Using Artificial Neural Networks to Determine the Extent to Which the Private Sector in the KSA Benefit from Quantitative Methods in Decision-Making

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Abstract:

The goal of this research was to investigate the actuality of employing quantitative tools in decision making. The most major issues that impede the adoption of quantitative approaches in the private sector in Saudi Arabia are the key sources of managers' knowledge, decision-making styles, identifying decision-making methodologies, and sectors of applications. Data were acquired by a questionnaire survey of 594 managers, and data were analyzed descriptively and inferentially. According to the findings, 80.1 percent of respondents use quantitative techniques in decision-making; the primary sources of quantitative method expertise were university study (34%), followed by applied practice (26%). Furthermore, 42 percent of participants used experience as a decision-making tool. Statistical analysis was utilized as a quantitative method, accounting for 17% of the total.

The most common fields of use for quantitative approaches were profitability analysis (12%) and inventory control (11%). With 30%, the most common reason preventing the use of quantitative approaches was a lack of professionals. The most common benefit of applying quantitative methods mentioned by participants was an increase in profitability (28%). In this study, we used two techniques: neural network and logistic regression. We concluded that the most important variables that have an impact on making the right decision in the private sector are academic qualification (46.6 percent), knowledge of quantitative methods (20 percent), the extent of application of quantitative methods (17.8 percent), and finally age (15.6 percent).
Keywords: Neural Network; Logistic Regression; Quantitative Methods; Information Technology; Decisions Support System.

1. Introduction

Managers devote significant time and effort to making sound decisions. Many scientists and practitioners regard decision-making as the most important and fundamental administrative activity. The vast majority of profitable business decisions rely on a reliable data source and data validation via the use of tools and models. The relevance of employing quantitative methods as a useful instrument for making choices and addressing administrative difficulties emerged in the modern period.

The right decisions made by decision makers are also influenced by operations research. The qualitative models and techniques used in the private sector, such as the creation of goods and services, manufacturing firms that determine the lowest-cost combination of inputs required for actual production, and how best to create, in the proper number and quality for customer satisfaction. Various companies employed qualitative approaches in some aspects of decision making, such as North American academic research libraries, which used statistical methods in budgeting, collection usage, and enhancing the efficiency of specialized processes, particularly processing. Rarely have data been linked to larger institutional performance or service quality indicators. The use of quantitative tools in decision making has been a huge success.

As the world becomes more data-driven, the complexity of decision-making in the private sector, such as manufacturing, business, and medical applications, is fast expanding. Managers face a plethora of decisions every day as a result of the rapidly changing corporate environment. They must make decisions, even if they do not want to.

Problem statement:

The main issue addressed in this paper is to investigate the extent to which quantitative methods are used in decision-making in the

private sector in Saudi Arabia, as well as to identify the constraints that limit the use of these methods and provide recommendations to address these constraints in order to substantiate the use of quantitative methods in the private sector.

The study's significance:

1. Academic level: researchers aspire to contribute to the advancement of scientific knowledge by employing quantitative decision-making methods.
2. Applied Level: This study is meant to attract decision-makers' attention to the need of using quantitative methods in decision-making.

The following are the research objectives:

1. Recognize the reality of employing quantitative approaches in the commercial sector, as well as the key sources of managers' knowledge and decision-making styles.
2. Identify decision-making methods and application fields.
3. Identifying the most significant barriers to the application of quantitative methods.
4. Emphasizing the benefits that quantitative methodologies provide to enterprises.
5. Measuring the impact of specific variables on decision accuracy in the private sector.

Background:

BABU (2012) conducted a study to investigate the relationship between various micro and macroeconomic aspects and to develop strategies based on data analytics. The elements influencing policymaking were technology with human-driven analytics has made the process of retrieving information easier than in the past, perfect uses of data mining and statistics necessitate the employment of computer science and client-domain knowledge. Successful knowledge discovery is dependent on coordination between the disciplines statistics-data mining, computer science, and domain expertise; if this coordination is realized, we will undoubtedly see broader applications of data mining in practically all areas of research institutes.

Hiller (2003) examined the use of quantitative approaches in decision-making and discovered that there is a considerable interest in using quantitative and qualitative data in library management and decision-making among North American academic research libraries. The study also identified a number of barriers to adopting statistical models in decision-making, such as the amount of data supplied and the length of the consultation process. Furthermore, there were few university research libraries, and information moved quickly. Above important, they lacked statistical data training and experience.

