Web-based learning system and simulation for time series seasonal adjustment

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\textbf{Abstract.} Time-series data is one of the data produced by the Badan Pusat Statistik (BPS). The time-series data has the potential to have a seasonal effect which can cause the analysis to be less accurate. Seasonal effects can be eliminated by making seasonal adjustments (SA). An understanding of SA is needed by BPS employees in analyzing time series data. Therefore we need a form of web-based learning that can be reached by all BPS employees. The goals of the system to accommodate the needs of users to get learning materials related to statistical material and provides convenience to users in implementing seasonal adjustments. An important feature that needed in this learning system is a simulation tool. The learning system is built using the SDLC method. In its development, the system uses the PHP programming language which is used as the main backend of web-based learning and R as a programming language in simulation applications. Data processing application simulation with seasonal adjustment method is built using the Jdemetra + package which is integrated with R Shiny. The evaluation results show that the system built was acceptable to the user with a SUS value of 73.8. The results showed that the participants can use the learning and simulation system as a pedagogical tool on SA learning.

1. \textbf{Introduction}

Seasonal effects are effects that arise due to seasonal patterns. For example, data on staple prices tend to increase during the fasting month, flight fares tend to increase during the holiday season, and so on [2,3]. Figure 1 is an example of data showing seasonal patterns. Foreign tourists tend to travel in July or June and in December. It is known that these months are times that are used as vacation time.
Seasonal effects can affect the analysis process of a time series data. This is because seasonal effects can obscure the direction of data movement between times, or data turning points (to see specific events that occur). As a result, the analysis becomes less sharp or even inaccurate. Therefore, it is necessary to make adjustments to the data to eliminate seasonal effects before further analysis. Adjustment is expected to produce data that better describes the real phenomenon. The method applied to the data is known as seasonal adjustment (SA) and the resulting data is called seasonally adjusted data.

The SA procedure can be carried out with the help of Jdemetra+ software statistics. Jdemetra+ has been officially recommended since 2 February 2015 to members of the European Statistical System (ESS) and the European System of Central Banks as software for seasonal and calendar adjustments from official statistics. Jdemetra+ has been used by most of the National Statistical Office (NSO). In its desktop application, Jdemetra+ has many advantages, easy to understand, and user-friendly. However, the disadvantage of desktop applications is that applications are not portable [4].

Efforts to implement SA in BPS face several obstacles. SA is still a new thing at BPS. The subject matter (SM) at the central, provincial, and district/city BPS which understands SA processing concepts and techniques is still limited. This causes the SA has not been widely implemented. It is expected that learning material about SA can be known, understood, and widely implemented by SMs at the central, provincial, and district/city BPS. Disseminating information through training and technical guidance will require more time and cost. Therefore, we need a tool that can help disseminate SA information to all levels in the form of SA learning methods. This tool is in the form of web-based learning.

Web-based learning as one form of e-learning is one method of learning by relying on electronic media, namely the internet. The use of the internet in e-learning makes it easy for users to access learning material wherever they are on the condition that they are connected to the internet and have a browser application. This shows the advantages of e-learning in terms of flexibility of study time and the cost is cheaper than face to face directly [5,6,7].

The application of web-based learning in seasonal adjustment learning is considered appropriate when looking at the benefits offered [8]. This application has a feature to do simulation. Simulations are used in the eLearning system to practice seasonal adjustment. The main purpose of a simulation is to offer an opportunity for practicing problem-solving skills. As a result, computer-based simulation can be regarded as a mind tool for invoking the learners’ high order thinking skills and creativity[9]. The computerized simulation learning system can improve spatial learning and perceptual skills of learners. Their effects on cognition and learning are often framed by the legacy of information
processing, which emphasized amodal problem solving and conceptual organization. The simulation tool has the potential to enhance statistics concept learning [10, 11]. There are different categorizations of simulation systems including live simulations, virtual simulations, and constructive simulations [12].

To assess the usability of web-based learning, we conduct the System Usability Scale test (SUS). The System Usability Scale (SUS) is a widely used standardized questionnaire for the assessment of perceived usability. SUS has become the most widely used measure of perceived usability and is likely to remain so for the foreseeable future [13, 14].

2. Methodology

2.1. Research Scope

The scope of this research is the development of web-based learning media and simulations to study seasonal adjustment statistical methods. This research resulted in a web-based system containing learning materials along with applications to make seasonal adjustments. The research is devoted to the use of the Central Bureau of Statistics so that users are people who are in the field of certification. The data used as demo data on system development and testing are airpass data contained in the fma R library and sample data from the Jdemetra-R folder.

2.2. Data Collection Methods

Data collection to support the creation of this e-learning system uses the following methods:

2.2.1. Literature Study

A literature study is carried out by reading and gathering information from various written sources such as journals, articles, and others related to the development of this system. In the development of the system, two main keywords are used in library research, namely web-based learning and seasonal adjustment.

