DEVELOPMENT OF A WEB APPLICATION FOR COMPUTING TRADE INDICATORS

Harshvardhan Deo Solanki1, Er Meenakshi2, Dr Sandeep Kaur Bhatia3

1(Department of Computer Science and Technology, Central University of Punjab, Bathinda, India)

2(Department of Computer Science and Technology, Central University of Punjab, Bathinda, India)

3(Department of Economic Studies, Central University of Punjab, Bathinda, India)

Abstract

Trade indicators are a mathematical measure of the changes in the country-level exports (mainly) and imports. They help in assessing the dynamics of a country's economy. A web application is a software that runs in a web browser. In this, a client, connected to a server via the internet, requests for computation. There are existing software that compute trade indicators however there are some requirements of the academia and industry that remain desirable. This web application is an attempt to fulfill these requirements by operating upon dynamic data entered by the user, providing all the required trade indicators in a user-friendly way. On evaluating the developed web application for accuracy, performance and reliability it was found that, the software works in a fairly prompt, accurate and reliable manner.

Keywords: Apache Tomcat, Eclipse, HTML5, Java Technologies, Servlets

1. Introduction

Trade indicators assess the nation level export execution via different measurements, that throw light upon a genuinely far-reaching idea about aggressiveness in imports and exports. There are existing software packages that compute trade indicators but they use internal datasets as inputs and have no option to take input from user. The web application developed as a part of this work accepts dynamic user input to compute the trade indicators. On the other hand, if the user wishes to use MS-Excel for these computations on user-supplied dynamic data then the formulae have to be configured by the user. This can become very cumbersome for lengthy computations. In addition, the web application has been developed to be easy to understand and provide all the trade indicators of interest.

Web applications are the means-of-choice when it comes to provide business functionality because of three main reasons: platform-independence, less hardware requirement (because of remote processing) and cloud storage and backup. Due to these advantages, this application has been developed as a web application rather than a desktop application. Java servlet technology has been used to implement server side business logic. Views has been handled in HTML5. After the web application was developed, it was evaluated against suitable parameters for ensuring accuracy, reliability and performance. Results show that in the simulation scenario, the web application successfully computes the trade indicators in an accurate and reliable manner delivering satisfactory performance. Thus, it can be used in real-time for computing trade indicators.

2. Web Application

A web application is a customer-server application in which the client (counting the UI and customer side rationale) keeps executing in a web program. Computer programs that can make requests to servers and fetch responses are called clients and those that make requests to web servers are called web clients. A browser is a web client. Server, listens to client requests and responds back with data. To use a web application, a software called browser should be installed on the system. The function of a browser is to make requests to server using URL (informally, web-address, formally uniform resource locator) and render the response data. The purpose of a URL is to find a server and a resource on that server. Modern browsers can interpret and run code (e.g.: JavaScript code) written by application author (e.g.: in Facebook clicking on icon shows friend requests). The purpose of this is to make the page interactive or dynamic (e.g.: Facebook newsfeed refreshes w/o refreshing the webpage, on the same webpage). Fig. 1 shows a snapshot of the web application developed to compute trade indicators.

Figure 1 Snapshot of the Web Application developed to compute trade indicators.

3. Trade Indicators

Trade indicators survey the nation level execution of exports along different measurements which together give a genuinely far reaching picture of exchange aggressiveness. It is constituted of pointers along four unmistakable estimations of trade execution: (I) the association, presentation and advancement of admissions and imports, (ii) the level of passage extension across finished things and markets, (iii) the level of intricacy of a country's crucial charges, and (iv) the survival rate of its toll associations. This thought empowers the analyst to survey the

3

movement of the country's admissions along different edges of trade and to benchmark specific countries' circumstance with respect to their colleagues. The idea can be utilized to survey the aggressiveness of a nation's general bin of items and additionally particular exchanged areas. It encourages the ID of the essential imperatives to enhance exchange intensity and the strategy reactions to conquer these limitations. TABLE-1 shows the trade indicators that have been implemented in the proposed application: ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]

