Information Systems

SAS® Software: A Powerful Development Tool for Statistical Decision Support System

Jen-Her Wu, Department of Information Management, National Sun Yat-Sen University
Tse-Chih Hsia, Software Research Center, National Sun Yat-Sen University
Yu-Wen Li, Software Research Center, National Sun Yat-Sen University
Serval Tsai, Software Research Center, National Sun Yat-Sen University

ABSTRACT

The SAS software is a powerful data analysis and report generation tool, with its abilities recently extending into Management Information Systems and Decision Support Systems (DSSs). Statistical decision support system (SDSS) is not only based on the concept of DSS, but is also used to support statistical operations in the Taiwan Provincial Government.

In this study, we successfully apply SDSS in the Taiwan Provincial Government, as developed using the SAS software (Release 6.08) under WINDOWS and UNIX platforms. This SDSS is an integrated system that can be defined in terms of four essential aspects: a language system (LS), a presentation system (PS), a knowledge system (KS), and a problem-processing system (PPS).

This study also provides a detailed description of various SAS module applications for each sub-system of SDSS. This included utilizing SAS/AF, SAS/AF FRAME, SAS/FSP and SAS/GRAPH to develop a graphic user interface, utilizing the Tabulate procedure of Base SAS to develop the format of matrix for a flexible data entry and report generation, and utilizing SAS/AF and SAS/ACCESS to integrate EXCEL for customized report generation and flexible word processing in LS and PS. For the PPS, all modules in LS and PS were included. Moreover, BASE SAS is utilized to construct modules for the works of input and output and utilize their built-in functions for statistical analysis, calculation and graphic generation. Moreover, SAS/SHARE is used for the file management in the network operation. All knowledge types created by SAS modules and EXCEL are stored in KS, including data set, spreadsheet, graph, frame, and function.

INTRODUCTION

The Taiwan Provincial Government initiates several projects to provide better services via the efficiency and effectiveness of the public sector. The Taiwan Provincial Government Statistical Decision Support System (TPGSDSS) is one of the many others. The Department of Budgets, Accounting and Statistics (DBAS) implemented this project. Statistical data are a major source of information for the Taiwan Provincial Government. DBAS accumulates and manages data from each county under Taiwan Province and regularly provides information or by requested to Central Government or other organizations. The TPGSDSS is designed to assist statistic staff to handle all statistical data and operations for sixty-four departments under the Taiwan Provincial Government.

THE BASIS OF SDSS

The TPGSDSS is a kind of SDSS, which is a special case of DSS. Wu et al. (1995) suggested the characteristics we might expect to observe in a SDSS:

The Characteristic of SDSS

(1) Has a flexible input design to satisfy various formats and ways of data entry.
(2) Has capabilities to present knowledge on an ad hoc basis in various customized ways, as well as in standard reports,
(3) Has a variety of presentation capabilities, including statistical analysis, calculation, and graph (statistical and geometrical graphs),
(4) Has the capability to acquire and maintain knowledge,
(5) Can interact with a user in such a manner that the user has flexibility in selecting and sequencing knowledge management activities,
(6) Has the capability to select any desired subset of stored knowledge for either presentation or deriving new knowledge in the course of problem recognition and/or problem solving.

These traits allow a computer to be responsive to spur-of-the-moment requirements that arise in the course of making semistructured or unstructured decisions. Creating such decisions typically generally leads a manager to request...
information that cannot be conveniently found in a stack of predefined reports.

**The Framework of SDSS**

Holsapple and Whinston (1992) presented a generic framework of DSS and defined a DSS in terms of four essential aspects (as shown in Figure 1): a language system (LS), a presentation system (PS), a knowledge system (KS), and a problem-processing system (PPS).

A LS consists of all of the messages that SDSS can accept. A PS consists of all messages the SDSS can emit. A KS consists of all knowledge the SDSS has stored and retained. A PPS is the SDSS’s software. A PPS recognizes and solves problems during the decision making process.

A SDSS is a computer-based system composed of a LS, a PS, a PPS, and a KS, which aims to support decision making activities for statistical operations in the Government. A SDSS is a special case of DSS, which also has four components (Figure 1).

**SDSS IMPLICATION**

The TPGSDSS, as developed with SAS software, runs on Windows and UNIX platform. It is an integrated system, composed of a LS, a PS, a PPS, and a KS (Figure 2). The system aims to achieve maximum efficiency and productivity for the statistical staff through the application of this system.

The following sections not only present the TPGSDSS’s client/server environment, but also detail the use of SAS modules to develop each sub-system.

**Client/Server Environment**

Figure 3 displays the client/server architecture of TPGSDSS. SAS/CONNECT is used to develop its client/server environment and distributed computing ability.