Prior to making forecasts, Kusiak (2002) examined the accuracy connected with the decision signatures. Some decisions may demand extreme precision, while others may necessitate a degree of uncertainty. The capacity to analyse the accuracy of a decision a priori makes the presented ideas appealing to technology, business, and medical applications. The evaluation was carried out in accordance with the human factors community's group assessment and decision-making processes. The study's findings improved the quality of decision-making by utilising an algorithm. In which the decision signatures were ranked and the utility index was updated using a group decision-making method. ANENE (2014) investigated the factors that influence the use of Quantitative Techniques (QTs) in production planning in a variety of Nigerian manufacturing industries. Data were acquired via a questionnaire provided to 160 employees of 20 companies chosen at random from each of the eight purposefully selected Nigerian Small-Scale Industries. The control chart, dispersion measures (range, variance, and standard deviation), forecasting techniques (regression and time series analyses), graphical and charting techniques, inventory model, capacity utilization model, and acceptance sampling were discovered to be the QTs used by the various companies in the selected industries. Control charts, which were discovered to be the most often used strategies, account for 35% of the total. This is consistent with the findings of (Grigg and Walls 2004). In terms of frequency of application,

dispersion measures (Range, Variance, and Standard Deviation) came in second (30 percent). Forecasting approaches (regression and time series analysis - the two traditional forecasting methods) (15%), graphical and charting techniques (12%), inventory model, capacity utilization, and acceptability sampling (1%) were the least often used techniques.

Kessy (2006) provided an assessment of how widely operations research methods are used in various firms. This data was gathered from 9 examples (Tanzanian organizations) by MBA students from the University of Dar es Salaam who followed an uniform methodology devised by the researcher in order to better understand the hurdles for an application. The study discovered a low level of application of operational research (OR) techniques in the businesses studied, as well as the difficulties for model underutilization. Despite managers' awareness of the benefits of employing OR models, the models were poorly conceptualized, constructed, and used in decision-making. The presence of under-qualified or well-trained employees in the OR field within organizations, a lack of experts in the OR field in the labor market, and resistance to change, which is primarily caused by conservative managers, i.e., they do not see the point in using "needless quantitative methods" were the challenges impeding the application and utilizations of operation research. Other problems included a lack of infrastructure, insufficient financial resources, a lack of management support, and opposition to

change. The dynamic environment is the major obstacle that operation managers cannot control.

According to Fuller (2003), 13 quantitative models were used for decision making in analysis models, linear programming models, game theory models, simulation models, network optimization models, project management models, inventory models, queuing models, dynamic programming, integer programming, nonlinear programming models, forecasting models, and Markov decision models.

Valero (1997) conducted a study to investigate the status and extent to which administrators of colleges and universities in the state of Virginia. Use qualitative and quantitative management techniques in planning and controlling activities, as well as determining the sorts of managerial techniques employed, the degree of expertise with these techniques, the frequency with which they are employed, the managerial benefits and constraints, and the person and organizational aspects involved in employing such techniques The examination proceeded directly to the highest and most operational organizational levels in two categories of administrators (nonacademic and academic). According to the findings of this study, administrators had a moderate understanding of the procedures and a limited application of them. Furthermore, no statistically significant variations in the degree of familiarity and amount of use with various management strategies (qualitative and quantitative) were

discovered, regardless of administrator assignment category (nonacademic or academic) or administrator level or type (executive or operative). Brainstorming was the most commonly mentioned strategy in terms of familiarity and breadth of use. Benchmarking checklists and cost-benefit analysis. Respondents use qualitative strategies for decision-making more positively and assess their value more favorably than quantitative ones.

Itanyi (2012) sought to determine the extent to which managers use quantitative and qualitative methodologies in organizational decision-making. Investment appraisal, break-even analysis, market research, sales forecasting, critical path analysis, decision trees, chi square, correlation analysis, regression analysis, simulation, transportation analysis, and t-test are some examples of quantitative decision-making criteria that were used. The researcher discovered that the use of both qualitative and quantitative methods was critical in managerial decision-making for the efficient and effective use of available resources for the organization's growth and development. If the managers in any business are inexperienced with the various methodologies, it may have a negative impact on the organization's decision-making process and, as a result, its competitiveness. As a result, it is important for managers to improve their decision-making skills through the accumulation of experience and scientific knowledge. This will ensure that the organization's decision-

making process is correct, that its communication mechanisms are effective, and that its resources are used efficiently.