Table-1 Trade Indicators and their Description("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]		
S.No.	**Name of Indicator**	**Description**
1	Openness to trade(Yanikkaya, 2003)[2]	It estimates the ratio of exchange and GDP. This measures the consolidated significance of products and ventures' fares and imports through an economy, showing reliance of residential makers upon outside request along with household purchasers upon remote production. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
2	Revealed comparative advantage (Balassa, 1965)[3]	It shows a nation's proportional leeway or weakness about a particular domain as confirm in terms of professional career streams. A value over the unit shows that a nation's offer of exports in that area surpasses the worldwide exports offer of a similar segment. If so, we derive that the nation has a similar favorable position in that area. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
3	Trade intensity index (Kojima, 1964)[4]	It utilizes comparative rationale along that of uncovered near favorable position, however for business sectors as opposed to items. It shows whether a columnist trades more, as a rate, to an accomplice than the world does, all things considered. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
4	Trade complementarity index(Michaely, 1996)[5]	It demonstrates the degree of matching of the fare contour of the columnist, or supplements, the nature of the cumulative imports of the accomplice. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]

5	Herfindahl-hirschman product concentration index(Hirschman, 1945)[6](Herfindahl, 1950)[7]	It indicates the scattering of an exporter's exchange incentive over exported items. A file esteem near 1 indicates a dominance of exchange esteem gathered through not many items. In this way, it is a pointer of the exporter's powerlessness to exchange stuns. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
6	Herfindahl-hirschman market concentration index(Hirschman, 1945)[6](Herfindahl, 1950)[7]	It shows the scattering of an exporter's accomplice-exchange incentive. A place having dominance about exchange esteem moved about not many trading places that show a file esteem near 1. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
7	Growth orientation of products	It assesses potential related to development of a nation's fares through the compound annual growth rate (CAGR) related to the essential fares with the overall development degree of such items. if development rate is greater than global development suggests of expansion about global piece of the pie. ("Online Trade Outcomes Indicators-User's Manual-," 2013)[1]
8	Growth orientation of markets	It assesses potential related to development of a nation's fares through the compound annual growth rate (CAGR) related to the essential fares with the overall development degree of such items. If development rate is greater than global development suggests of expansion about piece of the pie. Nations whose essential fares are in high development markets might be very much situated for future development. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
9	Index of export market penetration	It shows the degree a nation's fares achieve in officially demonstrated markets. Figured in terms of quantity of nations with whom the journalist trades some specific item separated along the quantity of nations bringing in the item at that time. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
10	Sophistication of exports(Hausmann, Hwang, & Rodrik,	Evaluating the level of innovative advancement exemplified in a nation's fare portfolio gives a sign of that nation's monetary improvement. PRODY is a result based

	2007)[8]	measure of complexity: if an item is for the most part delivered by rich nations, at that point it is uncovered as "rich," or refined, item. PRODY is ascertained like a weighted normal of per capita GDP of nations creating a specific item, having weights got by uncovering near preferred standpoint. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
11	Export portfolio and factor endowments(Shirotori, Tumurchudur, Cadot, & others, 2010)[9]	This marker thinks about the estimation of a nation's fares, the uncovered factor forces about such items, related gifts of human capital and physical capital. The revealed human capital intensity (RHCI) and revealed physical capital intensity (RPCI) are weighted midpoints about individual contribting blessings of nations delivering every item, with weights got from uncovered similar preferred standpoint. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
12	Decomposition of export growth along margins of trade(Newfarmer & Brenton, 2009)[10]	Fare development can be partitioned into the extension of existing exchange streams (the serious edge) and the expansion of new items and markets (the broad edge). This marker allocates all item development—and constriction—to one of seven receptacles. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
13	Trade Similarity(Finger & Kreinin, 1979)[11]	A measure of the degree to which two nations send out similar items. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]

The formulae used to compute the trade indicators are listed in TABLE – 2

Table 2 - Trade Indicators - Formulae("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]:		
S.no.	**Name**	**Formula**
1	Openness to trade(Yanikkaya, 2003)[2]	$$\frac{X_{it} + M_{it}}{Y_{it}}$$ here X denotes the total exports value, M denotes the total imports value, and Y denotes the GDP of country i at time t. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
2	Revealed comparative advantage (Balassa, 1965)[3]	$$RCA_{ijk} = \frac{\frac{x_{ijk}}{x_{ij}}}{\frac{x_{wjk}}{x_{wj}}}$$

