform for the
Evaluation of Building Performance Simulation Tools**

Department of Energy Award # EE0004261



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1 Executive Summary of the Building Performance Simulation Tools Survey

The online web-based simulation tool survey covering energy, lighting and CFD simulation is intended to gather pertinent information for evaluating the current usage, strengths, and weaknesses and provide recommendations on the best available Energy, CFD, and Lighting simulation tools in industry. The survey is deliberately designed to cover a wide spectrum of personnel involved in the building industry, including architecture and engineering practitioners, specialist consultants as well as those in the R&D within academia and research institutions.

The survey consists of various sections which gather information such as Personal information, Experiences with the use of simulation tools, General impressions of the simulation tools, Tool features specifications, Modelling information input, and Simulation result output and analysis.

All the participation in the survey is completely on a voluntary basis and any personal information will be kept strictly confidential and will not be disclosed.

2 Introduction and Display of the Building Performance Simulation Tools Survey Platform

2.1 Introductions of the building performance simulation tools survey platform

The online web-based simulation tool survey platform is implemented as an xml-based IT infrastructure and is developed based on advanced web application and database technologies, so it is able to be expanded to cover other building performance domains as well as facilitate data exchange for interoperability and extension of analytical features. The Java Enterprise Edition web application is the platform used in the project, which fully capitalize on the ubiquity of web browsers and the convenience of using a web browser as a client with inherent support for cross-platform compatibility. All updates and analysis can be independently managed on the server side.

The access to the survey is available via http://128.2.109.122:8080/GPICSurvey_v1/. Coordinators of the GPIC Survey group activities have reviewed the draft and provided comments and feedbacks. Members of the CMU Task 2 and 3 teams have also reviewed and commented on the draft. These have all been implemented in the final design of the survey. A small sample has also been drawn to test the functionality of the platform and to demonstrate. The complete survey will be conducted in GPIC Year 2 phase.

2.2 Display of the building performance simulation tools survey platform

The introduction page of the online building performance simulation tools survey platform is shown in Figure 1, on which participants can choose which survey (energy, lighting or CFD) to take.

For the participants' convenience, the system allows the participants to finish the survey in several times. When the participant takes the survey for the first time, a unique ID will be generated at the end of survey, no matter whether the survey is complete or not. Then the participant can provide the ID for future access later.



Figure 1 Introduction Page of the Online Building Performance Simulation Tools Survey

The questions in each survey are classified into several categories based on the features and focuses of each survey.

In the energy survey, the categories include Experiences with the use of simulation tool, General impressions of the energy simulation tools, Tool features specifications, Modeling information input, and Simulation result output and analysis, as shown in Figure 2. In the CFD survey, the categories include General Feedback of Geometry Construction, Mesh Generation, CFD Solver, and Post Processing, as shown in Figure 3. In the Lighting survey, the categories include General simulation Information, Model Building, Model Importation, Simulation Functionality, and Result Output, as shown in Figure 4.

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ENERGY SURVEY

Tool features specifications

14. Does this simulation tool have a History Tracking?
 Yes No I do not know

14-1. This function is easy to use
 Strongly disagree Disagree Neutral Agree Strongly agree

14-2. This function is important in energy simulation modeling
 Strongly disagree Disagree Neutral Agree Strongly agree

15. Is this simulation tool IFC compliant?
 Yes No I do not know

15-1. This function is easy to use
 Strongly disagree Disagree Neutral Agree Strongly agree

15-2. This function is important in energy simulation modeling
 Strongly disagree Disagree Neutral Agree Strongly agree

16. Is this simulation tool gbXML compliant?
 Yes No I do not know

16-1. This function is easy to use
 Strongly disagree Disagree Neutral Agree Strongly agree

16-2. This function is important in energy simulation modeling
 Strongly disagree Disagree Neutral Agree Strongly agree

Figure 2 Example Page of the Building Energy Simulation Tools Survey

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CFD SURVEY

Mesh Generation

11. Select the tool used to generate mesh on geometry models in this project?
 GAMBIT TGrid ALzPaK Phoenix OT_HIZ_CAD
 Other (Please specify) _____


12. Select the type of license you used for the mesh generation tool for this project?
 Commercial License
 Academic License Industrial License
 Other (Please specify) _____


Free License
 GNU General Public License GNU Lesser General Public License
 BSD License
 Other (Please specify) _____

13. How would you rate the user interface of the mesh generation tool you used for this project?
 Highly Satisfied Satisfied Neutral Dissatisfied Highly Dissatisfied

14. For compatibility with the CAD software of the mesh generation tool, please check one of the following boxes
 Import Function
 Compatible with CAD software Not Compatible with CAD software
 I do not know
 If compatible, please list filename extension _____

Figure 3 Example Page of the Building CFD Simulation Tools Survey



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LIGHTING SURVEY

Model Importation

34. Is the tool able to import simulation model generated from other software?
 Yes No I do not know

If yes, please answer the following questions (35-44)

35. Which type of file do you use most frequently as the import file?
 DXF file RAD file IDF file XML file
 Others:

36. Geometry information is correct in the file importation
 Strongly disagree Disagree Neutral Agree Strongly agree

37. NO geometry information is missing in the file importation
 Strongly disagree Disagree Neutral Agree Strongly agree

38. There are NO trash surfaces generated in the file importation
 Strongly disagree Disagree Neutral Agree Strongly agree

39. NO surfaces are divided into trash pieces in the file importation
 Strongly disagree Disagree Neutral Agree Strongly agree

40. Settings of building materials are correct complete in the file importation
 Strongly disagree Disagree Neutral Agree Strongly agree

Figure 4 Example Page of the Building Lighting Simulation Tools Survey

3 Analysis of the Survey Results from a Demonstration Small Sample

3.1 Personal information

To demonstrate the result analysis function of the survey platform, a small sample is investigated and displayed in this section. There are 24 copies of surveys in the Energy Section, 22 of which are finished and validated for analysis. Up to now, most of the surveys are finished by the graduate students at CMU and PSU. Consequently, none of them are qualified LEED AP or ASHRAE Members. Among the participants, 12 of them are students; 5 of them are Research Associate; 1 is Asst. Professor. Their primary responsibilities in the organization are shown in Table 1.