A study (Turpin, 2004) attempted to reconcile a variety of theoretical decision-making theories with how senior managers actually make decisions. Six influential decision-makers were interviewed about their decision-making habits and use of decision-support technology. The study's findings revealed a large diversity in personal decision-making styles. However, several key themes emerged, such as the significance of being sensitive to the decision-making situation, paying attention to information presentation, and using intuition. In terms of decision support technology use, self-help options such as office software were clearly preferred. One of the study's surprises was that, despite having formal training in advanced decision support methods and technology, a lot of the decision-makers found little use for it in their working environment. The recognition-primed decision (RPD) model, which describes naturalistic decision-making, was one of the decision-making models that gained relatively significant support in concept.

2. **Methodology**

All private-sector personnel participating in decision-making were included in the study population. This study employs a stratified random sample method in which a corporation is chosen at random and then participants are chosen using a simple random sample. The questionnaire was issued to

700 different businesses, and the return was (594) questionnaires with an 84.9 percent response rate.

The research instrument:

Data was obtained using a questionnaire prepared by the researcher after examining the literature on the issue and making use of it. The study was divided into two sections. The first section was a personal variable for employees (participants), such as length of service, experience and credentials, specialization, and all of these questions were near. The second section addresses a variety of significant features of quantitative approaches, such as the level of knowledge, the sources of knowledge, and the level of interest in learning them. Their application in the workplace, the sorts of procedures used, and the methods used in decision making. The reasons for not employing quantitative methods, as well as how frequently they made the correct conclusions. Following the development of the questionnaire statements, they were reviewed by a committee of specialized academics from King Saud University's departments of public administration and quantitative methods to ensure the clarity of words, language accuracy, and sincerity of the content. The approval of the resolution phrases was considered, and

after making the necessary revisions based on the professors' suggestions regarding the tool's content.

We used the following statistical tools to fulfil the goals of this study:

(A) Frequency and percentage tables.

(B) A neural network is a type of computer network.

(C) Logistic Regression is a type of regression analysis.

3. The Outcomes Achieved

This section is divided into two sections. The first part offers some sample characteristics in terms of three variables: sector, size, and business ownership. Then, describe some of the individuals' socio-demographic information, such as age, occupation, and qualification. The second section provides answers to all research questions, with a focus on the most noteworthy findings.

The sample's characteristics

According to Table (1), the majority of survey participants (53.7%) work in the industry (27.3%) and services (24.2%) sectors, followed by the trade sector (24.2%) and banking and finance (8.2%).

Table (1): Characteristics of firms where the participants work

Business Activity	**Frequency**	**%**
Industry	162	27.3%
Trade	144	24.2%
Banking and Finance	49	8.2%
Services	157	26.4%
Warehousing and Distribution	2	.3%
Agribusiness (agricultures)	30	5.1%
Other	50	8.4%
Total	594	100
Firm's size (number of employees)	**Frequency**	**%**
Less than 50 employees	198	33.3%
More than 50 employees	396	66.7%
Total	594	100
Ownership of the company	**Frequency**	**%**
General	125	21.0%
Special	469	79.0%
Total	594	100

In contrast, only 0.3 percent work in warehousing and distribution, and 5.1 percent work in agriculture. The second section of the table likewise shows that the majority of survey participants (66.7 percent) work in large-sized organizations with

more than 50 workers, while 33.3 percent work in small-sized companies with fewer than 50 employees. While the last section of the table shows that the bulk of research participants work for privately held businesses.

Table (2) depicts some of the characteristics of the participants, for example, young people account for 77.4 percent of the study sample individuals aged 40 or less, followed by 17.7 percent of respondents aged 41 to 50 years, and those aged more than 50 years account for no more than 4.9 percent of the participants. The second part of the table shows the distribution of the sample based on job position, and it is clear that those who occupy the functional head of department (30.1 percent) have the highest percentage, followed by functions other than those represented in the question (21.5 percent), and then assistant director and director of administration (27.3 percent). General managers and their assistants make up 21% of the sample. In summary, the majority of respondents work in managerial roles where they are obliged to make choices, with 78.5 percent holding at least the position of head of department. Part 3 of the table shows the sample distribution by educational qualification, with 55.7 percent having a college degree, 36.9 percent having a diploma certificate to high school, 5.1 percent having an advanced degree, and 2.4 percent having less than a high school qualification.