6

		here x denotes the total exports of product k from country i to destination j, and X denotes the total exports from i to j; w denotes the world as source. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
3	Trade intensity index (Kojima, 1964)[4]	$$100 * \left[\frac{x_{ijk}}{X_{ik}} \bigg/ \frac{x_{wjk}}{X_{wk}} \right]$$ here x denotes the total exports of product k from source country i to destination j, and X denotes total exports from i of product k; w denotes the world as source. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
4	Trade complementarity index(Michaely, 1996)[5]	$$100 * \left[1 - \sum_k \left| \frac{m_{jk}}{M_j} - \frac{x_{ik}}{X_i} \right| \right]$$ here x denotes exports of product k from reporter country i, and X denotes country i's total exports. Partner country j's total imports of product k is denoted by m, and its total imports is denoted by M. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
5	Herfindahl-hirschman product concentration index(Hirschman, 1945)[6](Herfindahl, 1950)[7]	$$\frac{\sum_{k=1}^{n_i} \left(\frac{x_{ik}}{X_i} \right)^2 - \frac{1}{n_i}}{1 - \frac{1}{n_i}}$$ X denotes the total exports from reporter i, x denotes the value of exports of product k from country i, and n denotes the number of products exported by country i. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
6	Herfindahl-hirschman market concentration index(Hirschman, 1945)[6](Herfindahl, 1950)[7]	$$\frac{\sum_{j=1}^{n_i} \left(\frac{x_{ij}}{X_i} \right)^2 - \frac{1}{n_i}}{1 - \frac{1}{n_i}}$$ X denotes the total exports from reporter i, x denotes the value of exports from country i to destination market j, and n denotes the number of partner markets to which country i exports. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
7	Growth orientation of products	$$CAGR_{ijk} = 100 * \left[\left(\frac{x_{ijkt_2}}{x_{ijkt_1}} \right)^{\frac{1}{t_2 - t_1}} - 1 \right]$$ here x denotes the value of exports of product k from origin country i to destination j. Total exports are given by X. The beginning and finish years are given by t1 and t2, respectively.

7

8	Growth orientation of markets	$$CAGR_{ijk} = 100 * \left[\left(\frac{x_{ijkt_2}}{x_{ijkt_1}} \right)^{\frac{1}{t_2 - t_1}} - 1 \right]$$ here x denotes the value of exports of product k from source country i to destination j. Total exports are given by X. The beginning and finish years are given by t1 and t2, respectively. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
9	Index of export market penetration	$$\frac{n_{x,ik}}{n_{m,k}}$$ here n_x denotes the number of nations to which country i exports product k, and n_m is the number of nations that import product k from any origin. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
10	Sophistication of exports(Hausmann, Hwang, & Rodrik, 2007)[8]	$$PRODY_k = \sum_i \frac{\frac{x_{ik}}{x_i}}{\frac{x_{wk}}{x_w}} * y_i \quad EXPY_i = \sum_k \frac{x_{ik}}{X_i} * PRODY_k$$ PRODY is a result based measure of advancement: if an item is for the most part delivered by rich nations, at that point it is uncovered as "rich," or complex, item. PRODY is computed to be weighted normal of per capita GDP of nations delivering that item, with weights got from uncovered relative preferred standpoint. The nation's normal GDP per capita, EXPY, is obtained by totaling all the PRODY esteems in the items traded by the nation, all weighted by the item's offer in absolute fares. X denotes aggregate estimation consisting of fares making columnist I, x denotes the estimation of fares of item k, and denotes the world. Y denotes per capita GDP. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
11	Export portfolio and factor endowments(Shirotori, Tumurchudur, Cadot, & others, 2010)[9]	$$RPCI_k = \sum_i \frac{\frac{x_{ik}}{x_i}}{\frac{x_{wk}}{x_w}} * \frac{K_i}{L_i} \quad RHCI_k = \sum_i \frac{\frac{x_{ik}}{x_i}}{\frac{x_{wk}}{x_w}} * H_i$$ The revealed physical capital intensity (RPCI) and revealed human capital intensity (RHCI) are processed as weighted midpoints of the individual factor blessings of nations delivering every item, with weights got from uncovered relative favorable position. X denotes aggregate estimation constituting fares from columnist I, x is the estimation of fares of item k, and w denotes the world. Human capital, H, is evaluated using normal long periods of tutoring. Physical capital, K/L, is assessed using interminable stock strategy, that recreates capital stock evaluations using speculation streams by recursively including

