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A STUDY OF INTERFACE BETWEEN OPERATION RESEARCH AND STATISTICS

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Abstract

Operations Research is concerned with analysing complex problems and helping decision makers get the best means of achieving some objective. Statistics is the science of collecting and analysing numerical data in large quantities, especially for the purpose of inferring proportions in a whole from those in a representative sample. Operation Research makes use of Statistical concepts to select the best method to solve complex problems in real world. People in real world assume that Operation Research and Statistics are two different field and there is no interface between them. Hence, this study is done to understand the Interface between Operation Research and Statistics. The research is done using both primary as well as secondary data. A sample size of 120 respondents from various Industries where Operation Research is highly used has been taken.

Introduction

Operation Research

Operations Research (OR) is one of the popular managerial decision science tools used by profit and nonprofit organizations. Operations Research has gained significance in applications like world-class Manufacturing systems (WCM), Lean production, Six-sigma quality management, Benchmarking, Just-in-time (JIT) inventory techniques. In order to be competitive, businesses must meet the challenges present in a global market by offering products and services that offer good value to their customers, which is a combination of low cost, high quality, rapid availability and real time information on these.

Operations research is usually the mathematical treatment, analysis of a process, problem, or operation to determine its purpose and effectiveness and to gain maximum efficiency. The operation technique is utilized by functional groups such as Industrial Engineering in effort to support Operation Managers to make economically feasible decisions on a range of systematic challenges. An important component of decision-making process is verifying and validating alternatives, which typically involve decision makers, engineers or analysts.

Significance of Operation Research

Operation Research is concerned with providing the decision-maker with decision aids derived from:

i) A total system orientation,

ii) Scientific methods of investigation, and

iii) Models of reality, generally based on quantitative measurement and techniques.

Operation Research has come to be used in a very large number of areas such as problems of traffic, question of deciding a suitable fare structure for public transport etc. It also has application in academics like problems of communication of information, socio-economic fields etc.

Statistics

'Statistics' has gained its importance in recent times and is also growing rapidly. Research is highly dependent on Statistics and hence new things are being discovered to be made available worldwide.

Statistics is majorly concerned with methods for collecting, organising, summarising, presenting and analysing data and deriving conclusions to make proper decisions on the basis of analysis.

Functions of Statistics

There are many functions of statistics. Following are a few important functions:

1. **Condensation:**

   "To condense", means to reduce or to lessen. Condensation is mainly applied at embracing the understanding of a huge mass of data by providing only few observations. Statistical measures reduce the complexity of the data and helps to understand huge mass of data.

2. **Comparison:**

   Statistics helps in tabulation of data and classify them into various categories. Grand totals, measures of central tendency, measures of dispersion, graphs and diagrams, coefficient of correlation etc. are some techniques used for comparison. Using statistics, comparison is always possible and comparison helps to understand the data in a better way.

3. **Forecasting:**

   The dictionary meaning of forecasting is to predict or to estimate beforehand. Given the data of the last ten years connected to rainfall of a particular district in a State, it is possible to predict or forecast the rainfall for the near future. Certain techniques in Statistics for forecasting are analysis of time series and regression analysis.

4. **Estimation:**

   Drawing Inferences about a population from the collected sample is an important task in Statistics. The four major branches of statistical inference are Estimation theory, Tests of Hypothesis, Non Parametric tests and Sequential analysis.

5. **Tests of Hypothesis**:

   A statistical hypothesis is some statement about the probability distribution, characterizing a population on the basis of the information available from the sample observations. Testing of Hypothesis is an important aspect in Statistics.

The Operations Research and Statistics is involved in a wide variety of theoretical and applied topics related to optimization, probability, machine learning etc. Operations Research is the discipline of applying advanced analytical methods to help make better decisions. With the combination of probabilistic modeling expertise and strong optimization skills, the operations research and statistics group is at the cutting edge of developing solutions to the most important data-driven problems facing today's modern enterprises. With this background, this study have been performed in order to understand a strong relation between Operation Research and Statistics.

Literature Review

Statistics are numerical statement of facts in any department of enquiry placed in relation to each other (A.L. Bowley, 1901). Bowley gives another definition for statistics, which states 'Statistics may be rightly called the scheme of averages'. This definition is incomplete, as averages play a role in comparing data whereas statistics provide more measures.

With further work done by Croxton and Cowden, Statistics was defined as the science of collection, presentation analysis and interpretation of numerical data from the logical analysis. According to this definition there are four stages:

1. Collection of Data: It is the first step and this is the foundation upon which the entire data set. Careful planning is essential before collecting the data. There are different methods of collection of data such as census, sampling, primary, secondary, etc., and the investigator should make use of correct method.
2. Presentation of data: The mass data collected should be presented in a suitable, concise form for further analysis. The collected data may be presented in the form of tabular or diagrammatic or graphic form.
3. Analysis of data: The data presented should be carefully analysed for making inference from the presented data such as measures of central tendencies, dispersion, correlation, regression etc.,
4. Interpretation of data: The final step is drawing conclusion from the data collected. A valid conclusion must be drawn on the basis of analysis. A high degree of skill and experience is necessary for the interpretation.