Table (2): Participants' socio-demographic information

Age	Frequencies	%
20-30	214	36.0%
31-40	246	41.4%
41-50	105	17.7%
More than 50	29	4.9%
Total	594	100
Occupation	**Frequencies**	**%**
General manager	70	11.8%
Assistant general manager	55	9.3%
Director of the administration	86	14.5%
Assistant Director of the administration	76	12.8%
Head of Department	179	30.1%
Other	128	21.5%
Total	594	100
Qualification	**Frequencies**	**%**
Less than High School	14	2.4%
High School	95	16.0%
Diploma (two or three years)	124	20.9%
Parchment(college degree)	331	55.7%
postgraduate degree (Master and over)	30	5.1%
Total	594	100

Answering the research questions

Q1: Where do you get your information about quantitative methods?

According to table (3), university study is considered to be the largest source of knowledge of quantitative methods, accounting for 34%, followed by applied practise (26%), training courses (24%), and books and references (8%). It should be noted that the total

number of replies is greater than the number of sample participants since it allows participants to select more than one option.

Table (3): Knowledge sources for quantitative approaches

The question and levels of answer		Responses		
		N	%	Rank
Knowledge sources for quantitative approaches	University study	220	34	1
	Applied Practice	170	26	2
	Training Courses	155	24	3
	Other	54	8	4
	Books and references	50	8	5
Total		649	100	

Q2: What decision-making style do you use?

Table (4) depicts the decision-making techniques, with 42.2 percent of participants utilizing prior experience as the decision-making method, followed by 28 percent consulting, 11.3 percent personal judgement, and 18.5 percent alternative methods, trial and error, and feeling and guess work. It should be noted that the total number of answers is greater than the number of sample participants because the participants might select more than one option.

Table(4): Decision-making's styles do you use?

Question and levels of answer		Responses		
		N	%	Rank
Decision-making's styles used	Previous Experience	299	42.2	1
	Consulting	198	28.0	2
	Personal judgment	80	11.3	3
	Other	48	6.8	4
	Trial and error	45	6.4	5
	Feeling and guessing	38	5.3	6
Total		708	100.0	

Q3: What quantitative methodologies are employed?

Table (5) demonstrates that statistical analysis is the most commonly utilized quantitative method (17%), followed by

Table (5): Quantitative methods used

Question and levels of answer		Responses		
		N	%	Rank
Quantitative methods	Statistical Analysis	136	17	1
	Prediction models	107	13	2
	Linear Programming	91	11	3
	Inventory models	85	10	4
	Financial models	81	10	5
	Computer simulation	80	10	6
	Cost-benefit analysis	79	10	7
	Other	60	7	8
	Decision Tree	50	6	9
	Queuing Theory	39	5	10
	Bert model	7	1	11
Total		815	100	

prediction models (13%), and linear programming (11%). Whereas ten percent of participants use each of four methodologies, namely inventory models, financial models, computer simulation, and cost-benefit analysis. Finally, decision trees, queuing theory, and the Bert model are the less

quantitative methods that are often used, accounting for 7%, 6%, 5%, and 1%, respectively.

Q4: In what domains do you use quantitative methods؟

According to Table (6), the most common fields of use for quantitative approaches are profitability analysis (12%), inventory control (11%), and sales analysis (10%). Production scheduling and quality control both draw a comparable percentage of participants (9%). Another three fields, accounting procedures, project scheduling, and others, have used quantitative methods at a comparable rate of 9%. Pricing is the field that uses quantitative methods the least, accounting for 3% of all fields.

Q5: What are the causes for the lack of use of quantitative methods?

The most common reason for not employing quantitative approaches is a lack of professionals (30%). A quarter or less of the participants cite three reasons for not using quantitative approaches: 14 percent cite a lack of expertise of these methods, 11 percent cite a lack of management attention, and 10 percent cite a lack of reliable data availability. The least prevalent explanations, which account for 3% of all cases, are a lack of computer access and "used but did not succeed," as indicated in Table (7).