		present venture against some past phase's principal store, minus devaluation. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
12	Decomposition of export growth along margins of trade(Newfarmer & Brenton, 2009)[10]	$$share_{bin} = 100 * \sum_{k=\Omega_{bin}} \frac{x_{ijkt}}{X_{ijt}} \quad \forall \, bin \in \{1 \dots 7\}$$ X denotes aggregate estimation from every fare from columnist I to accomplice j, and x denotes estimation of fares of item k in year t. Begin and finish years are denoted by t1 and t2, separately. Ωbin speaks to an item gathering, with all items isolated among 7 totally unrelated canisters. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]
13	Trade Similarity(Finger & Kreinin, 1979)[11]	A measure of the degree to which two nations send out similar items. Characterized for trading nations j and k as XSjk = Si[min(Xij,Xik)x100], where Xij, Xik are the offers of item I in their aggregate fares. XSjk ranges from zero in the event that they have no fares in like manner to 100 on the off chance that they send out similar things in similar extents. ("Online Trade Outcomes Indicators- User's Manual-," 2013)[1]

4. Related Work

Two existing software that compute trade indicators have been explored. They use internal datasets to compute trade indicators. The names of these datasets are given in the TABLE-3. Also given.is, the number of trade indicators computed by the existing software and by the web application developed as a part of this work.

Table- Existing Software Packages			
S. No.	Main features	Application		
		WITS	ADB	PROPOSED APPLICATION
1	Data source	UN-COMTRADE, World Bank's World Development Indicators and UN Revealed Factor Intensity Indices.	International Monetary Fund Direction of Trade Statistics (DOTS), CEIC Data, UN-COMTRADE	Dynamic data entered by the user
2	Number of	21	12	13

trade indicators			

5. Programming Language Selection

The World Wide Web Consortium (W3C) characterizes a web service for the most part as: A web service is a product framework intended to help interoperable machine-to-machine collaboration over a system. ("Web Services Architecture, 2017").[12]

A web service gives a question arranged, electronic interface to a database server, used for instance by another web server that gives a UI to the end client. One of the principal request in an architect's mind when starting to make Web Services is—what lingo to use? While it is possible to make web benefits in any vernacular including Perl, Fortran et cetera., it is unequivocally assumed that the Java™ Programming Language is the most reasonable because of its ability to scale from the humblest of Java Cards beyond what many would consider possible up to the solid Enterprise Edition. (Kleijnen & Raju, 2003).[13]

With the Java Platform, software engineers can promptly characterize activities and place that rationale on for all intents and purposes any PC framework, paying little mind to the basic equipment design or working framework—an unmistakable favorable position in the differing universe of web administrations.

6. Java Servlet Technology

Within very short time of the roll out of the web, a need was felt for providing users with dynamic content. This was accomplished by using applet which worked on the client platform to provide dynamic user experiences. Common Gateway Interface (CGI) server-side scripts, were the counterpart on the server side. However, due to the limitations of platform-dependence and lack of scalability, Java Servlet technology was introduced. Although servlets can handle any communication protocol, they mostly use HTTP. They are usually used to listen to requests pertaining to applications on web servers. For this purpose a standard was developed, called the Java Servlet API. This outlines the structure to implement Java classes that service requests. They usually generate HTML but can also be used to generate other types of data like XML.