Table 1 Primary Responsibilities of the Survey Participants

1. Students & Taking courses in Building performance modeling, sustainable buildings. (8 people)
2. Research (4 people)
3. Project manager (1 people)
4. Education (1 people)
5. Facility Management (1 people)

3.2 Experience with the use of simulation tool

All of the participants show interest in building energy simulation. Design Exploration and Design Verification are shown in Figure 1, from which it can be judged that the participants are same interested in Building Geometry, Materials Selection, HVAC System Sizing, but less interested in the Renewable Energy Systems. Figure 2 shows that almost 1/3 of the participants think that Building Energy Simulation is used for LEED Certification and Verifying Code Compliance.

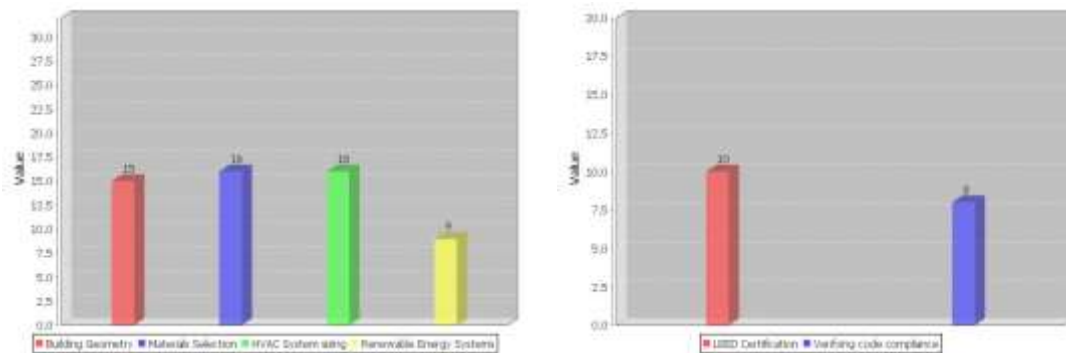


Figure 5 Design Exploration and Design Verification

Almost all of them (22) have some experience with building energy simulation. The simulation tools used include eQuest, Green Building Studio, EnergyPlus, Design Builder, TRNSYS, System Advisor Model, Radiance, RETScreen, Ecotect, Energy10, NBSLD and REMrate. The selection result of used simulation tools are shown in the bellowing Figure.

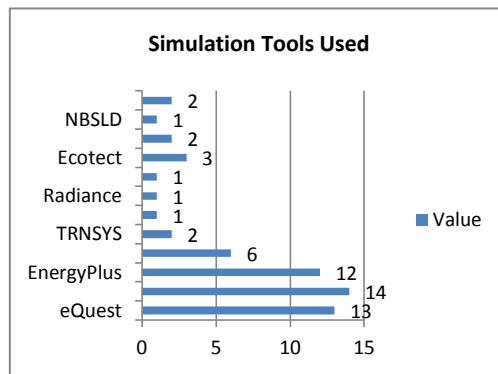


Figure 6 Comparison of the Simulations Tools Used

3.2.1 Some general patterns in this section:

- (1) The popular tools in the survey are Energyplus, GBS and eQuest. Two participants from PSU both choose TRNSYS for Research Use.
- (2) Most of the participants have a less than 1 year simulation experience. (Students)
- (3) 5 people have the 3-5 years experience and they mainly use the tools for Research. Their currently using simulation tools are EnergyTen(2), TRNSYS(2), Ecotect(2), EnergyPlus(4). EP seems to be a popular tool at present.
- (4) Most of them built less than 5 models. Even the participants with 3-5 years experience built just 5-20 models.
- (5) Most of them use the tools in Schematic Design and Design Development. Due to the complex process of simulation, it is possibly considered that these tools cannot be used in the final design process and less used in the design development process.
- (6) The main BIM or CAD software currently using are AutoCAD, Revit Architecture, Revit Ecotect. 3 of them choose DesignBuilder. It seems that the productions from Autodesk are the popular BIM or CAD tools among students and researchers.

3.3 General patterns in the impressions of the energy simulation tool

- (1) Almost half of the participants are using EnergyPlus.
- (2) They do not have a quite positive answer on the difficult levels of learning the BES tool, but agree that they are easy to use once learned. (Q7 and Q8)
- (3) The participants have a negative attitude on the good graphic user interface. (Q9)
- (4) They don't agree that the tools are easy to create the simulation model and modify the models.
- (5) It is agreed that the tools can provide good result report and help menu.

3.4 Some general patterns in tool features specification

- (1) When referring to some specific features, it can be found that almost half of them choose "I do not know" in every question, so they might do not well know this tool in detail.

(2) The features that participants are not familiar with are shown in Table 2.