The source code used to connect the functions and data located in HP server, Windows NT server and client are as follows:

```plaintext
options remote=NT command=tcp;
filename rlink 'c:\sas\connect\saslink\tcpnt.scr';
libname stdata 'c:\stdata';
signon NT;
rsubmit NT;
libname gstdata '/home/stdata';
proc upload data=stdata.st05s001 out=lstdata.st05s001;
run;
options remote=HP command=tcp;
filename rlink 'd:\sas\connect\saslink\tcpnhp.scr';
signon HP;
rsubmit HP;
libname gstdata 'home/stdata';
proc upload data=lstdata.st05s001 out=gstdata.st05s001;
run;
endsubmit;
signoff HP;
endsubmit;
signoff NT;
```
Language System

The LS must provide a user friendly interface and has the flexibility to accomplish the user requirement. To do so, the first task entails determining what the main menu looks like. SAS/AF FRAME and SAS/FSP are used to develop all of the graphic user interfaces (e.g., Figure 4). This includes creating the format of matrix for flexible on-line data entry and interactive dialogs. This interface was used to translate a one-dimensional data set into two dimensional matrix forms which is similar to the form of report.

Figure 4. Data entry dialog menu

Functions of this interface include the definition of data item, format, title etc. and loading title and data, which is achieved by TABLTRAN and PAGEDUMP methods. The source codes are as follow:

```plaintext
if (datloc ne 0) then do;
    do i=1 to rown;
        do j=1 to coin;
            rc=fetchobs(temphdl,(i-1)*coln+j+1);
            tempval=getvar(temphdl,1);
            cellval=setitemn(cellval,tempval,
                         (i-1)*coln+j+1,y);
        end;
    end;
    link TABLTRAN;
    link PAGEDUMP;
    _msg_='待編修資料載入完畢!';
end;

TABLTRAN:
    cond = 'FORMNO=' || tagnum || 'n';
    rc=where(tabshdl,cond);
    if (rc = 0) then do;
        tmpnum = getvarc(tabshdl,1);
        do until ((tmpnum ne tagnum) or (rc = -1));
            if (rc = 0) then do;
                tmpnum = getvarc(tabshdl,1);
                tagpos = getvarc(tabshdl,3);
            end;
            if (tagpos = 'H') then
                hstaitem=insertc(hstaitem,tagstr,-1);
                if (tagpos = 'V') then
                    vstaitem=insertc(vstaitem,tagstr,-1);
            end;
        end;
    end;
    rc=fetch(tabshdl);
    return;

PAGEDUMP:
    do i=1 to 6;
        do j=1 to 6;
            s=1+OFFSET;j=1+OFFSET;k=(s-1)*coln+t+1;
            if ((s <= rown) and (t <= coin)) then
                tempval=getitemn(cellval,k);
            else tempval= _blank_; 
            cellpos(i,j)=tempval;
        end;
    end;
    return;
```

In addition, SAS/ACCESS are utilized to integrate EXCEL for data entry from the outside system. The task was performed, firstly, by utilizing SAS/ACCESS to create a SAS VIEW and acquire data from EXCEL. Second, SAS/AF were utilized to create a dialog frame to provide interaction with user. Finally, all data were stored in the data set by utilizing SAS/ACCESS.

Presentation System

As in the LS, SAS/AF FRAME and SAS/FSP are used to construct the graphic user interface to provide interactive dialog with the user (Figures 5-6). In addition, the Tabulate procedure (in BASE SAS) and SAS/AF are utilized to acquire data from data sets and transmit those to EXCEL environment by the function of dynamic data exchange provided by WINDOWS platform. Integrating EXCEL aims to provide flexible word processing ability and customized report generation.

Figure 5. Data retrieval dialog menu
The following source codes are used to create the frame to retrieve the desired report format by using SAS/AF and transmit the result to tabulate by using Macro.

**query:**

```sas
/* clear output window */
sysrc = woutput('clear');

/* generate options list */
opstr = "options nocenter missing='*';"
if (pageyn = '1') then
  opstr = opstr || 'pageno=1';
if (dateyn = '1') then
  opstr = opstr || 'date';
else
  opstr = opstr || 'nodate';

/* generate class-variable-list, page-expression, row-expression and column-expression in Proc tabulate */
classstr = "class";
pagestr = "";
if (pagelen ne 0) then do;
  fvar = getitemc(pagelist,1);
  link varname;
  if (rowlen eq 0 and collen eq 0) then
    pagestr = fvar;
  else
    pagestr = fvar || "=";
  classstr = classstr || fvar || " ";
end;
rowstr = "";
do i=1 to rowlen;
  fvar = getitemc(rowlist,i);
  link varname;
  classstr = classstr || fvar || " ";
  rowstr = rowstr || fvar || "=";
end;
if (collen ne 0 and rowlen ne 0) then
  rowstr = substr(rowstr,2) || ";
else
  rowstr = substr(rowstr,2);
colstr = "";
do i=1 to collen;
  fvar = getitemc(collist,i);
  link varname;
  classstr = classstr || fvar || " ";
  colstr = colstr || fvar || "=";
end;
colstr = substr(colstr,2);
tblstr = 'table'||pagestr||rowstr||colstr||
"*value="*sum=";
```