7. Characteristics of a Good Software for Economics

Although there are many software packages available for statistics and economics related computation with varying level of features but along with the required set of features, what is also needed is user-friendliness, because different users can be of different level of acquaintance with working on computers. Although providing more features and customizations surely makes the software more productive but it also makes it more difficult for the novice user. So it is very important to balance this trade-off in the appropriate direction keeping the users in mind. Keeping this concept in mind it is appropriate to use the following characteristics as guidelines:

7.1 The "Four-F" Test

Concentrating on the system of Higher Education, Statistics and Econometrics have turned out to be progressively vital in a few college degrees identified with Economics, Business Administration,

10

Finance, Accountancy or Human Resources. An exceptional part is played by programming in the instructing learning procedure of these subjects and along these lines testing its appropriateness through the "four - F" test is advantageous, which includes the hypotheses of freedom, functionality, flexibility and friendliness.

The four requirements (Lopez-Menendez & Perez Suarez, 2013) [14]: freedom, functionality, flexibility and friendliness are described as under:

    i.   Freedom

The prerequisite of Freedom, additionally comprehended as receptiveness is for the most part identified with the entrance. The comprehensive term Free Open Source Software (FOSS) alludes to programming that is both free and open source, implying that it is generously authorized to allow clients the privilege to utilize, duplicate, study, change, and enhance its plan through the accessibility of its source code. Along these lines, the "free" term alludes to the opportunity to duplicate and re-utilize the product, instead of to the cost of the product. (Lopez-Menendez & Perez Suarez, 2013) [14]

    ii.   Functionality

The requirement of functionality refers to the quality of being suited to serve a purpose well. Functionality is mainly related to the use of statistical and econometric software, which should provide a wide range of operations adapted to the needs of its potential users. (Lopez-Menendez & Perez Suarez, 2013) [14]

    iii.   Flexibility

Flexibility is closely related to the software usability and can be understood as the ability to be easily modified. Thus, flexibility should be understood in a broad sense including menu options, functions, languages and many other software attributes. (Lopez-Menendez & Perez Suarez, 2013) [14]

    iv.   Friendliness

The quality of being friendly refers the software capability to facilitate understanding of statistical and econometric and economics concepts. Therefore, this requirement is particularly important for instructional purposes, and especially with regard to the less advanced users. (Lopez-Menendez & Perez Suarez, 2013) [14]

8. Need of this Software

There are some issues with regards to the way the existing software packages handle the computation of trade indicators:

i.   The existing software operate upon an internal database(s) which are generally sourced from various international organizations like United Nations, World Bank etc., however they don't have any provision for performing the desired operations on dynamic data entered by the user, which is required in real-time in many applications.

ii.   No single software provides all the functionalities (trade indicators) that are intended to be implemented in the web application that is being developed as shown in TABLE-1. One has to use separate software for separate functionalities.

iii. The existing software packages are difficult to operate as they lack a GUI and have a very steep learning curve, which consumes a lot of time and energy of the desired audience (economics academicians) while also dividing their focus on their core subject area.

The application is aimed at removing the three problems mentioned above.

9. Methodology and Simulation tools

9.1 Methodology

The steps taken to develop the web application and to test it for accuracy, reliability and performance are discussed below:

i.   Analysis and assessment of problems from the existing software: in this step, the existing software are executed and studied for their features and shortcomings. These shortcomings are attempted to be removed in the proposed software.

ii.   Write the code to compute the trade indicators listed in TABLE-1: in this step, Eclipse IDE is used to develop the web application for computing trade indicators.

iii. Execute various trade indicators by taking user input and generate their outputs: in this step, various trade indicators are executed to check if the results are getting displayed.

iv.   Provide graphical user interface to the software: in this step, a visual interface is implemented in the software.

v.   Ensure accuracy, reliability and performance of the software by testing against suitable evaluation parameters through manual testing: in this step the software is tested for accuracy, reliability and performance.

9.2 Simulation Tools

For developing and evaluating the web application three tools are used: Eclipse IDE, Apache Tomcat and Google Chrome for application development, simulation and execution and evaluation respectively. These tools are open-source and very easy to use thus save time and money.

i.   Eclipse IDE: it is an integrated development environment available for free. Its source code is also available. It is used for developing software in many languages like Java, PHP, Ruby on Rails etc. It greatly simplifies the task of developing a web application, through its various plugins and features. It consists of a workspace where the user can write code and use the built-in features to simplify the code development process. These include code auto-completion, debugging, compiling and showing warnings and suggestions.

