

CHAPTER FOUR

DATA DESIGNING TECHNIQUES

4.1 Research Designing Techniques:

This study is essentially concerned with the future patterns of Sudan's sustainable economic development through the adoption of a strategy for developing a knowledge-based economy. The nature of this research requires different sets of data to answer the research questions from different viewpoints but focused tightly upon the questions being searched. Because of the importance of including all the relevant data, and involving the main stakeholders in this process both qualitative and quantitative methods should be employed since they could complement one another if applied efficiently. The main advantage of this multi-method research strategy is to focus on the research problem from different points of view and to enrich the data gathering particularly in this new research area, and to test the variables with different methodologies those methods should be employed independently. This multi-method research strategy tests the validity of measurements by means of triangulated cross-method comparisons.

4.2 Exploratory Research:

The exploratory research was first undertaken by the researcher through a deep literature review about knowledge based economy, in order to understand its history, evolution, development, applications. Many life cases from different countries around the world and comparative studies have been reviewed by the researcher. She explored the dynamics of a knowledge-based economy, knowledge economy indicators (KEIs); the importance of KEIs, theoretical and methodological considerations, data sources,

international best practice examples, as well as policy and future development considerations.

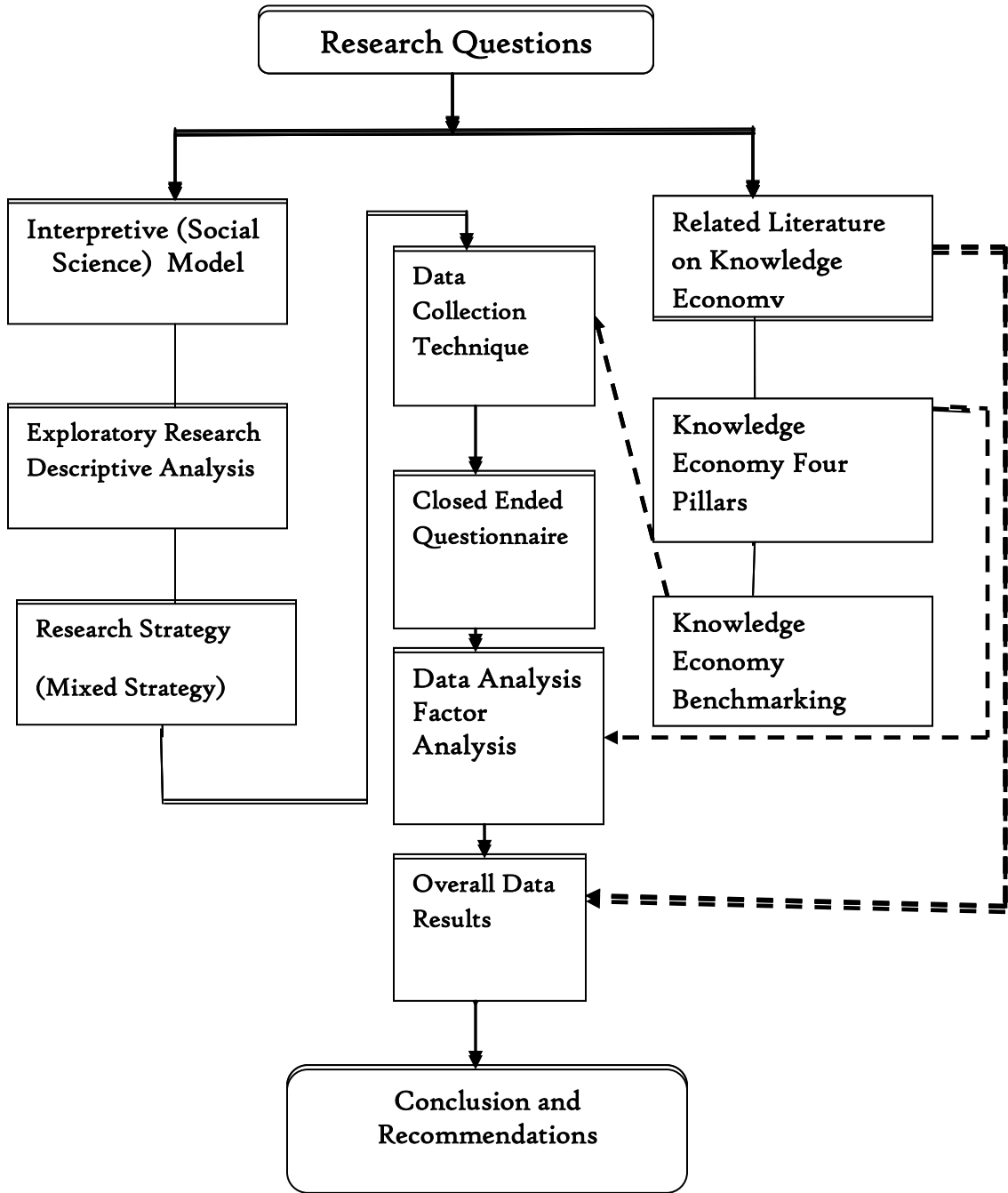
4.3 Benchmarking Process:

The benchmarking methodology provides an analytical tool for policy-makers to identify strong and weak areas in their country's performance on the four drivers of knowledge Economy.

The benchmarking process for this research uses the knowledge assessment methodology (KAM). This has been developed by the World Bank Institute to test a country's readiness for a knowledge economy compared with other regions and countries (World Bank Institute, 2002; World Bank, 2004). The world's overall knowledge economy average provides a good indicator of a country's specific status and could be utilized to generate a reasonable understanding of Sudan's current knowledge economy readiness.

Figure 4.1 explains diagrammatically the different phases of research design. It shows our research design as a logical sequence that connects the empirical data to a study's initial research questions and ultimately to its conclusions. It consists of a set of guidelines and instructions to be followed in addressing our research problem.

Figure 4.1 The Different Phases of Research Design:



— Shows the flow from research question to conclusion

----- Shows the use of literature, knowledge economy drivers and benchmarking to aid data collection, analysis and confirmation.

In this research, Sudan has been benchmarked against the average performance of its comparators from Middle Lower income countries,

The choice of these countries is based on the following reasons:

- a) The choice of the above countries was based on social, cultural and economic relevance. This comparison provides a closer picture with countries from the same economic levels.
- b) It is also important to create a knowledge economy cluster that would assist in consolidating and harmonizing these countries' policies toward better socio-economic integration.

Sudan is a developing country where many output indicators are still too low to be useful to be analyzed. The researcher observed that only few indicators have used in almost all readiness analysis for the countries at the early stage of knowledge economy development. Input such as number of patents, productivity level and number of scientists in comparisons are rarely used in those countries. Rather only input indicators such as education levels, ICT development level, and research and development expenditure have been used.

Comparisons in the KAM are made on the basis of 83 structural and qualitative indicators that serve as proxies for the four knowledge economy drivers. The researcher selects analyzed only five variables and eighteen (18) knowledge economy indicators. The main reason behind the selection is availability of information.

Table 4.1 reveals the indicators we have used in the benchmarking process according to the drivers of knowledge-based economy:

Table 4.1: Knowledge Economy Main Drivers (Variables) and Their Indicators (as used by the researcher)

<i>Variables (Drivers)</i>	<i>Indicators</i>	<i>Sources</i>
<i>Economic performance</i>	Annual GDP Growth (%), 2005-2009	KAM
	GDP per Capita (in/nal current \$ PPP), 2009	
	GDP (current US\$ bill), 2009	
	Human Development Index	
<i>Governance</i>	Government effectiveness	
	Regulatory quality	
	Rule of Law	
	Press Freedom	
<i>Training support</i>	Training programs	
	Training expertise	
	the government's coordination regarding training needs	
	Financial support	
<i>Education</i>	Adult literacy rate	
	Secondary enrolment rate	
	Tertiary enrolment rate	
	Public Spending on Education as % of GDP	
<i>Research and Development</i>	Total expenditure for R&D as % of GDP	
	Researchers in R&D per 1,000,000 inhabitants	
	Scientific and technical journal articles produced per 1,000,000 inhabitants	
	FDI Outflows as % of GDP	
	Private Sector Spending on R&D	
	avg number of citations per S&E article	
<i>Information And Communication Technologies</i>	Mobile phones per 1000 people	
	Computers per 1000 people	
	Internet users per 1000 people	
	ICT Expenditure as % of GDP,	
<i>Information And Communication Technologies' infrastructure</i>	Internet service	
	Mobile telephone service	
	Telephone service	
	Fees	