Table 2 Patterns in Tool Features Specification

History tracking(8)	Export input files to other tools(9)
IFC Compliant(10)	Export model input files to CAD tools(11)
gbXML Compliant(10)	Provide coupling with decision-making tools or algorithms(13)
Code Compliance(16)	Energy cost estimation function(8)
Life cost estimation(12)	have real time network collaborative functions in geographically distributed environments (12)
parallel processing functionality (16)	provide a file save interval (10)
provide file management functions (14)	

Note: Numbers are the people who choose I don't know

(3) The participants show a relative strong agreement on the importance of some features, including import model input files from other simulation tools, conduct parametric studies, provide coupling with decision-making tools or algorithms, energy cost estimation functions, life cycle cost estimation/optimization functions, provide user documentations (manuals, tutorials), supports user group/forums for feedback and problem solving, have geometric model display.

(4) It can be found that most of them did not choose any answer on the difficult level of use of these functions, because they do not know these functions well. From this point, it can be judged that the participants lack some knowledge of detail information about the tools.

3.5 General patterns in modeling information input

After reviewing some patterns in this section, it can be found the frequent input issue include provide clear guideline and tutorial, graphic interface, build and modify models, good built-in library for schedule and require expert knowledge on HVAC and Water system.

3.5.1 Some general patterns in general information input

- (1) Half of the participants choose that they do not know the function of providing pre-defined space types (e.g., lobby, kitchen). This question is especially suitable for GBS and eQuest.
- (2) It is strongly agreed on the importance of Zone management functions and they don't agree on "easy to use" this function the same as the importance.
- (3) The function of providing pre-defined building types (office, resident building) is satisfying.
- (4) It is less agreed on "easy to modify/edit geometrical building model".
- (5) The limitations of this simulation tool in geometrical modeling, mainly focusing on

user friendly interface, Compatibility issues and Building models.

Table 3 Patterns in Modeling Information Input

Modeling is not very easy and user friendly.
Compatibility issues.
Creating variations of model components like widow and door
Difficult to create more sophisticated shapes than boxes. Problems in creating pitched roof
Neither tool is a graphic tool, a building must be modeled in another program.
Iterations are between SketchUp add-on and TRNSYS Type 56 multi-zone building component. The iterations between updates are not so user friendly at this time.
Need a friendly user interface (design-builder) which is unfortunately very expensive.
Shapes and spaces you can make are limited. Surface construction surface description is limited.
Solar Irradiance Shade impact on opaque surfaces.
It does not provide its own graphical interface.
There is an interoperability issue when the Revit model exports to eQUEST such as missing geometrical component of angular roof.

3.5.2 *Some general patterns in building construction materials input*

- (1) There is a strong agreement on the materials input, especially on the “Built-in library is easy to use”. It seemed that they do not know the connection to external database.

3.5.3 *Some general patterns in building construction input*

- (1) It shows a neutral attitude on providing guideline/recommendation on building construction.
- (2) They show an agreement on the function of built-in library, defining building construction and providing automatic U-factor adjustments for building construction assemblies
- (3) Limitations of this simulation tool in building construction input, mainly focusing on the defining the materials in BES tools.

Table 4 Patterns in Building Construction Input

Problems with data changing back to default
Ill defined requirements and value weight.
Knowledge of materials is more helpful than the default listings. Databases can be out of date for any simulation tool
You can't simply pick a wall of a certain R-value without building the wall yourself. You could probably get any wall library from someone online.
It does not provide a graphical display of construction material layer like Design builder. The function which users are able to intuitively show and understand the construction material type they newly made.

3.5.4 *Some general patterns in internal loads (occupants, lighting, equipments) input*

- (1) The function of defining loads by spaces and their own schedules are satisfying, but the participants show a lower agreement on the function of providing built-in library of schedule. Consequently, the participants are not so satisfied with the built-in library of schedule.
- (2) They do not highly agree on providing clear guideline/recommendation on internal loads (e.g., code compliance, default value according to building types)
- (3) Limitations of this simulation tool in internal loads input

Table 5 Patterns in Internal Loads

Loads for weekend differ for different types of building which is not accounted for in this tool.
Problems with data changing back to default
Non-intuitive definition of schedules - cumbersome layering.
As a default does not include thermal gains that are associated with plug loads which may impact HVAC loads in the zone. This feature can in the zone. This feature can be built in with minimal effort though.
It needs a function to show a useful guideline (e.g. direct link to ASHRAE handbook) to help input accurate and appropriate data as a parameter.

3.5.5 *General patterns in infiltration input*

- (1) They show a nearly neutral attitude on defining the rate and providing clear guideline/recommendation on infiltration.

3.5.6 *General patterns in utility*

- (1) It is easy to define the utility rate, but less agreed on “easy to define your own schedules”
- (2) The attitude on providing clear guideline/recommendation on utility (e.g., default value according to building types) is neutral. Consequently, this function should be strengthened.

3.5.7 *General patterns in HVAC input*

- (1) They show a nearly neutral attitude on providing clear guideline/recommendation on HVAC system input, providing HVAC component library for conventional configurations, providing HVAC component library for conventional configurations and HVAC component library for conventional configurations.
- (2) They highly agree on “easy define thermostat setpoint” and “easy to define HVAC zones”.
- (3) It seems that the users agree that it is easy to make some basic definition, but less agree on the definition of some specific component definition, which often needs specific information.
- (4) Most of people think that HVAC system input needs expert knowledge.
- (5) Limitation of BES tools in HVAC system input.