Statistics is also defined by Horace Secrist as the aggregate of facts affected to a marked extent by multiplicity of causes, numerically expressed, enumerated or estimated according to a reasonable standard of accuracy, collected in a systematic manner, for a predetermined purpose and placed in relation to each other.

Relation between OR & Statistics

Mathematics and Operations Research in Industry

Operation Research has been successful in providing a systematic and scientific approach to all kinds of government, military, manufacturing, and service operations. It is a splendid area for graduates of Statistics to use their knowledge and skills in creative ways to solve complex problems and have an impact on critical decisions. (Dennis E. Blumenfeld, Debra A. Elkins, and Jeffrey M. Alden)

Some key steps in OR that are needed for effective decision-making are:

1. Problem Formulation (motivation, short- and long-term objectives, decision variables, control parameters, constraints);
2. Mathematical Modeling (representation of complex systems by analytical or numerical models, relationships between variables, performance metrics);
3. Data Collection (model inputs, system observations, validation, tracking of performance metrics);
4. Solution Methods (optimization, stochastic processes, simulation, heuristics, and other mathematical techniques);
5. Validation and Analysis (model testing, calibration, sensitivity analysis, model robustness);
6. Interpretation and Implementation (solution ranges, trade-offs, visual or graphical representation of results, decision support systems).

These steps all require a solid background in Statistics and familiarity with other disciplines (such as physics, economics, and engineering), as well as clear thinking and intuition. Statistics prepare students to apply tools and techniques and use a logical process to analyze and solve problems. There are many Statistical techniques that were developed specifically for Operation Research applications. These techniques arose from basic statistical ideas and became major areas of expertise for industrial operations.

Techniques of Statistics for optimization include linear programming (optimization where both the objective function and constraints depend linearly on the decision variables), non-linear programming (non-linear objective function or constraints), integer programming (decision variables restricted to integer solutions), stochastic programming (uncertainty in model parameter values) and dynamic programming (stage-wise, nested, and periodic decision-making).

Related to the topic of stochastic processes is Queuing Theory. Statistical analysis has been essential in understanding queue behavior and quantifying impacts of decisions. Queuing Theory has various applications in such as customers at a bank, orders waiting for production, ships docking at a harbor etc.

Other OR topics requiring statistical analysis are inventory control (when to reorder material to avoid shortages under demand uncertainty), manufacturing operations (what size of production run will minimize sum of inventory), etc.

Statement of the Problem

Students majoring in Statistics might wonder whether they will ever use the Statistics they are learning, once they graduate and get a job. Is any of the analysis, calculus, algebra, numerical methods, linear programming, etc. going to be of value? There is a lack of awareness among young population about the application of Statistics. Also people wanting to work in the field of Operation Research are of the view that Statistics doesn't play an important role.

Objective of this study

An exciting area of applied Statistics called Operations Research combines mathematics, statistics, computer science, physics, engineering, economics, and social sciences to solve real-world business problems. Numerous companies in industry require Operations Research professionals to apply statistical techniques to a wide range of challenging questions.

Hence, the present study is undertaken with the objectives of identifying the relation between Operation Research and Statistics. How important Statistics and that Operation Research is a part of Statistics.

Hypothesis for the Study

H0: There is no relationship between Statistics and Operation Research

H1: There is a relationship between Statistics and Operation Research

Research Methodology

Coverage

Private Sector Organizations are distributed a structured questionnaire. The focus is on individual working in sectors like Aviation, Shipping, Telecommunication, Manufacturing and Transportation.

Data Collection

The study will include primary data which will be gathered using the questionnaire which will be distributed both offline and online to reach out to wider audience. Secondary data will be gathered from peer reviewed journals.

Data Analysis

Hypotheses will be tested using the Chi-squared test for Independence. Chi-squared test is a nonparametric statistical test analyzing method often used in experimental work where the data consists of frequencies, counts or percentages.