Table (6): Fields of applying quantitative methods

Question and the levels of answer		Responses		
		N	%	Rank
Fields	Profitability analysis	116	12	1
	Inventory control	103	11	2
	Sales Analysis	97	10	3
	Production schedule	85	9	4
	Quality Control	81	9	5
	Accounting procedures	76	8	6
	The project schedule	75	8	7
	Other	73	8	8
	Manpower Planning	66	7	9
	Allocation of resources	56	6	10
	Capacity planning	45	5	11
	Maintenance and repair	33	4	12
	Pricing	31	3	13
Total		937	100	

Table(7): The reasons for not using quantitative methods

The question and levels of answer		Responses		
		N	%	Rank
Reasons	Unavailability of specialists	169	30	**1**
	Lack of knowledge of these methods	81	14	**2**
	Lack of management attention	64	11	**3**
	Lack of accurate data availability	59	10	**4**
	The firm is successful without using these methods	31	6	**5**
	Lack of necessary funds	30	5	**6**
	Lack of encouragement from chairpersons	29	5	**7**
	High cost	28	5	**8**
	The firm is a small size	25	4	**9**
	Other reasons	23	4	**10**
	Lack of availability of computer	14	3	**11**
	Used but did not success	14	3	**12**
Total		567	**100**	

Q6: What are the advantages of employing quantitative methods?

According to table (8), the most common benefits of employing quantitative methods mentioned by survey participants are improved profitability (28%), cost reduction (19%), and time savings (19%). "Other benefits" account for 1% of the benefits reported by participants.

Table (8): The benefits of using quantitative methods

Question and levels of answer		Responses		
		N	%	Rank
Benefits of using Quantitative methods	Improve profitability	229	28	1
	Reduce costs	156	19	2
	Save time	154	19	3
	Improve productivity	141	18	4
	Improve the decision-making process	117	15	5
	Other	10	1	6
Total		807	100	

Q7: Do you use quantitative methods to make decisions?

When asked if they use quantitative methods or not, it was discovered that 80.1 percent of respondents use quantitative approaches in decision-making, whereas 19.9 percent do not (see table (9)).

Table (9): Extent of applying quantitative methods in decision-making

Answers	Frequencies	%
Applied	476	80.1
Non applied	118	19.9
Total	594	100

Q8: How frequently do you make good decisions?

How often do the participants make the correct decision? This is demonstrated in table 10, where the majority of 49.3 percent say that their decisions are frequently correct (correct) and 13.8 percent

indicate that their decisions are always correct, for a total of 63.1 percent, which is by no means low. While only 4.1 percent of participants make proper selections on a regular or seldom basis. Those in the middle account for 32.8 percent of all participants.

Table (10): The frequency of making the right decisions

Answers	frequencies	%
Never	7	1.2
Rarely	17	2.9
Sometimes	195	32.8
Often	293	49.3
Always	82	13.8
TOTAL	594	100.0

Those in the middle account for 32.8 percent of all participants. There have been Merged answers are combined (always, frequently) to indicate correct decisions and (never, rarely, occasionally) to symbolize incorrect decisions, with table (11) displaying the majority. 63.1 percent made accurate decisions, whereas 36.9 percent made incorrect decisions.

Table (11): the accuracy of the decision-making

Answers	frequencies	%
non correct	219	36.9
Correct	375	63.1
Total	594	100.0

We have two components covered under two axes: the first is the extent of quantitative techniques use, and the second is quantitative methods. Whereas the first axis includes the application of quantitative methods to questions (14, 16, 9, 8, 15), and the second axis includes special knowledge regarding Quantitative Methods questions (10, 13, 12), the two axes represent the independent variables influencing decision-making accuracy (the dependent variable). The quartiles approach was used to divide the categories and merge them using the sum of the scores.

Table (12) illustrates the extent of the application of quantitative methods

	Frequency	Percent
Low	195	32.8
Medium	277	46.6
High	122	20.5
Total	594	100.0

Illustrates table (12) applied the quantitative methods 46.6% with a Medium degree while 32.8% applied the quantitative methods with a low degree

Table (13) knowledge regarding Quantitative Methods

	Frequency	Percent
low	238	40.1
Medium	212	35.7
High	144	24.2
Total	594	100.0

Table (13) depicts the knowledge with Quantitative Methods with a high degree of roughly a quarter 24.2 percent vs 40.1 percent knowledge with Quantitative Methods.