Table 6 Patterns in HVAC Input

As a novice user of energy simulation tool, it is hard to get useful help in the simulation program itself.

3.5.8 General patterns in Water Heating System input

- (1) It shows a lower agreement on two parts in WHS, “easy to connect water heating equipments with plant side HVAC components” and “provides SWH component library”.
- (2) It is also agreed that this input requires expert knowledge for SWH system input as HVAC input.

3.5.9 General patterns in Service Water Renewable Energy System (RES) input

- (1) There is a relative low agreement or neutral attitude on RES input and WHS input. Half of participants choose neutral on each question in this section.
- (2) Limitations in this RES input

Table 7 Patterns in Service Water Renewable Energy System (RES) Input

None. This is strength of TRNSYS.
The input information should be updated with the most recent RES system.

3.6 General patterns simulation result output and analysis

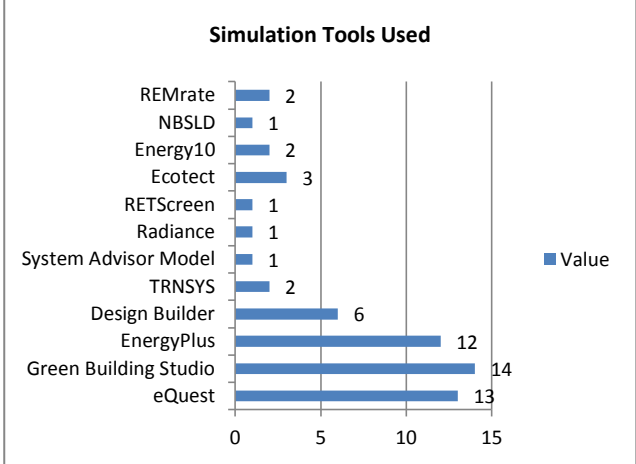
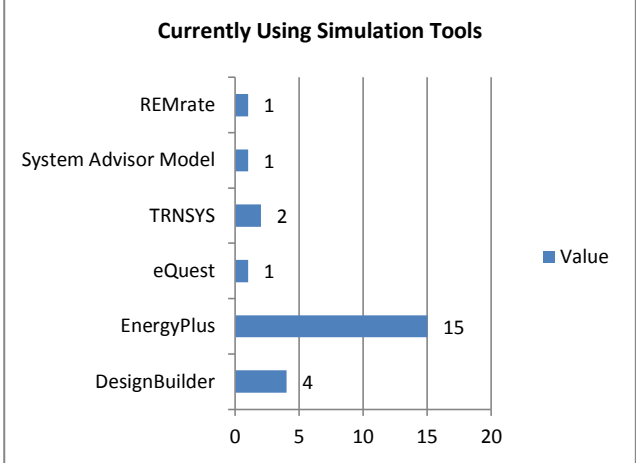
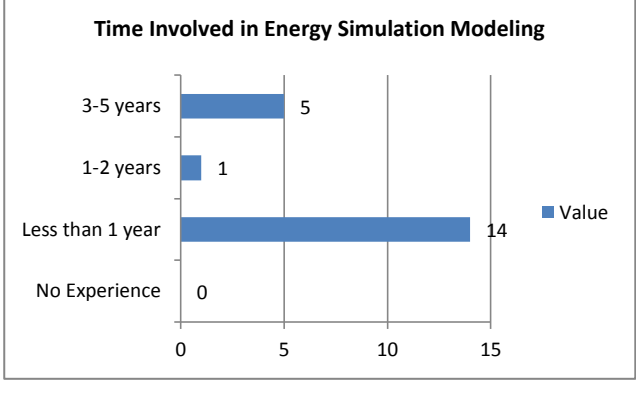
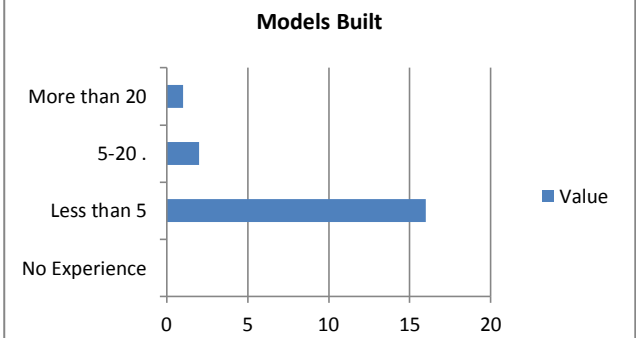
- (1) There is a relative high agreement on three parts, “the results are comprehensive and relevant for your design process”, “Numeric outputs of this simulation are well-formatted to be read easily” and “The output can be readily captured for use in reports”.
- (2) It shows a lower agreement on the function of producing good graphical outputs and the output can be easily exported to office software. There seems to be some improvement on the graphical outputs and the compatibility with other office software.

3.7 Others

- (1) There is a negative attitude on providing weather data visualization for future analysis. Almost half of the participants disagree on this function.
- (2) It provides a satisfied function of providing easy weather data input and necessary conversions from related databases.
- (3) There is a high agreement that the use of BES tools requires high level of background knowledge on building simulation.
- (4) Half of the participants are satisfied with the tool and the results obtained.