ii.   Apache Tomcat 7: it is a web container. It integrates with Eclipse IDE. It is used to simulate the functions of a server while running the web application. This is done by creating a local host where the web application is deployed.

iii.   Google Chrome Browser: it is a free and open-source browser. Is supports HTML5. It is used to operate the web application. It is also used for analyzing the web application. It has a rich set of developer tools that are used for evaluating the web application for performance. The following tools are used:

   a.   In the network tab of the developer tools, the size column shows the collective magnitude of the reply headers and the reply body that are provided by the server.

   b.   The waterfall column shows the TTFB (Time to First Byte). It consists of 1 round trip of latency and the time the server took to prepare the response. Since the application is hosted locally, the round trip time can be safely neglected and the response time of the server can be used as a posteriori measure of the time complexity of the computation operation.

10. Parameters Used for Testing the Software

10.1 Performance Metrics

   These parameters are used to evaluate whether the application is functioning properly or not.

i.   Time complexity (posteriori): The posteriori time complexity is the actual execution time of the program for a given hardware configuration.

   Execution time = finish time of the program – start time of the program

ii.   Space complexity (priori and posteriori):

   Space complexity is the storage space occupied by the software (priori) + the size of data generated by sample execution instance(s) of the program (Posteriori)

10.2 Reliability Metrics

i.   Probability of failure on demand (POFOD): the chances of a service request by a system ending into a system failure. For example, POFOD = 0.005 implies that there is a 5/1,000 chance that a demand resulting into a failure. If the probability of failure on demand is low the software is estimated to be more reliable.

ii.   Lines of Code: it calculates the magnitude of a software by totalling the quantity of lines in the script of the software.

iii.   Function point metrics: denotes "unit of measurement" that shows the volume of professional facility a software delivers to a customer. They are used to calculate a practical size amount of application. They are employed to size software packages precisely. Sizing plays an important role for defining efficiency (outputs/inputs). They are calculated at distinct times by distinct people to get the same result subject to an understandable boundary of mistake. They are simple to interpret by the non-technical person. Thus simplifying conversing sizing facts to an operator or client. They are employed for deciding if a software, has greater usability with regards to others.

a. External Inputs (EI) - is a fundamental procedure where data passes from external to internal region. This data could originate from a data input platform or alternative program. The data can be employed to sustain interior system archives. Data is of two types: Control and commercial. Control data does not modify any interior system archive.

b. External Outputs (EO) - a fundamental procedure in which derivative data transitions through the border from interior to exterior. Moreover, an EO might apprise an interior logical archives. The data generates accounts or production records directed to different packages. These documents and data are generated using some outside crossing point archive.

10.3 Accuracy Testing

For testing the accuracy of the software, its results are compared with those obtained from MS-Excel for same input data.

11. Results

The web application has been evaluated along three dimensions for determining whether it is appropriate for computing trade indicators. The three dimensions are: performance, reliability and accuracy. In the performance criterion, the time and space complexity of the execution of the web application in the simulation scenario is calculated. This is done to assess whether the application is responsive and that there is no lag in it. Also it is assessed that the data generated by sample executions is handled by the web application in the simulation environment. In the reliability criterion, the probability of failure on demand (POFOD) is calculated and software size is measured to assess whether the application performs in a reliable manner in the simulation environment. In the accuracy criterion the correctness of the computations performed by the application is checked. The results are described below:

11.1 Performance Evaluation

TABLE 3 shows the results of performance evaluation. It lists the running times and output sizes of computations of trade indicators:

Table 3 Performance Metrics			
S.no.	Name of Indicator	Running Time(ms)	Output Size(B)
1	Openness to trade(Yanikkaya, 2003)[2]	1.31	136
2	Revealed comparative advantage (Balassa, 1965)[3]	1.14	153