4. Models And Analytical Hypotheses

We used a Neural network and Logistic regression to determine the important aspects that influence decision-making. The term "Neural Network" refers to the nervous system as an adjective. Neural networks, also known as Artificial Neural Networks, function similarly to neurons in the human brain. It acquires knowledge through the learning process, much as the human mind does from past experiences. Different from traditional methods, neural networks provide an appropriate way to represent relationships between variables. Neural networks are known as artificially intelligent neural network models, which do not require the availability of restricted assumptions about the

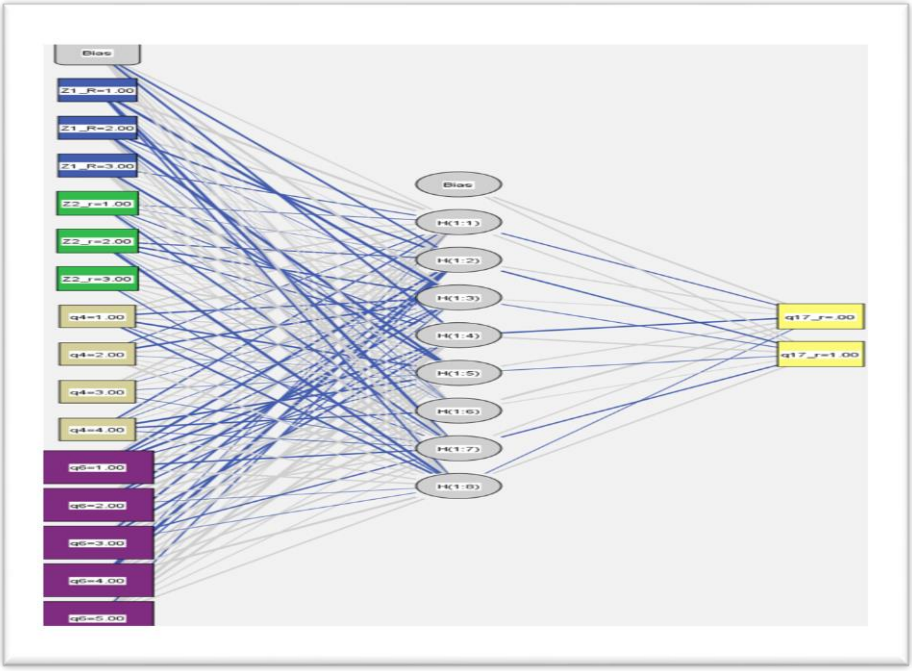
relationship between dependent variables and independent variables; neural networks treat non-parametric data with a high degree of accuracy. Logistic regression analysis investigates the relationship between a categorical dependent variable and a set of independent (explanatory) variables. Linear logistic regression models are one of the most prominent models used to create the discriminant function (no& Yes)

We have two components covered: the first is the extent of quantitative techniques use, and the second is quantitative methods. Whereas the first axis includes the application of quantitative techniques to questions (14, 16, 9, 8, 15), and the second axis includes particular knowledge regarding quantitative methods questions (10, 13, 12), the two axes indicate the independent variables influencing the decision-making accuracy (the dependent variable).

The data was processed by integrating the variables that represent the independent variables, and categories were divided using quartiles, in order to build models capable of predicting decision-making accuracy, the extent of the use of quantitative methods in decision-making in the Saudi private sector, and the relative importance of the determinants influencing decision-making accuracy. We employed Neural networks are one of the ways of artificial intelligence in general, and one of the methods of machine learning in particular, because they provide a novel

approach to describe the correlations between variables than traditional methods.

Figure (1) Multilayer Perceptron – Architecture of Neural Network



The data was processed, and the networks were trained on it, which means the network learned and recognized all information as well as the link between the various variables. The network inputs were represented by four independent determinants, with the following results

Table (14) Classification model

Sample		Predicted		
		No	yes	Percent Correct
Training	false	79	79	50.0%
	true	51	227	81.7%
	Overall Percent	29.8%	70.2%	70.2%
Testing	false	32	29	52.5%
	true	16	81	83.5%
	Overall Percent	30.4%	69.6%	71.5%
Dependent Variable: the accuracy of the decision-making				

According to the previous table, the overall percentage of correct prediction is 70.2 percent, while the percentage of incorrect forecast is 29.8 percent. This signifies that the sum of correct predictions and incorrect predictions equals 100 percent.