Source: the table has been developed by the research using the KAM (World Bank KAM)

4.3.1 Basic Scorecard:

The KAM scorecards demonstrate performance on the individual key variables, each of the four KE pillars (average of the normalized scores on the corresponding key variables) and Knowledge (KI) and Knowledge Economy (KEI) indexes (average of the relevant pillar performance scores). This study will utilize only eighteen of these indicators as proxies of Sudan's basic scorecard.

4.4 Quantitative Method:

A descriptive quantitative approach was also used to gain valuable information about the pillars of knowledge economy. A questionnaire survey was conducted to collect data from targeted grade excellent service companies situated at the State of Khartoum. Those companies constitute the main end users of knowledge economy. This method is very important in order to explain, relate and find the appropriate factors or variables that could contribute to knowledge economy development.

The questionnaire is very important to establish analytical and measureable tools that Sudan can benefited from in the long run. This questionnaire can provide some primary quantitative observations about knowledge economy on a constant level. In addition to that this questionnaire can be considered as a new measurement tool for knowledge economy in other similar countries.

Since we have a large number of companies that provide different kinds of services, these companies will be selected according to their registration at the Sudan’s Chamber of Commerce.

Table 4.2 presents the steps the researcher followed in order to select the research sample.

Table 4.2: Steps of Selecting the Research Sample:

Stage	<i>Process</i>	<i>Selection for this research</i>
The 1 st	the Target Population	Private Service Sector in Sudan
The 2 nd	The population Frame	900 of grade excellent companies in the private sector in Sudan
The 3 rd	Sampling Design	Purposive (targeted) sampling
The 4 th	Selection of Sampling units	sample size, accuracy, time, resources, and correct analysis
The 5 th	Determination of sample size	400 of grade excellent companies in the private sector in Sudan
The 6 th	Field Work	Survey of 400 of grade excellent companies in the private sector in Sudan

Source: developed by the researcher

4.5 Steps of Selecting the Research Sample:

- a. Identification of the target population that the researcher wishes to investigate. The population for this research was defined as the private sector in Sudan as potential creators, adaptors and utilizers of knowledge economy elements.
- b. Creation of population frame. Service companies graded ‘excellent’ in the service sector in Sudan were considered as potential creators, adaptors and utilizers of knowledge economy elements. Only these service companies can afford to implement such new policies particularly at the starting phase of knowledge economy strategy pursuance.

- c. Determining the sampling design or sampling method: This research used the purposive sample (non-probability sampling method). In this case, the sampling is confined to the companies with the grade 'excellent', which have the desire and capability to provide the desired information. We believed that purposive sampling is appropriate in this case where a limited number or category of people have the information that is sought; and in case of multiple sources of evidence are used to triangulate on the final result.
 - d. Planning of selecting sampling units: This research used a questionnaire survey in collecting data, within a two-month collection period. The data received were checked to make sure they were ready for coding and transfer to data storage. The purpose of this step was to ensure the completeness, accuracy and reliability of data before analysis.
- c) Determining sample size is a very important issue because samples that are too large may waste time, resources and money, while samples that are too small may lead to inaccurate results. Three criteria usually will need to be specified to determine the appropriate sample size: **a) the level of precision**, **b) the level of confidence or risk**, and **c) the degree of variability in the attributes being measured** (Miaoulis and Michener, 1976). There are many methods to decide on the sample size:
- i. For Roscoe (1975) the sample size should be larger than 30 and less than 500.
 - ii. While Cavana *et al.* (2001) suggest that for multivariate analysis including factor analysis, the sample size should preferably be 10 times or more large than the number of variables in the study.