3	Trade intensity index (Kojima, 1964)[4]	1.45	143
4	Trade complementarity index(Michaely, 1996)[5]	1.11	149
5	Herfindahl-hirschman product concentration index(Hirschman, 1945)[6](Herfindahl, 1950)[7]	1.09	173
6	Herfindahl-hirschman market concentration index(Hirschman, 1945)[6](Herfindahl, 1950)[7]	1.85	174
7	Growth orientation of products	2.7	161
8	Growth orientation of markets	2.6	160
9	Index of export market penetration	2.76	151
10	Sophistication of exports(Hausmann, Hwang, & Rodrik, 2007)[8]	5.11	132
11	Export portfolio and factor endowments(Shirotori, Tumurchudur, Cadot, & others, 2010)[9]	1.47	151
12	Decomposition of export growth along margins of	1.49	342

	trade(Newfarmer & Brenton, 2009)[10]		
13	Trade Similarity(Finger & Kreinin, 1979)[11]	2.0	140

Total Size Complexity= 43.4 KB (priori) + 2.53 KB (Posteriori) = 45.93KB

In this calculation, 43.4 KB is the size of the war file of the web application which can be deployed on the server. 2.53 KB is the total size of the outputs generated by one execution of each trade indicator as shown in TABLE 3.

Analysis: the running time of all the computations is observed to be of the order of milliseconds. The output of each computation is observed to be of the order of bytes. The computational latency of sample executions of the application is in milliseconds. Thus the application performs in a workable manner under the simulation conditions because the computational latency is bearable for all practical purposes. Also, the size of data generated in each iteration is of the order of bytes. Hence the application is not memory-intensive. So it can safely be concluded that the application can be deployed to a real-time environment for practical use.

11.2 Reliability Evaluation

TABLE 4 shows the data used to calculate POFOD.

Table 4 Trade Indicators – Number of successful and unsuccessful requests				
S.no.	Number of parallel users	Requests per user	Total requests	Number of successful requests	Number of unsuccessful requests
1	1000	17	17000	16867	133

Analysis: From the above data POFOD is calculated using the formula:

POFOD = (Number of unsuccessful requests/ total requests)

POFOD= 133/17000=.0078

Thus, the application has a very low probability of failure on demand and hence is reliable.

TABLE 5 shows the values of Function Point metrics and Lines of Code.

Table 5 Trade Indicators – Function point metrics and Lines of code				
S.no.	Name of Indicator	External inputs	External	Lines of

			outputs	code
1	Openness to trade(Yanikkaya, 2003)[2]	3	1	92
2	Revealed comparative advantage (Balassa, 1965)[3]	4	1	102
3	Trade intensity index (Kojima, 1964)[4]	4	1	95
4	Trade complementarity index(Michaely, 1996)[5]	6	1	125
5	Herfindahl-hirschman product concentration index(Hirschman, 1945)[6](Herfindahl, 1950)[7]	4	1	109
6	Herfindahl-hirschman market concentration index(Hirschman, 1945)[6](Herfindahl, 1950)[7]	4	1	102
7	Growth orientation of products	4	1	108
8	Growth orientation of markets	4	1	102
9	Index of export market penetration	2	1	90
10	Sophistication of exports(Hausmann, Hwang, & Rodrik, 2007)[8]	10	2	150
11	Export portfolio and	10	2	148

	factor endowments(Shirotori, Tumurchudur, Cadot, & others, 2010)[9]			
12	Decomposition of export growth along margins of trade(Newfarmer & Brenton, 2009)[10]	21	7	212
13	Trade Similarity(Finger & Kreinin, 1979)[11]	4	1	121

Analysis: The application has a small size as the lines of code of all the computations is calculated to be of the order of 250 lines and the number of function points are also small. The trade indicator "Decomposition of export growth along margins of trade" is producing seven outputs, while two indicators are producing two outputs and remaining ten are producing one output. Since the application has a small size and its probability of failure on demand (POFOD) is also small (0.0078), the application is reliable.

11.3 Accuracy Evaluation

The following table shows the variation of results of the web application from that of MS-Excel.