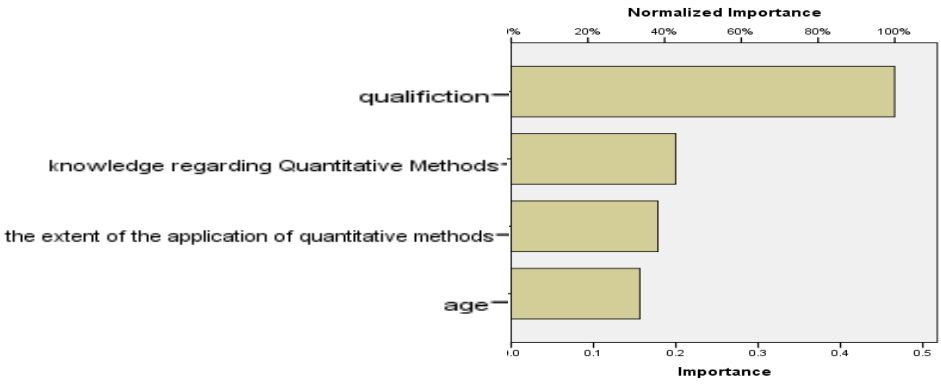
Table (15) Importance of Independent Variables

	Importance	Normalized Importance
the extent of the application of quantitative methods	0.178	38.2%
knowledge regarding Quantitative Methods	0.200	42.9%
Age	0.156	33.5%
Qualification	0.466	100.0%

The relative importance of the variables in the previous table that the academic qualification came in first place, followed

by the educational qualification 46.6 percent, knowledge regarding quantitative methods 20 percent, the extent of the application of quantitative methods 17.8 percent, and finally age 15.6 percent, figure shows

Figure (2) Indicators of Importance



The previous Figure depicts the normalized relevance of each predictive variable. This is basically a bar chart with importance values sorted in descending order. Normalized importance is a measure of how much the predicted value of the dependent variable would be affected by the exclusion of a specific predictive indicator. The educational qualification was ranked first in terms of importance, followed by knowledge of Quantitative Methods in second place, and then the extent of quantitative method application in third place and finally the age.

The logistic linear regression model is one of the most important models used to formulate the discrimination function, and this model is characterized by its suitability for many uses, and logistic regression is used in general to analyze the relationship between the use of quantitative methods to support and decision-making or not.

Logistic regression arises from using the previous logit transformation when the dependent variable (Y) expresses the probability of a certain event (θ), and there is a set of explanatory variables X = {X_1, X_2, ..., X_p} whose number is P variable, and there is a relationship between Probability (θ) and explanatory variables on the following linear form:

$$\theta_k = \beta_0 + \beta_1 x_{1k} + \beta_2 x_{2k} + \ldots + \beta_p x_{pk}$$

Since the left side is finite (0< θ<1) while the right side of the equation is infinite, and using the logit transformation we get that:

$$P_r\ (\ Y_k = 1/X\ ) = \frac{\exp(\beta^{\backslash} X)}{1+\exp(\beta^{\backslash} X)} = P_r(X)$$

The logit transformation, which is the basis for this model, is known as:

$$g(X) = Ln(\frac{P_r(X)}{1-P_r(X)}) = \beta^{\backslash} X$$

Assumptions of the logistic linear regression model are

1. The dependent variable is a binary or multiple nominal variable. The conditional expectation for this variable E(y|x) is a variable limited to the period (0, 1). As for the explanatory variables, they can be continuous or discontinuous, nominal binary or multiple, as it is assumed that all Variables are measured without errors.
2. The dependent variable and the explanatory variables have a substantial relationship.
3. The expected value of the random error is zero, the variance of the random error is constant, and the random error (u_k) follows a binomial distribution with a probability determined based on the conditional mean.
4. There is no correlation between random errors (independence errors).
5. There is no correlation between random error and explanatory variables.
6. There is no complete correlation between the explanatory variables.

Data application

The analysis included 594 questionnaires, and the following are the features of the estimated model, which included four independent variables using the logistic linear regression model at a level of significance of 5%. The classification table is

another method to evaluate the predictive accuracy of the logistic regression model

Table (16) The System of Classification

Observed		Predicted		
		the accuracy of the decision-making		
		No	yes	Percentage Correct
the accuracy of the decision-making	No	85	134	38.8
	Yes	58	317	**84.5**
	Overall Percentage			**67.7**

According to the previous table, the total classification degree for the model has achieved 67.7 percent, with the right predicted amounting to 84.5 percent.