- iii. To use the same sample size as those of studies similar to the one you plan. Without reviewing the procedures employed in these studies you may run the risk of repeating errors that were made in determining the sample size for another study. However, a review of the literature in your discipline can provide guidance about "typical" sample sizes that are used. (Israel, 1992).
- iv. This research took into account all of the above approaches:
 - The sample size of this research is 400 grade -excellent service companies since 400 is larger than 30 and less than 500.
 - Since we used factor analysis therefore the sample size is 10 times or more larger than the variables in our research,(4 *independent variables* representing the knowledge economy drivers and 2 *dependent variables* representing the knowledge economy outcome).

Thus, the choice of 400 companies fits into the above mentioned ranges. The total number in the sample size selected for this research was approximately 19.6 per cent of the sampling frame of service companies in Sudan. The sample size of 400 companies was considered to be manageable in size, cost and time (Cavana et al., 2001; Pallant, 2006).

- d) *Selecting the sampling units*: a total of 400 grade excellent service companies were selected purposefully to represent the sample units of this research.

The conditions of selection are:

1. A good position in the market, (Product quality-wise and quantity-wise)
2. Enterprise legal status
3. No. of employees (from 50- 250 persons)
4. Specialized in unique or diverse products

5. Have a clear management hierarchy
6. Have a history of inventions creation.

Table 4.3 depicts the process of selecting the sample size:

Table 4.3 The Process of Selecting the Sample Size:

Sudan’s private sector in Khartoum (the Target Population)	(204,635) registered members. More than 83% of them are grade (4) small businesses
Grade excellent (large businesses)	2046 (1 %) of the total companies
The sample size	400 or 19.6% of service sector companies were targeted

Source: *Sudan Chamber of Commerce*

4.6 The Development of the Questionnaire:

The questionnaire is very important to collect data from business firms as the main stakeholder to the government in creating the knowledge economy. The questionnaire consists of nine parts (see Appendix I). The questionnaire was developed firstly in English, and then presented to the supervisor, who directed the researcher to present it to three well known experts in questionnaire design to evaluate it and give their final judges. The researcher got the final approval and modifications were made. Then the questionnaire was translated by the researcher into the Arabic language, edited by an English-Arabic translator.

The questionnaire was divided into seven parts:

Part one consists of seven sub questions to collect general information that dealt with

- a. The company and its status.
- b. specific service activity,
- c. legal status,

d. market (agents and geographic)

Part Two: concentrates on the opinions of the respondents on the status of the status of quality government institutions and economic incentives as a factor of knowledge economy development in Sudan.

Part Three: includes the questions regarding how the respondents evaluate education and training enhancement as a factor of knowledge economy development in Sudan.

Part Four: deals with elements that make up the third driver of knowledge economy development research & development, and innovation.

Part Five: deals with status of information and communication technologies as a factor of knowledge economy development in Sudan.

Part Six: deals with knowledge economy output of productivity.

Part seven: deals with knowledge economy output of knowledge acquisition.

4.7 The Construction of the Questionnaire's Questions:

The questionnaire consists of closed-ended questions where the respondents were asked to choose the answer closest to his/her view points.

The measurement scale mainly used in this research is the interval scale the researcher also used the other attitude measurement such as the Likert scale, It is very important that questions in the questionnaire be linked to the research problem and research question that relates to the field of study.

Table 4.4 reveals the linking of research questions to the appropriate questionnaire questions.

Table 4.4 Research Questions and its Relationship to Questionnaire’s Questions

<i>Variable</i>		<i>Research Questions</i>
<i>Dependent Variables</i>	Knowledge Economy inputs	Q1. What is the status of quality government institutions and economic incentives as a factor of knowledge economy development in Sudan?
		Q2. What is the status of training support as a factor of knowledge economy development in Sudan?
		Q3. What is the status of as a education factor of knowledge economy development in Sudan?
		Q4. What is the status of research & development, and innovation as a factor of knowledge economy development in Sudan?
		Q5. What is the status of information and communication technologies as a factor of knowledge economy development in Sudan?
		Q6. What is the status of information and communication technologies’ infrastructure as a factor of knowledge economy development in Sudan?
<i>Independent Variable</i>	Knowledge Economy Output	Q7. What are the potential factors (outcomes) of sustainable knowledge economy development in Sudan?