submit continue;
&opstr;
proc tabulate data=temp1 order=data missing f=&fdsize;
&classstr;
&var value;
&tblstr;
run;
endsubmit;
call execmd('output');
sysrc = woutput('popon');
return;

SAS/GRAPH is used to provide all the necessary graphic presentations (e.g., Figures 6-10). For instance, Figure 6 was developed via a dialog box to determine the space, title and associated data. The results were presented by SAS/GRAPH, and later transmitted via a Macro.

![Taiwan Map](image)

**Figure 6.** Integration of Taiwan map and the associated data

The source codes used to create the Taiwan map are as follows:

submit continue;
goptions reset=global gunit=pct border ftext=kai htitle=6 htext=3 cback=white swap;
&range
&t1
&t2
&f1
&f2
pattern1 v=m2n c=L1GRR;
pattern2 v=m2n45 c=red;
pattern3 v=m2n90 c=pink;
pattern4 v=m2x45 c=L1PB;
pattern5 v=m2n45 c=DAG;
pattern6 v=m2n90 c=C;
pattern7 v=m2x45 c=O;
pattern8 v=m2n60 c=BLG;
pattern9 v=m2n180 c=DAG;
pattern10 v=m2n270 c=BLUE;
legend label=(position=top j=1 ' ') proc gmap map=maps.taiwan5 data=work.temp7 all;
   id id;
   choro idsum/&dis cempty = red coutline = gray ctext = blue
   legend = legend;
&f
run;
quit;
endsubmit;

In addition, The TPGSDSS also can easily display the line chart, bar chart and pie chart via a graphic editing dialog menu. Those are shown in Figures 7-10 below.

**Figure 7. Graphic editing dialog menu**

**Figure 8. Line Chart**

**Figure 9. Bar Chart**

Problem Processing System

All modules stated in LS and PS are included in PPS, which provide capabilities to accomplish the works in LS and PS. These capabilities include the following: knowledge acquisition, knowledge presentation, and knowledge selection/derivation. For instance, Base SAS, SAS/AF and SAS/FSP are used to (a) develop modules for the works of input and output and (b) utilize their built-in functions for the statistic analysis and graphic generation. In addition, SAS/GRAPH and SAS/SHARE are used to process all the necessary graphic presentations and manage all of the files in the network operation, respectively.

Knowledge System

We have a SDSS that accommodates a full spectrum of knowledge representations in its KS. Conceiving such a PPS focuses primarily on how to integrate the software capabilities conventionally founded in separate tools. Advances in the theory of software integration have shed light on this. Such knowledge includes data sets, spreadsheets, graphs, frames, and functions. In the KS, all files created by SAS/AF and Base SAS are stored in the format of a data set. The data handled by EXCEL are stored in a spreadsheet format. The objects created by SAS/AF FRAME and SAS/GRAPH are stored in the formats of frame and graph, respectively. All functions provided by Base SAS are stored in a function format.

DISCUSSIONS AND CONCLUSION

The SAS Software is an excellent tool for developing SDSS. For instance, all types of data can be easily accessed by SAS/ACCESS. Desired application results can always be achieved with the tools, functions and SCL code provided in the SAS/AF and In addition,
SAS/AF and SAS/FSP make it easy for an applications developer to design a customized and sophisticated graphical user interface.

This study work has not only provided some general information on working with the SAS Software, (indicating that the tool is best suited for statistical operations), but also highlighted a few key implementation issues and provided solutions where appropriate.

The TPGSDSS was successfully developed by utilizing SAS Software. The user response to the system has been extremely favorable. For instance, a task which previously took hours can now be accomplished in a couple minutes. Figures 4-10 summarize some of those results.

REFERENCES


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Correspondence should be addressed to:

Jen-Her Wu
Dept. of Information Management
National Sun Yat-Sen University
Hsi-Tze Wan, Kaohsiung, 80424, Taiwan, ROC.
Phone: (07) 531-6171 EXT. 4556
Fax: (07) 531-6988
E-mail: jhwu@mis.nsysu.edu.tw