2.2.2. Secondary Data

Secondary data is used in this study to assist in the development of seasonal adjustment simulation applications. The data used is data in the form of time series. Two demo data are used in the simulation application, namely the airpass data contained in the fma R library and sample data from the Jdemetra-R folder. Airpass data can be seen in Figure 2 while sample data from the Jdemetra-R folder can be accessed in the data folder with the file name xm.txt.

```r
> airpass
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1949 112 118 132 129 121 135 148 148 136 119 104 118
1950 115 126 141 135 125 149 170 170 158 133 114 140
1951 145 150 178 162 172 178 199 199 184 162 146 156
1952 171 180 193 181 183 218 230 242 200 191 172 194
1953 196 196 236 235 229 243 264 272 237 211 180 201
1954 204 188 235 227 234 264 302 293 259 229 203 229
1955 242 233 287 269 270 315 364 347 312 274 237 278
1956 284 277 317 313 318 374 413 405 355 306 271 306
1957 315 301 356 348 355 422 465 467 404 347 305 336
1958 340 318 362 348 363 435 491 505 404 359 310 337
1959 360 342 406 396 420 472 548 559 463 407 362 405
1960 417 391 419 461 472 535 622 606 508 461 390 432
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Figure 2. Airpass data
2.2.3. **Interview**
Interviews were conducted on the subject matter by asking questions related to the needs of the system. In this study, interviews were conducted with the Head of the Sub Directorate for Statistics Model Development. From the interview, we know that BPS needs a learning system for supporting BPS employees to learn Seasonal Adjustment.

2.2.4. **Questionnaire**
The questionnaire consisted of a list of questions compiled to ask respondents. In this study, the questionnaire was used in the evaluation stage of the product resulting from the development process. Specifically, the questionnaire used was the System Usability Scale (SUS) questionnaire and the Black Box Testing. The SUS questionnaire was used to determine satisfaction [16, 17].

2.3. **Development Methods**
The system development method used is the System Development Life Cycle (SDLC), namely the traditional method. In SDLC there are known stages in system development namely system initiation, system analysis, system design, system implementation, and testing and system evaluation [15].

3. **Application Architecture**
The system architecture used is the development of web applications that are connected to the internet network. Display application in the form of a web interface that can be opened by the user through a web browser. The proposed system architecture can be seen in the following figure 3.

![Application Architecture Diagram](image)

**Figure 3. Application Architecture**

4. **Results and Discussion**
The construction of this learning system uses two types of servers. The servers used on this system are the apache server and the shiny-server. Apache server is used to run web applications that are the main framework, while shiny-server to run JDemetra + applications that have been re-language using R by NBB RD then translated into web forms using R Shiny. The analysis application is embedded into the application using an iframe.
4.1. Web-based Learning System

The web-based learning system that was built was named the Sistem Rumah Model Statistik (SiRumStat). In this system there are seven menus namely login, homepage, guide, processor, forum, manage and help. The menu on the system is displayed based on user roles. User Role is divided into two namely users and admin. The difference in the menu displayed is the admin menu will appear to manage while the user does not. The difference can be seen in Figure 4. The three main menus that are the focus of this system are guides, processors, and forums. The general explanation of the three menus is that the guide is used by users to find guidelines in statistical modeling, processors are used by users to do data processing and reporting, and forums are used by users to conduct discussions regarding issues raised at the forum.

![Figure 4. Homepage SiRumStat](image)

The guidance page contains the guidelines that have been entered into the system. There are two guide file formats in this system, namely in the form of books and videos. In the form of a book guide, besides it can be read directly through a browser, it can also be downloaded by the user. At the top of the start page, there is a search button. If the search button is pressed it will bring up a form to search based on the material and file format of the guide. The initial page of the guide can be seen in the image below.

Figure 5 shows the pdf viewer page on the guide menu. At the top of the pdf window, there are menus such as enlarging or reducing the size of pdf in the viewer, opening pdf in presentation mode, downloading pdf, and so on. Information of each icon on the menu can be seen by hovering over the icon. Figure 6 shows the video viewer page. There are different functions in the pdf and video viewers. In the video viewer, only functions can be used to play videos and cannot be downloaded functions to videos.
4.2. Simulation

Users can do the SA simulation work on the SA simulation application. It starts by selecting the data used. There are two kinds of data input methods that can be chosen, namely using demo data and uploading your own data. Next, the data will appear in the main panel. There are two methods for displaying data: head and all. Then the user can set the time needed in the process of transforming data into a time series data form.
Next, users need to go to the workspace tab to set the seasonal adjustment method and its specifications. After the method and specifications are determined then the main panel will appear the results of processing consisting of the characteristics of the time-series data used and the results of the transformation. The available characteristics are summary data and plot data. Furthermore, the seasonal adjustment data can be seen in the Time series Union section, in the seasonally adjusted data column.

![Image of user interface for time series data processing](image1)

**Figure 7.** User interface for time series data processing

![Image of workspace data plot](image2)

**Figure 8.** Workspace data plot


4.3. System Evaluation

In the calculation of the SUS score, it is known that the overall SUS value is good. The highest points are obtained for questions on points 3, 6, and 8 while the lowest points are obtained for questions on points 4 and 9. Points 3, 6, and 8 show that the system is made easy to use, not too many mismatches in the system, and the system created is not complicated. In points 4 and 9 show that users still need help from technical people to use this system and users still feel awkward using this system so it needs to be improved on the system to make users more comfortable and not awkward using this system.

5. Conclusion

The development of an online learning system with a focus on seasonal adjustment methods using PHP and R has been successfully implemented. PHP is used to build the main frame sections such as guides and forums while R is used to build a seasonal adjustment processing simulation system. Based on the evaluation results, the SUS score of 73.8 indicates that the system built has been accepted by the user. Simulation can be applied as a pedagogical tool for perceived effective learning. Simulation exercises positively influence the experiential learning among the students.

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