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Quantitative Decision Making; Mathematical and Managerial Perspectives Comparative Case Study (MSA Versus Cairo University)

Emad El-Din Hussein Hassan, Zeinab Abbas Zaazou*

Management Information System Department, Faculty of Management, October University for Modern Sciences and Arts (MSA), Cairo, Egypt

Email address

zabbas@msa.eun.eg (Z. A. Zaazou), eeldin@msa.eun.eg (E. El-Din H. Hassan)

*Corresponding author

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Abstract

This paper is mainly focusing on the contribution that quantitative techniques can make to managerial decision making. It is also marking the importance of using quantitative techniques in decision making whether in a public or private entity. The aim of this study is to prove that decision making is always based on data and information, which is increasingly quantitative and managers of various backgrounds need the knowledge of the techniques and processes appropriate for analyzing such information apart from the sophistication of the statistician or mathematician specialists. That's why students should be familiar and be aware of the importance of the quantitative approach in decision making. This concept triggered the researcher to present through a case study how can instructors use the quantitative decision making technique with students of different faculties and majors, such as management students and engineering or statistics students. The case study methodology is well established in the social sciences. This approach may help to inform practice by illustrating what has worked well and what didn't. The main study finding was that almost all the participants of the two groups gained good knowledge about the importance of the quantitative decision making techniques and the deference it makes in the result of decision making process and also the rule of each mathematics and management sciences in it. About 50% of the students of management sciences group were interested in seeing some examples of using quantitative methods in decision making. About 70% of the mathematics students were attracted to see more managerial applications in management field. Researchers believe that this study is one of the very few studies done regarding this topic in Egypt. Using quantitative techniques in managerial fields is quite new in the educational and practical field in developing countries in general and in Egypt in specific.

Keywords

Quantitative Decision Making, Management Decision Making, Quantitative Techniques

1. Introduction

The wellbeing of any society is embedded in the efficiency and effectiveness of the performed work. To accomplish that, individuals and organizations have to choose the best alternative to attain goals and objectives. Bottom line, making right decisions as much as possible. Herbert A. Simon et. al came up with the theory of rationality in decision making, which entails four steps of intelligence,

design, choice and review assuming the manager has the needed information to make decisions. He also, proposed the bounded rationality theory, where the manager is assumed to have incomplete information for decision making. According to Simon and his associates, managers work is about setting goals, designing suitable courses of action, finally evaluating and choosing among alternatives. To achieve quality decision making, managers are advised the use of quantitative techniques. [10]

Quantitative techniques can be defined as mathematical

and statistical models which describe a diverse array of variable relationships, and are designed to assist health managers with problem-solving and decision making. Managers in our increasingly turbulent and changing environment, have to carefully assess and analyze the available information and react soundly to a problem or opportunity and to make right decisions whether trivial or strategic within an increasing local and global competition. The contribution of quantitative technique to management decision making is significant, as it tackles business problems from the quantitative perspective and handles data and information used in conjunction with other sources. Organizations, now-a-days, use many quantitative methodologies such as: network analysis, forecasting and cost-benefit analysis. Furthermore, decisions support systems and computers are depending increasingly on these techniques for enhancing organizations capabilities. [9]

To conclude, students from different academic backgrounds should be familiar and be aware of the importance of the quantitative approach in decision making. The intelligent use of the quantitative perspectives, can make problematic issues very manageable. Moreover, one has to agree that the biggest impact of the quantitative approach is not only embedded in the area of problem solving, but is rather contributing in problem formulation. Here lies the greatest effect on management art.

2. Literature Review

2.1. The Importance of Quantitative Methods for Managers

The quantitative approach has many attributes, such as: employing measurable data to reach useful results, choosing appropriate sampling method, using parameters for forecasting and planning purposes... etc. He also claimed that the consequences of taking wrong decisions is becoming more serious and costly in the 21st century. That's why anything that can help managers of any organization in facing problems and finding the right solutions for them is highly important. As quantitative approach provides information regarding a certain problem or situation and in addition provides a different way for examining this situation, it is highly recommended that managers use this approach. [11]

2.2. The Role of Quantitative Technique that Will Enable Industry/Business Organizations Gain Competitive Advantage

Quantitative Technique provides solutions for many business problems, such as how best can managers and executives allocate the available resources so that they attain the maximum profits and lowest cost possible. Also, for example, how can managers and executives arrange the quantity and time of orders so that the overall profit with given resources will reach the maximum.