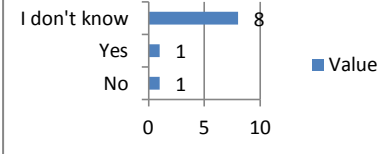
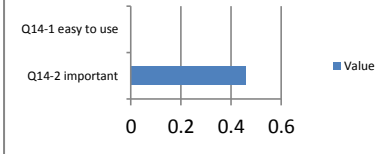
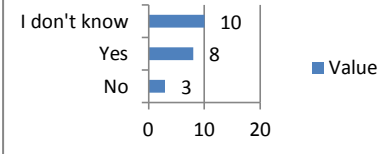
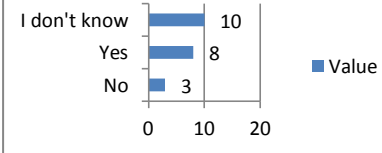
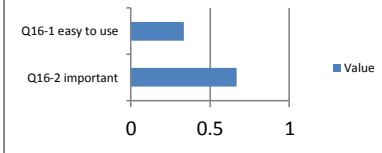
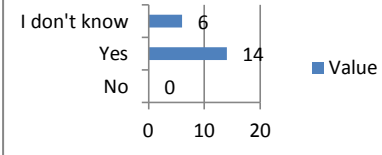
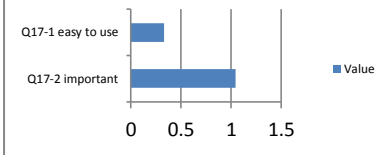
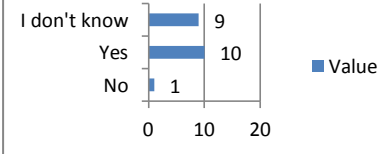
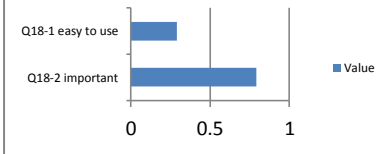
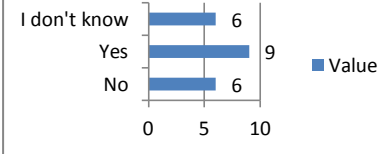
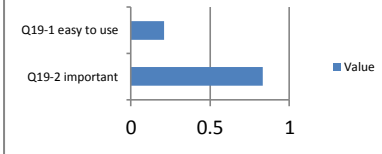
Note: strongly disagree = -2, disagree = -1, neutral = 0, agree = 1, strongly agree = 2.

Table 8 Patterns and Analysis in Other Parameters

<p>4-1</p>	 <table border="1"> <caption>Simulation Tools Used</caption> <thead> <tr> <th>Tool</th> <th>Value</th> </tr> </thead> <tbody> <tr><td>REMrate</td><td>2</td></tr> <tr><td>NBSLD</td><td>1</td></tr> <tr><td>Energy10</td><td>2</td></tr> <tr><td>Ecotect</td><td>3</td></tr> <tr><td>RETScreen</td><td>1</td></tr> <tr><td>Radiance</td><td>1</td></tr> <tr><td>System Advisor Model</td><td>1</td></tr> <tr><td>TRNSYS</td><td>2</td></tr> <tr><td>Design Builder</td><td>6</td></tr> <tr><td>EnergyPlus</td><td>12</td></tr> <tr><td>Green Building Studio</td><td>14</td></tr> <tr><td>eQuest</td><td>13</td></tr> </tbody> </table>	Tool	Value	REMrate	2	NBSLD	1	Energy10	2	Ecotect	3	RETScreen	1	Radiance	1	System Advisor Model	1	TRNSYS	2	Design Builder	6	EnergyPlus	12	Green Building Studio	14	eQuest	13	<p>1. The popular tools in the survey are Energyplus, GBS and eQuest. Most of the students took the BPM course at CMU, so GBS, eQuest, EnergyPlus and DesignBuilder learned at class have a high value.</p> <p>2. Two participants from PSU choose TRNSYS for Research Use.</p>
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4-5	<p style="text-align: center;">% Worktime Spent on BES</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>more than 30%</td> <td>5</td> </tr> <tr> <td>20~30%</td> <td>6</td> </tr> <tr> <td>10~20%</td> <td>3</td> </tr> <tr> <td>1~10%</td> <td>4</td> </tr> <tr> <td>Not at all</td> <td>2</td> </tr> </tbody> </table>	Category	Value	more than 30%	5	20~30%	6	10~20%	3	1~10%	4	Not at all	2	
Category	Value													
more than 30%	5													
20~30%	6													
10~20%	3													
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4-6	<p style="text-align: center;">Stages using BES tools</p> <table border="1"> <thead> <tr> <th>Stage</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Final Design</td> <td>3</td> </tr> <tr> <td>Design Development</td> <td>9</td> </tr> <tr> <td>Schematic Design</td> <td>13</td> </tr> </tbody> </table>	Stage	Value	Final Design	3	Design Development	9	Schematic Design	13	<p>Most of them use the tools in Schematic Design and Design Development.</p> <p>Due to the complex process of simulation, it is possibly considered that these tools cannot be used in the final design process and less used in the design development process.</p>				
Stage	Value													
Final Design	3													
Design Development	9													
Schematic Design	13													