Table 6 Accuracy Evaluation			
S.no.	Name of Indicator	Variation from MS-Excel	Accuracy (%)
1	Openness to trade(Yanikkaya, 2003)[2]	0	100
2	Revealed comparative advantage (Balassa, 1965)[3]	0	100
3	Trade intensity index (Kojima, 1964)[4]	0	100

4	Trade complementarity index(Michaely, 1996)[5]	0	100
5	Herfindahl-hirschman product concentration index(Hirschman, 1945)[6](Herfindahl, 1950)[7]	0	100
6	Herfindahl-hirschman market concentration index(Hirschman, 1945)[6](Herfindahl, 1950)[7]	0	100
7	Growth orientation of products	0	100
8	Growth orientation of markets	0	100
9	Index of export market penetration	0	100
10	Sophistication of exports(Hausmann, Hwang, & Rodrik, 2007)[8]	0	100
11	Export portfolio and factor endowments(Shirotori, Tumurchudur, Cadot, & others, 2010)[9]	0	100
12	Decomposition of export growth along margins of trade(Newfarmer & Brenton, 2009)[10]	0	100
13	Trade Similarity(Finger & Kreinin, 1979)[11]	0	100

Analysis: All the computations are producing the same result as obtained from MS-Excel. They have no variation from results obtained from MS-Excel. Thus the accuracy of the web application is hundred percent.

12. Conclusion

The Web Application was developed successfully for computing trade indicators. It can be used to compute trade indicators upon the input data provided dynamically by the user. It generates the output in a practically feasible time. Computational latency observed is in milliseconds. The size of the output generated is in bytes hence manageable at the scale of its operation. The size of the software is also small as no computation takes more than 250 lines of code. The computations performed are found to be error-free as they produce the same result as that obtained from MS-Excel. The software simplifies the work of the user because instead of configuring MS-Excel with the desired formulae to perform the computations, the web application has all the formulae in-built. The user has to just provide the input data and the computation is performed.

The difference between WITS, the existing software for computing trade indicators and the web application developed as a part of this work is that WITS uses internal datasets (UN-COMTRADE, World Bank's World Development Indicators and UN Revealed Factor Intensity Indices.) to compute the trade indicators, whereas our web application takes input from the user dynamically for computing the trade indicators.

References

[1]*Online Trade Outcomes Indicators- User's Manual-*. (2013). Retrieved from http://wits.worldbank.org/WITS/docs/TradeOutcomes-UserManual.pdf.

[2]Yanikkaya, H. (2003). Trade openness and economic growth: a cross-country empirical investigation. *Journal of Development Economics*, *72*(1), 57–89. https://doi.org/10.1016/S0304-3878(03)00068-3

[3] Balassa, B. (1965). Trade Liberalisation and "Revealed" Comparative Advantage. *The Manchester School*, *33*(2), 99–123. https://doi.org/10.1111/j.1467-9957.1965.tb00050.x

[4] Kojima, K. (1964). The Pattern of International Trade Among Advanced Countries. *Hitotsubashi Journal of Economics*, *5*(1), 16–36.

[5] Michaely, M. (1996). *Trade Preferential Agreements in Latin America an Ex-Ante Assessment.*

[6] Hirschman, A. O. (1945). *National Power and the Structure of Foreign Trade*. University of California Press, Berkeley.

[7] Herfindahl, O. C. (1950). *Concentration in the US Steel Industry*.

[8] Hausmann, R., Hwang, J., & Rodrik, D. (2007). What you export matters. *Journal of Economic Growth*, *12*(1), 1–25. https://doi.org/10.1007/s10887-006-9009-4

[9] Shirotori, M., Tumurchudur, B., Cadot, O., & others. (2010). *Revealed factor intensity indices at the product level*. UN.

[10] Newfarmer, R., & Brenton, P. (2009). Watching More than the Discovery Channel to Diversify Exports. *Breaking Into New Markets: Emerging Lessons for Export Diversification*, 111–126.

[11] Finger, J. M., & Kreinin, M. E. (1979). A Measure of `Export Similarity' and Its Possible Uses. *The Economic Journal*, *89*(356), 905–912. Retrieved from http://www.jstor.org/stable/2231506

[12] Web Services Architecture. (2017). Retrieved August 20, 2017, from https://www.w3.org/TR/ws-arch/

[13] Kleijnen, S., & Raju, S. (2003). An Open Web Services Architecture. *Queue*, *1*(1), 38:38--38:46. https://doi.org/10.1145/637958.637961

[14] Lopez-Menendez, A., & Perez Suarez, R. (2013). *Challenges and achievements of econometric software. The "Four-F" test*.