Furthermore, the quantitative technique is facilitating the

process of decision making through

for instance, simulation as it is mainly used to initiate an operation or process prior to actual performance. The aim of simulation is enabling decision makers to find out the impact of alternative courses of action in various uncertain situations where mathematical formulation is not possible. The quantitative technique is designed to test how a business system would react to various situations internally and externally. [7]

2.3. All Possible Outcomes by the Quantitative Technique

Multiplying the possible outcomes and their probabilities and adding all that for each strategy, will inform the decision maker or the manager to know the possibilities of the outcomes in the future, thus requiring use of present values and discounted cash flow. This is what we call the "Expected Monetary Value"; which is a quantitative technique. John Von Neumann developed the 'Monte Carlo Simulation' while working on the Manhattan Project during World War II. It is tackling a range of values and their probabilities for achieving the end result. When managers or executives are making a decision under conditions of uncertainty, this simulation would be very useful. The end result of any decision taken is the dependent variable and the factors affecting this end result are the independent variables. For each independent variable, we can establish a range of possible values and the probability within that range. Then we enter the ranges and the probabilities for each independent variable and choose one value and its probability per occurrences for each independent variable. This way, decision makers will be able to figure out nearly all possible outcomes of each decision before they take it. [6]

2.4. The Multi - Criteria Analysis (MCDA) as One of the Quantitative Approaches

Multi - criteria Analysis (MCDA) as one of the quantitative approaches, is a method of dealing with complex problems with breaking each problem into more manageable pieces and then reassembling these pieces into a coherent overall picture to decision makers. The purpose of this techniques is providing different ways of disaggregating a complex problem in order to measure the extent to which options achieve objectives. Furthermore, to be able to measure the weight of each piece of the problem to reflect its relative importance to the decision. The use of MCDA enables the decision maker to develop a new model for benefit-risk assessment, which allows the balancing of multiple criteria. The model allows focusing on the scientific data and the scores and weights to be derived from those data, instead from the model itself. [8]

3. Managerial Perspectives of Quantitative Decision Making

A complete understanding of management requires an

appreciation of, classical, behavioral, and quantitative approaches: The Systems Approach and The Contingency perspective, which is an integrative framework of management perspectives. The classical perspective is about finding ways to increase the efficiency of the individual workers and the whole organisation which is presented through the scientific management theory and the administrative theory; while the behavioral approach is concerned of finding ways to understand individuals behavior, groups and teams, to motivate them and effectively lead them (the Hawthorn Study, the Human Relations Movement Theory and the Organizational Theory). As for the quantitative perspective it is about finding ways to improve the operation, decision making and resource allocation, which is represented by the Management Science and Operation Management.

The management science focuses specifically on the development of mathematical models in order to come up with adequate managerial decisions (simplified representation of a system, process, or a relationship) The operations Management applies quantitative techniques (mgt science) to management to help the organization produces goods and services more efficiently and to run the operation (inventory mgt and linear programming). All these perspectives are considered universal management perspectives.

A framework is established for the development of new and improved quantitative methodologies. Mathematical modelling and quantitative methods are used currently for regulatory decision-making in Europe and also are described for risk assessment of chemicals in food and diet. Quantitative mathematical approaches have played a crucial role in the organizational development theory. The majority of research in the area of mathematical organizational theory has been and is being done in four areas: organizational design, organizational learning, organizations and information technology, and organizational evolution and change. These methodological approaches have been used to examine organizations using formal models and to address a variety of questions about organizations. [3]

Even individuals who are well educated and those who have studied pure mathematical courses, often remain largely ignorant when called upon to make quantitative judgments of problems that are related to fuel-efficiency standards, tax cuts, and the health care crisis, for example. That's why, moving mathematics away from a preparatory role for the scientific fields and into a more ecumenical position as a facilitator of everyday action entails a rethinking of the curriculum in public schools. [4]

4. Mathematical Perspective of Quantitative Decision Making

The increase of complexity of the problem formulations and the progress in mathematics, statistics and computing science, led to the development of organizational research as a branch of applied mathematics and computer science. It

also provided us with valuable insights in basic trade-offs, at a managerial level, but cannot be characterized as explanatory or predictive models of operational processes. The problems were formulated in mathematical terms, and mathematical techniques were used for analysis and solution.

Organizational research is mainly related to the mathematical aspect-model of the process and the quality of the mathematical solutions. It is dealing with technique-oriented modeling of real-life problems and implementing of solutions derived from the model. The methodology of organizational research based on quantitative models, offers a great opportunity for operations management researchers to further advance theory and facilitates organizational problems solutions and it definitely supports the executives in taking a sound and right decision. [13]

5. The Case Study

Quantitative Decision Making represents good example for the topics that can be viewed from several points and can be introduced to different students in different Fields like Mathematics, Management, Economics and etc., the problem that may face the instructor of this topic concentrated in how to formulate and express the same set of concepts and notions to the students of each field using the suitable terminology and motivation. Also the instructor has to know the objective (s) of teaching this topic to the students of every specific field.