6	<p style="text-align: center;">Currently Using BSE tools</p> <table border="1"> <thead> <tr> <th>Tool</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Green Building Design</td> <td>1</td> </tr> <tr> <td>TRNESS</td> <td>2</td> </tr> <tr> <td>DesignBuilder</td> <td>2</td> </tr> <tr> <td>eQuest</td> <td>4</td> </tr> <tr> <td>EnergyPlus</td> <td>10</td> </tr> </tbody> </table>	Tool	Value	Green Building Design	1	TRNESS	2	DesignBuilder	2	eQuest	4	EnergyPlus	10	<p>Most of the participants are currently using Energyplus.</p>				
Tool	Value																	
Green Building Design	1																	
TRNESS	2																	
DesignBuilder	2																	
eQuest	4																	
EnergyPlus	10																	
7~13	<p style="text-align: center;">Value</p> <table border="1"> <thead> <tr> <th>Question</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Q7 easy to learn</td> <td>0.1</td> </tr> <tr> <td>Q8 easy to use</td> <td>0.8</td> </tr> <tr> <td>Q9 good graphic user...</td> <td>0.1</td> </tr> <tr> <td>Q10 easy to create model</td> <td>0.1</td> </tr> <tr> <td>Q11 easy to modify model</td> <td>0.1</td> </tr> <tr> <td>Q12 good result report</td> <td>0.5</td> </tr> <tr> <td>Q13 good help menu</td> <td>0.4</td> </tr> </tbody> </table>	Question	Value	Q7 easy to learn	0.1	Q8 easy to use	0.8	Q9 good graphic user...	0.1	Q10 easy to create model	0.1	Q11 easy to modify model	0.1	Q12 good result report	0.5	Q13 good help menu	0.4	<p>Investigators don't have a positive answer on the learning of BES tools but agree that they are easy to use.</p> <p>They don't agree that they are easy to modify models.</p> <p>They agree that they can provide good result report and help menu.</p>
Question	Value																	
Q7 easy to learn	0.1																	
Q8 easy to use	0.8																	
Q9 good graphic user...	0.1																	
Q10 easy to create model	0.1																	
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Q13 good help menu	0.4																	

<p>Q14 have a history tracking?</p>  <table border="1"> <thead> <tr> <th>Response</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>I don't know</td> <td>8</td> </tr> <tr> <td>Yes</td> <td>1</td> </tr> <tr> <td>No</td> <td>1</td> </tr> </tbody> </table>	Response	Value	I don't know	8	Yes	1	No	1	<p>Value</p>  <table border="1"> <thead> <tr> <th>Question</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Q14-1 easy to use</td> <td>0</td> </tr> <tr> <td>Q14-2 important</td> <td>0.45</td> </tr> </tbody> </table>	Question	Value	Q14-1 easy to use	0	Q14-2 important	0.45	<p>Participants don't know the history tracking function too much, but they think it is important. About half of them do not answer this question, perhaps because they do not understand it too much.</p>
Response	Value															
I don't know	8															
Yes	1															
No	1															
Question	Value															
Q14-1 easy to use	0															
Q14-2 important	0.45															
<p>Q15 IFC compliant?</p>  <table border="1"> <thead> <tr> <th>Response</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>I don't know</td> <td>10</td> </tr> <tr> <td>Yes</td> <td>8</td> </tr> <tr> <td>No</td> <td>3</td> </tr> </tbody> </table>	Response	Value	I don't know	10	Yes	8	No	3	<p>Value</p>  <table border="1"> <thead> <tr> <th>Question</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Q15-1 easy to use</td> <td>0.1</td> </tr> <tr> <td>Q15-2 important</td> <td>0.55</td> </tr> </tbody> </table>	Question	Value	Q15-1 easy to use	0.1	Q15-2 important	0.55	<p>About half of them do not know IFC. This function is considered to be important and easy to use.</p>
Response	Value															
I don't know	10															
Yes	8															
No	3															
Question	Value															
Q15-1 easy to use	0.1															
Q15-2 important	0.55															
<p>Q16 gbXML compliant?</p>  <table border="1"> <thead> <tr> <th>Response</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>I don't know</td> <td>10</td> </tr> <tr> <td>Yes</td> <td>8</td> </tr> <tr> <td>No</td> <td>3</td> </tr> </tbody> </table>	Response	Value	I don't know	10	Yes	8	No	3	<p>Value</p>  <table border="1"> <thead> <tr> <th>Question</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Q16-1 easy to use</td> <td>0.3</td> </tr> <tr> <td>Q16-2 important</td> <td>0.6</td> </tr> </tbody> </table>	Question	Value	Q16-1 easy to use	0.3	Q16-2 important	0.6	<p>About half of them do not know gbXML. They have a positive answer on the easy use and importance of this function.</p>
Response	Value															
I don't know	10															
Yes	8															
No	3															
Question	Value															
Q16-1 easy to use	0.3															
Q16-2 important	0.6															
<p>Q17 import files from others?</p>  <table border="1"> <thead> <tr> <th>Response</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>I don't know</td> <td>6</td> </tr> <tr> <td>Yes</td> <td>14</td> </tr> <tr> <td>No</td> <td>0</td> </tr> </tbody> </table>	Response	Value	I don't know	6	Yes	14	No	0	<p>Value</p>  <table border="1"> <thead> <tr> <th>Question</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Q17-1 easy to use</td> <td>0.2</td> </tr> <tr> <td>Q17-2 important</td> <td>1.0</td> </tr> </tbody> </table>	Question	Value	Q17-1 easy to use	0.2	Q17-2 important	1.0	<p>Most of them know this function and they strongly agree that it is important</p>
Response	Value															
I don't know	6															
Yes	14															
No	0															
Question	Value															
Q17-1 easy to use	0.2															
Q17-2 important	1.0															
<p>Q18 export input files to others?</p>  <table border="1"> <thead> <tr> <th>Response</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>I don't know</td> <td>9</td> </tr> <tr> <td>Yes</td> <td>10</td> </tr> <tr> <td>No</td> <td>1</td> </tr> </tbody> </table>	Response	Value	I don't know	9	Yes	10	No	1	<p>Value</p>  <table border="1"> <thead> <tr> <th>Question</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Q18-1 easy to use</td> <td>0.2</td> </tr> <tr> <td>Q18-2 important</td> <td>0.75</td> </tr> </tbody> </table>	Question	Value	Q18-1 easy to use	0.2	Q18-2 important	0.75	<p>Half of them don't know this function well. They more strongly agree the importance of exporting function.</p>
Response	Value															
I don't know	9															
Yes	10															
No	1															
Question	Value															
Q18-1 easy to use	0.2															
Q18-2 important	0.75															
<p>Q19 import model from CAD?</p>  <table border="1"> <thead> <tr> <th>Response</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>I don't know</td> <td>6</td> </tr> <tr> <td>Yes</td> <td>9</td> </tr> <tr> <td>No</td> <td>6</td> </tr> </tbody> </table>	Response	Value	I don't know	6	Yes	9	No	6	<p>Value</p>  <table border="1"> <thead> <tr> <th>Question</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Q19-1 easy to use</td> <td>0.2</td> </tr> <tr> <td>Q19-2 important</td> <td>0.8</td> </tr> </tbody> </table>	Question	Value	Q19-1 easy to use	0.2	Q19-2 important	0.8	<p>Half of the tools qualified this function and is considered to be important.</p>
Response	Value															
I don't know	6															
Yes	9															
No	6															
Question	Value															
Q19-1 easy to use	0.2															
Q19-2 important	0.8															