Testing of Hypothesis

The significance level taken in 0.05

Category	Company	Strongly Agree	Agree	Neither Agree No Disagree	Disagree	Strongly Disagree	Total
Aviation	Max Aerospace & Aviation Ltd.	7	4	3	1	0	15
	TAL Aviation Group	5	6	2	2	0	15
Shipping	United Shippers Ltd.	11	1	1	2	0	15
	MSK Shipping & Logistics Pvt. Ltd.	9	4	1	0	1	15
Telecommunication	Shreeji Comsec India Pvt. Ltd.	9	2	1	2	1	15
	TeleSOft	7	4	3	1	0	15
Manufacturing	Arcraft Plasma Equipments (India) pvt. Ltd.	11	2	1	1	0	15
	TAN SWA Technologies Inc.	10	3	1	1	0	15
Total		49	39	15	12	5	120

Category	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Total
Aviation	12	10	5	3	0	30
Shipping	20	5	2	2	1	30
Telecommunication	16	6	4	3	1	30
Manufacturing	21	5	2	2	0	30
Total	69	26	13	10	2	120

Degree of Freedom = (r-1)*(c-1)

Where:

r = row

c = column

Degree of Freedom = 12

$$X^2 = \sum \frac{(O-E)2}{E}$$

Where:

O = Observed frequency

E = Expected frequency

Decision Rule: If $X^2 > 21.0261$ then Null Hypothesis will be rejected

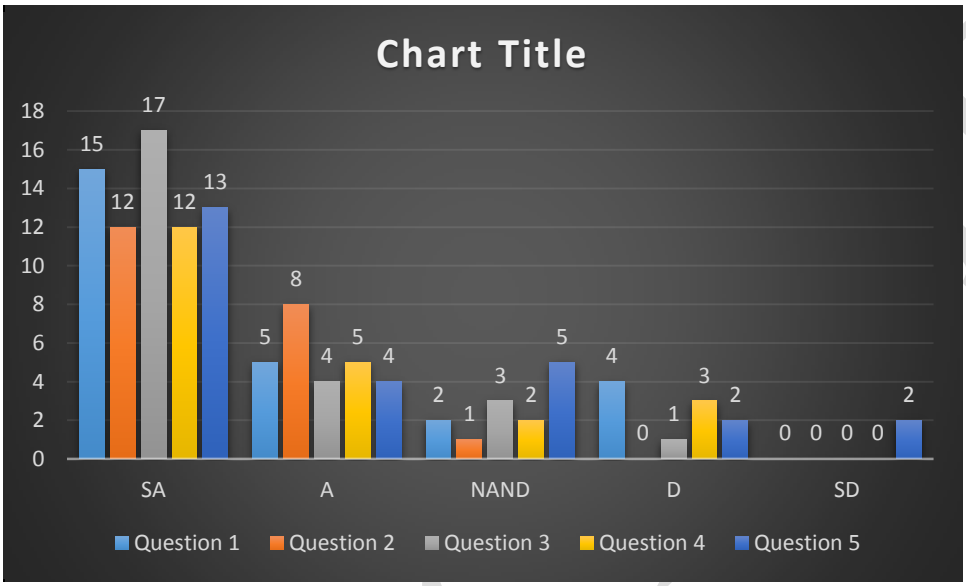
After Calculation we get:

$X^2 = 23.72$

The value of X^2 statistic calculated exceed the critical value. Thus, Null Hypothesis is rejected and Alternate Hypothesis is accepted.

Finding and Interpretation

The below shows the view of respondents on different issues. The x- axis shows the view in form of their level of agreement and y-axis shows the number of respondents. The study shows that there exist a strong relationship between Statistics and Operation Research.



Conclusions

OR is basically a science of decision making. Decision making becomes a problem when the availability of alternatives is many. OR techniques are of great support to make better and suitable decisions because all the methods are scientific and systematic.

As the world becomes more complex and more dependent on new technology, statistics applied to business problems is likely to play an increasingly important role in decision-making in industry.

But the tools and techniques used in Operation Research is derived from Statistics. In general, Operations Research requires use of Statistics to model complex systems, analyze trade-offs between key system variables, identify robust solutions, and develop decision support tools.

OR analysts can model difficult practical problems and offer valuable solutions and policy guidance for decision-makers. Constraints involving budgets, capital investments, and organizational considerations can make the successful implementation of results as challenging as the development of Statistical models and solution methods.

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Only for Research Purpose

Name and Address: _____

Investor or Builder: _____

Please tick ✓ against appropriate box.

Note: SA: Strongly Agree, A: Agree, NAND: Neither Agree nor Disagree, D: Disagree, SD: Strongly Disagree

Sr. No.	Statements	SA	A	NAND	D	SD
1.	Operations research is used as a technique for Decision Making					
2.	Operations Research uses Statistical Techniques to solve Complex Problems					
3.	Industrial Operations majorly depends upon Statistical Technique					
4.	Operations Research requires use of Statistics to model complex systems, analyze trade-offs between key system variables, identify robust solutions, and develop decision support tools.					
5.	Statistics helps in developing logical process that helps in Analysis and Solve Problems in real world					

Bio

Ms. Ritu Chakraborty is young, energetic and result oriented person. Have completed Bachelors in Electronics Engineering and Masters in Management Studies in finance. Have been in teaching industry since last 5 years. Specialisation Subjects include Mathematics, Operation Research, Total Quality Management, Management Information System. Was also associated with companies like Siemens and was a part of there live projects. She can be contacted at ritubhatta@gmail.com