Source: the researcher

4.8 The Dependent and Independent Variables:

4.8.1 The Dependent Variables:

The dependent variable in this research is the knowledge economy output.

Where respondents were asked to rate or evaluate from their organizations’ point of view a knowledge outcome in terms of:

1. improvement in productivity;
2. improvement in profitability;
3. increase in sales, revenues, new jobs, gender equality, better support from vendors and the government, and new knowledge acquisition;
4. improvement in R&D understanding, management and employee skills, and product quality, services and process; and

5. Acquisition of licenses to use intellectual property laws and filling patent applications.

4.8.2 The Independent Variables:

This research consists of six independent variables represents knowledge economy (pillars) factors.

IV 1	Governance quality and economic incentives
IV2	Training support
IV3	Education
IV4	Research and development (R&D), and innovation
IV5	Information and communication technologies (ICTs)
IV6	Infrastructure of information and communication technologies

4.9 Pre-Testing the Questionnaire Design:

In order assist the researcher in determining whether the questionnaire meets the aims of the research and to make sure that the respondents will understand the questions; and the questions included in the questionnaire are proper and serve the planned purpose. We conducted a pre testing pilot survey. We have selected a group of 20 respondents from Grade A-organizations (managing directors and general managers) who are not divergent from the actual respondents. The researcher carried out the pre testing by herself. The filling out of the questionnaire was carried out in the researcher's presence to observe, time taken in answering the questionnaire, and to ask for respondent's comments. All the comments were written down.

4.10 The Survey Administration:

The research survey was conducted according to the following conditions:

- a. A draft questionnaire was submitted to the supervisor for approval.
- b. According to the Sudan' University for Science and Technology conduct of ethics a draft has been also submitted to four professors in the field for final revision and approval.

- c. All comments were taken into considerations. Corrections were made. The final questionnaire was professionally designed by the researcher herself (see Appendix 1). 400 copies were produced.
- d. An invitation letter addressed to managing directors and general managers of grade excellent service companies in Sudan was designed and attached to the questionnaire. (See Appendix 2).
- e. The survey was carried out by the researcher herself. The whole process took two months. Sometimes, the filling of the questionnaires was done in the presence of the researcher, but in most cases, the response sheets were collected two days later.
- f. The total of 400 questionnaires were returned and finalized at the end of the survey process.
- g. About 23 returned questionnaires were excluded because most of their parts were incomplete, and thus only 377 returned questionnaires were used in this study.

4.11 Coding, Tabulation and Data Entry:

The coding and tabulation of data was done by the researcher using SPSS (Statistical Packages for social sciences)

4.12 Ethical Considerations:

Ethical considerations followed in this research according to the scientific and University of Sudan for Technology and Science code of research ethics. These are:

- a. Follow the research regulation; as far as the high standards of research, accuracy of the data, honesty in data collection methods. Defending the rights, confidentiality and information of the respondents, and significance and correctness of the results.

b. Avoiding false conclusions that are not in line with the research objectives.

4.13 Reliability; Validity:

In order to judge the quality of the research design, we must identify three principles to be tested; validity, reliability and generalizability (Merriam: 1995). Validity ensures the researcher really measured what should be measured, following the objectives and purpose of the study. Further, it guarantees that the study is free from any bias in terms of inferences and conclusions (Creswell and Miller, 2000). Reliability is the degree to which a tool can generate consistent results that should be free from measurement errors. Reliability is a necessary step to have a valid measure, but it does not guarantee its validity (Neuman, 1994).

These related research issues ask us to consider whether we are studying what we think we are studying and whether the measures we use are consistent.

4.13.1 Reliability:

Clarifying allows the reader to understand the author's position and any biases or assumptions that may impact upon the inquiry (Merriam, 1998).