<p>Q20 export model to CAD?</p> <p>I don't know 11 Yes 5 No 5</p> <p>Value</p>	<p>Value</p> <p>Q20-1 easy to use Q20-2 important</p> <p>Value</p>	<p>Most of people do not know this function.</p>
<p>Q21 conduct parametric studies?</p> <p>I don't know 5 Yes 15 No 1</p> <p>Value</p>	<p>Value</p> <p>Q21-1 easy to use Q21-2 important</p> <p>Value</p>	<p>Almost all the tools have this function. It is strongly agreed that it is important.</p>
<p>Q22 coupling with decision-making tools or algorithms?</p> <p>I don't know 13 No 8</p> <p>Value</p>	<p>Value</p> <p>Q22-1 easy to use Q22-2 important</p> <p>Value</p>	<p>Most of participants do not know this function.</p>
<p>Q23 have code compliance function?</p> <p>I don't know 16 No 5</p> <p>Value</p>	<p>Value</p> <p>Q23-1 easy to use Q23-2 important</p> <p>Value</p>	<p>Most of participants do not know this function.</p>
<p>Q24 energy cost estimation functions?</p> <p>I don't know 8 No 11</p> <p>Value</p>	<p>Value</p> <p>Q24-1 easy to use Q24-2 important</p> <p>Value</p>	<p>Half of people know that tools have this function.</p>
<p>Q25 life cycle cost estimation/optimization?</p> <p>I don't know 12 No 7</p> <p>Value</p>	<p>Value</p> <p>Q25-1 easy to use Q25-2 important</p> <p>Value</p>	<p>Most of them do not know this function</p>
<p>Q26 have real time network collaborative functions?</p> <p>I don't know 12 No 5 Yes 4</p> <p>Value</p>	<p>Value</p> <p>Q26-1 easy to use Q26-2 important</p> <p>Value</p>	<p>This function is thought to be less important.</p>

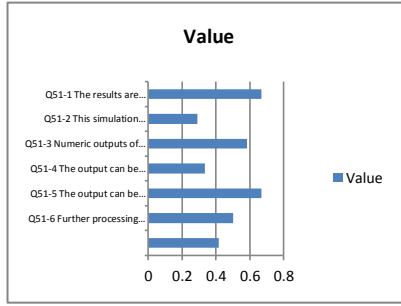
<p>Q27 parallel processing functionality?</p> <p>I don't know 16 No 4</p>	<p>Value</p> <p>Q27-1 easy to use Q27-2 important 0.3</p>	<p>Most of people do not know this function, and it is thought to be less important.</p>
<p>Q28 provide user documentations (manuals, tutorials)?</p> <p>I don't know 3 No 0</p>	<p>Value</p> <p>Q28-1 easy to use 0.5 Q28-2 important 1.0</p>	<p>Most of the tools have this function, which is thought to be very important.</p>
<p>Q29 support user group for feedback and problem solving?</p> <p>I don't know 7 No 1</p>	<p>Value</p> <p>Q29-1 easy to use 0.4 Q29-2 important 0.8</p>	
<p>Q30 support user group for feedback and problem solving?</p> <p>I don't know 10 No 3</p>	<p>Value</p> <p>Q30-1 easy to use 0.2 Q30-2 important 0.5</p>	<p>It seems less important than other functions.</p>
<p>Q31 provide file management functions?</p> <p>I don't know 14 No 4</p>	<p>Value</p> <p>Q31-1 easy to use 0.1 Q31-2 important 0.6</p>	<p>Most of them do not know this function.</p>
<p>Q32 geometric model display?</p> <p>I don't know 1 Yes 12 No 7</p>	<p>Value</p> <p>Q32-1 easy to use 0.8 Q32-2 important 1.0</p>	