Table (17) The strength of the relationship between dependent and independent variables

Independent variables	B	S.E.	Wald	df	Sig.	Exp (B)
the extent of the application of quantitative methods	-0.18	0.13	1.95	1.00	0.16	0.83
knowledge regarding Quantitative Methods	**0.36**	0.12	8.38	1.00	**0.00**	**1.43**
age	0.04	0.11	0.16	1.00	0.69	1.05
qualification	**0.64**	0.11	36.17	1.00	**0.00**	**1.89**
Constant	-2.01	0.43	22.11	1.00	0.00	0.13

The previous table demonstrates that education level has a positive effect on decision-making, 0.64, which is significant because the P-value is smaller than 0.05. The odds ratio demonstrates that as a person's education level improved, so did

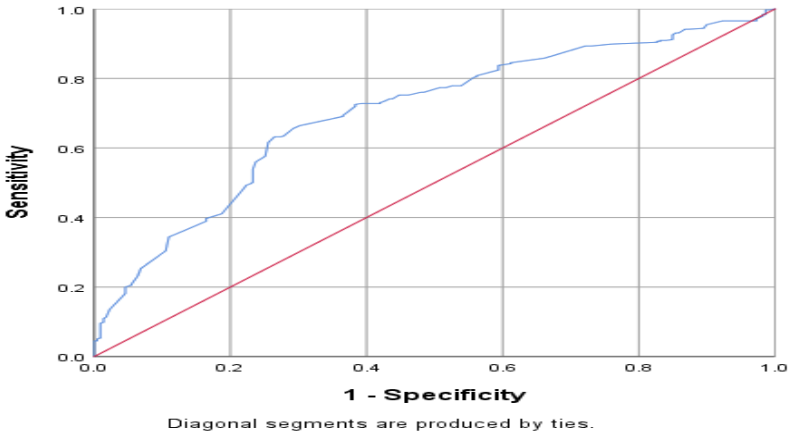
their chances of making the right selection. Furthermore, the understanding quantitative approaches have a favorable effect on the decision, 0.36, and its coefficient is significant at the level of 0.05. When understanding of quantitative methods improved, the odds ratio climbed by 1.5, indicating that the chance of making the correct decision increased by 1.5. While both age and the extent to which quantitative approaches are used have a negligible impact on decision making.

Table (16) reveals that 85 items were correctly split at a rate of 38.8 percent out of 219 items that did not apply quantitative decision support systems, and 317 items were successfully divided at a rate of 84.5 percent out of 375 items that used quantitative decision support systems. It is also obvious that the number of 402 things was successfully divided, with a percentage of 67.7 percent out of the sample size of 594 items.

Table (18) Dimensions of the curve

Area Under the Curve				
Area	Std. Error	Asymptotic Sig	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
0.702	0.022	0	0.659	0.745

Figure (3) ROC Curve



The area under the rock curve (Roc Curve) was calculated to quantify the sensitivity of the model in classification, and it reached 0.702, as in table (18), which is excellent and significant (0.000), indicating that the logistic regression is classed in a more significant and better way to predict.

5. Conclusion and Recommendations

According to the findings of this study, the degree of education and mastery of quantitative methods are the most essential factors in making the appropriate decision in the private sector. As well as expertise and qualifications of decision makers, the adoption of appropriate decision-making models and tools is essential to effective decision-making. Managers must improve their knowledge of models and management tools in order to reap the benefits of quantitative approaches. Quantitative analysis

must be used by managers in every facet of their enterprises. The lack of quantitative analysis specialists was the biggest problem for the management. Managers in various organizations must have both human relations skills and technical competence to make successful and efficient decisions.

1. Behavioral approaches and quantitative techniques in businesses are closely related and should be used to solve problems because they are important productivity instruments.
2. The managers should think about the three key essential variables which are environment, technology and people, before making a decision.
3. Expansion of training for managers on the use of quantitative methods in decision-making
4. Establishing a Centre to assist managers in decision-making and in collecting the essential precise data to aid them in decision-making
5. Because of the practical and realistic attitude, quantitative methods should be included in management approaches.
6. Machines and software needed in decision-making must be provided, purchased, and upgraded.
7. The application of quantitative methods in decision making and increasing managers' understanding of decision making are among the topics that will be discussed at conferences and seminars in this area.

8. The business sector should have access to a quantitative techniques expert who can assist managers and decision makers to better reason their actions.

Acknowledgments

The author would like to express gratitude to the Deanship of Scientific Research at King Saud University, as represented by the Research Center at CBA, for financially supporting this research.

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