In order to clarify findings in this study, we have applied triangulation to validate the findings. Yin (2009) suggests that a chain of evidence should be established to increase the research reliability. The researcher developed a chain of evidence through: Keeping collected data in well organized forms and records. She also engaged in Peer Consultation to provide an external check of the research process.

The researcher produced full details of each and every piece of information provided during the research time. The use of the qualitative approach

helped to gain rich data, with many examples and a comprehensive explanation, providing thick description of the whole process.

According to Holloway (1997), it is crucial to establish the truth and authenticity of a piece of research. Therefore, the researcher conducted a detailed discussion in order to reject or confirm the research findings.

In order to measure reliability we used the Cronbach's alpha method. Data should be subjected to such testing before any further analysis to ensure that the data being analyzed are reliable.

Alpha coefficient ranges in value from 0 to 1 and may be used to describe the reliability of factors extracted from dichotomous (that is, questions with two possible answers) and/or multi-point formatted questionnaires or scales (i.e., rating scale: 1 = poor, 5 = excellent). The higher the score, the more reliable the generated scale is (Cronbach: 1951). Reliability estimates for the measures of variables were computed using the software package SPSS version 13.0.

4.13.2 Validity:

We believed that a reasonable degree of confidence of the content validity was achieved through the pre-testing for the questionnaire and modifications we have been made. In addition we relied basically on the existing theories. We reviewed many previous studies which add a lot to the validity of this research. We also took into considerations all the comments made by the experts and professors in the field.(see appendix IV)

4.14 Data Processing Procedures:

Data processing procedures involves converting raw data into information include editing, coding, data entry and data analysis.

4.14.1 Editing:

Data editing is defined as the process involving the review and adjustment of collected survey data. The purpose is to control the quality of the collected data. Editing includes a process of checking and adjusting the data, and making it ready for coding and transfer to data storage. In this research in-house editing was used to investigate the results of data collected in the questionnaires, to check for errors, incomplete answers and omissions in the returned questionnaires.

4.14.2 Coding:

Coding is the process of identifying the data from the questionnaires using numerical scores or other character symbols, then transcribing scores or symbols into electronic format. Since we used pre-coded questions, therefore, all of the questions is numbered against the answer. Where the answer is already a number and the respondents were asked to select only one answer there is no need to code the answer, because the computer program can handle the numerical answer. After completing the editing procedures, the code for each answer was then transferred to data storage in SPSS for analysis.

4.15 Data Entry:

Data entry refers to data entry as a process of transferring data from a research project into a computer program. Transferred data include answers from the survey questionnaire. In this research, the first keyboard operator (the researcher) manually keyed in the data into a computer program, while a second academic researcher verified the data entered to ensure accuracy before the data were ready for analysis. The software program SPSS for Windows (Version 13.0) was used in this process.

4.16 The Analytical Tools:

The analytical tools used were descriptive statistics and inferential statistics. In this research factor analysis was used to group survey items into a meaningful order to identify key factors for knowledge economy in Sudan. The factor analysis is a useful tool for data reduction and provides a clearer picture of which factors act together according to their underlying dimensions. The criteria and procedures for selection and evaluation were in accordance with the standards for social sciences research.

4.17 Factor Analysis:

Factor analysis is used mostly for data reduction purposes: To get a small set of variables (preferably uncorrelated) from a large set of variables (most of which are correlated to each other)

In this research we have used in data analysis the technique of factor analysis. Factor analysis is a multivariate statistical technique, which is useful to extract information from large databases and identify the interrelated data. The factor analysis was used in this research for the following purposes:

- a. To group the questions in the questionnaires in a meaningful order.
- b. To identify the key factors which are very important for knowledge economy in Sudan?
- c. To prioritize the importance of these factors according to their loading values

4.17.1 Factor Loading:

Factor loadings are the correlation of each variable and the factor. The higher the loading value the more representative the variable to the factor.

4.17.2 Number of Items in Each Factor:

Refers to the number of items extracted from the data reduction process that load significantly on each factor.