<p>Q33 zone management functions?</p> <p>I don't know: 9 Yes: 12 No: 1</p>	<p>Value</p> <p>Q33-1 easy to use: ~0.5 Q33-2 important: ~1.0</p>	<p>This function is thought to be very important.</p>
<p>Q34 provide pre-defined types(office, resident building)?</p> <p>I don't know: 4 Yes: 16 No: 1</p>	<p>Value</p> <p>Q34-1 easy to use: ~0.5 Q34-2 important: ~0.7</p>	
<p>Q35 provide pre-defined space types(lobby, kitchen)?</p> <p>I don't know: 12 Yes: 4 No: 5</p>	<p>Value</p> <p>Q35-1 easy to use: ~0.15 Q35-2 important: ~0.3</p>	
<p>Q36 have a geometrical input for building modeling?</p> <p>I don't know: 6 Yes: 11 No: 4</p>	<p>Value</p> <p>Q36-1 create...: ~0.4 Q36-2 create...: ~0.3 Q36-3 represent...: ~0.3 Q36-4 easy to...: ~0.1</p>	
<p>37</p>		
<p>38 building constructing materials</p>	<p>Value</p> <p>Q38-1 built-in library is easy to use: ~0.7 Q38-2 library connected to external database: ~0.3 Q38-3 easy to define own material properties: ~0.5</p>	
<p>39 building construction input</p>	<p>Value</p> <p>Q39-1 built-in library is easy to use: ~0.5 Q39-2 easy to define construction: ~0.4 Q39-3 provide guideline on building construction: ~0.4 Q39-4 provide automatic U-factor adjustment: ~0.5</p>	
<p>40</p>		

41 internal loads	<p>Value</p> <table border="1"> <thead> <tr> <th>Question</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Q41-1 easy to define loads by space</td> <td>0.5</td> </tr> <tr> <td>Q41-2 easy to define schedule</td> <td>0.7</td> </tr> <tr> <td>Q41-3 provide built-in schedule library</td> <td>0.3</td> </tr> <tr> <td>Q41-4 provide guideline</td> <td>0.1</td> </tr> </tbody> </table>	Question	Value	Q41-1 easy to define loads by space	0.5	Q41-2 easy to define schedule	0.7	Q41-3 provide built-in schedule library	0.3	Q41-4 provide guideline	0.1															
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44 utility	<p>Value</p> <table border="1"> <thead> <tr> <th>Question</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Q41-1 define rate</td> <td>0.3</td> </tr> <tr> <td>Q43-2 define schedule</td> <td>0.25</td> </tr> <tr> <td>Q43-3 provide clear guide</td> <td>0.1</td> </tr> </tbody> </table>	Question	Value	Q41-1 define rate	0.3	Q43-2 define schedule	0.25	Q43-3 provide clear guide	0.1																	
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45 HVAC input	<p>Value</p> <table border="1"> <thead> <tr> <th>Question</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Q45-1 define rate</td> <td>0.6</td> </tr> <tr> <td>Q45-2 easy to define...</td> <td>0.7</td> </tr> <tr> <td>Q45-3 easy to edit HVAC...</td> <td>0.2</td> </tr> <tr> <td>Q45-4 easy to define...</td> <td>0.2</td> </tr> <tr> <td>Q45-5 easy to define...</td> <td>0.2</td> </tr> <tr> <td>Q45-6 provides a good...</td> <td>0.5</td> </tr> <tr> <td>Q45-7 requires expert...</td> <td>0.2</td> </tr> <tr> <td>Q45-8 provides clear...</td> <td>0.1</td> </tr> <tr> <td>Q45-9 provides an HVAC...</td> <td>0.1</td> </tr> <tr> <td>Q45-10 provides an HVAC...</td> <td>0.1</td> </tr> <tr> <td>Q45-11 provides...</td> <td>0.1</td> </tr> </tbody> </table>	Question	Value	Q45-1 define rate	0.6	Q45-2 easy to define...	0.7	Q45-3 easy to edit HVAC...	0.2	Q45-4 easy to define...	0.2	Q45-5 easy to define...	0.2	Q45-6 provides a good...	0.5	Q45-7 requires expert...	0.2	Q45-8 provides clear...	0.1	Q45-9 provides an HVAC...	0.1	Q45-10 provides an HVAC...	0.1	Q45-11 provides...	0.1	
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47 service water heating system input	<p>Value</p> <table border="1"> <thead> <tr> <th>Question</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Q47-1 easy to define...</td> <td>0.35</td> </tr> <tr> <td>Q47-2 easy to define...</td> <td>0.3</td> </tr> <tr> <td>Q47-3 easy to connect...</td> <td>0.2</td> </tr> <tr> <td>Q47-4 easy to define...</td> <td>0.3</td> </tr> <tr> <td>Q47-5 provides a good...</td> <td>0.2</td> </tr> <tr> <td>Q47-6 requires expert...</td> <td>0.35</td> </tr> <tr> <td>Q47-7 provides clear...</td> <td>0.2</td> </tr> <tr> <td>Q47-8 provides SWH...</td> <td>0.2</td> </tr> <tr> <td>Q47-9 provides...</td> <td>0.3</td> </tr> </tbody> </table>	Question	Value	Q47-1 easy to define...	0.35	Q47-2 easy to define...	0.3	Q47-3 easy to connect...	0.2	Q47-4 easy to define...	0.3	Q47-5 provides a good...	0.2	Q47-6 requires expert...	0.35	Q47-7 provides clear...	0.2	Q47-8 provides SWH...	0.2	Q47-9 provides...	0.3					
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50																										

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51 result output



51 Others