The study started in the academic year: Fall 2016 and Spring 2017. During this academic year, the second author (Emad El Din Hussein) taught 'Quantitative Decision Making' to both participants; the management faculty groups (MSA University) and the mathematics and statistics group of Cairo university. Regarding the mathematics and statistics participants, the instructor was making sure that the quantitative decision making course main learning objective is building quantitative methods needed to solve decision making problems, test and prove the validity and effectiveness of these methods, also the students have to be acquainted with how to apply these quantitative methods in real life problems.

Quantitative decision making from a managerial perspective is about how to use the numerical (quantitative) Methods and mathematical results in order to find the optimum possible decisions in is about how to create and apply mathematical structures and theorems that can be used to design numerical methods and techniques of finding the optimum solutions of decision making problems. The participants of each major (Mathematics and Management) have completely different backgrounds and also are familiar with completely different terms and concepts such as: Mathematics participants are supposed to have deep knowledge about terms like: Theorem, Lemma, Corollary; Assumption; Prove, Proof; Algebraic operations; Ordering; Differentiability, Non-differentiability; Algorithm; Convex set, Concave set; Probability distribution; Maximum and minimum point; Randomness and Running time. Whereas

management sciences participants are supposed to have deep knowledge about managerial and economic terms as following: Decision; Product; Profit, Loss, Risk, cost; Facility location, Path; Optimum decision; Combination; Purchase, Merchandizing; Hire, Fire; Overtime; Subcontracting and Layout.

Because the students have different expectations, each group of students is assumed to need different motivation to attract them to learn the course and realize its importance like that:

1. Students of Mathematics and Statistics department are always asking about the fields in which the deep mathematical structures and results they study can be used. This course is excellent chance to show them that the distance between the pure mathematics and applications in real life is not so long.
2. Students of Management Sciences Faculty are always wondering about why they study mathematics and what we can do by the simple mathematical skills that they study in the beginning level courses. This course is a good chance to show them that using mathematical techniques makes differences in the field of decision making, Management and Economics

5.1. The Research Methodology

The case study methodology is well established in the social sciences. This approach may help to inform practice by illustrating what has worked well, what has been achieved and what have been the issues or dilemmas. [14] Outcomes from individual case studies are analytically generalizable [12], but not statistically generalizable. In our case, the 180 voluntary participants (studying quantitative decision making) 100 participants from MSA University and 80 participants from Cairo University (mixed major of Statistics and Mathematics).

5.2. The Main Objectives of the Study Are

1. Examining the knowledge of each group of participants regarding the two quantitative perspectives (managerial and mathematical) of decision making.
2. Trying to narrow the gap between the two participant groups find and make them know more about each others' perspectives in the studied subject.
3. Discovering the common and different aspects in both managerial and mathematical approaches of the wide topic "Quantitative Approach to Management"

With respect to management sciences participants, *the course main learning objective* is knowing how to transform managerial cases into appropriate mathematical models and how to solve it.

In order to attain these objectives, instructors had to start with choosing the suitable text-book (s) for each group of participants. For example, for the management groups, a book with managerial perspective and background was chosen. [2] and for the mathematic and statistics group, a text-book with mathematical approach containing a complete

mathematical results' proofs was chosen [5] in addition to another book with managerial applications containing real life case study [1] was suggested as supplementary reading book. A proper suitable learning and teaching strategy should be applied.

The instructors tried very hard to meet each groups' expectations; mathematics and statistics participants are always concerned with the fields in which the deep mathematical structure and results can be used. As for management participants, they are always wondering about why they study mathematics and how can it be an added value to their studies and skills. Well, we can surely say that studying this course from different perspectives, will proof to the mathematic and statistics participants that the gap between pure mathematics and applications in real life is not so wide. We can also proof to the management participants that using mathematical techniques increases remarkably the validity and effectiveness of decision making. Although, the two courses of mathematics and management are containing similar topics, such as: *Linear programming, Queueing Systems (waiting line systems), Decision analysis, Game theory....* etc. Every topic can be introduced differently according to the different taught major (mathematics or management). Also the teaching methods and assessment scheme should be compatible with each course and each approach (mathematical and managerial)

These mentioned courses can be introduced and taught using either of mathematical or managerial approach as follows: mathematic and statistics participants (students) will be introduced to several techniques to solve the problem in hand, then they should investigate the validity of each technique, and its computation complexity, then little of real life applications has to be clarified. As for the management sciences participants (students), the above-mentioned courses could be dealt with by studying each possible technique for solving the problems introduced in the cases and trying to interpret these techniques through managerial perspective.

Finally, they have to report the solutions of the problems. So we can sum up the steps of solving a problem (decision making) from a managerial perspective as following:

1. Formulation (changing the managerial case into mathematical model)
2. Solution of the mathematical model
3. Reporting the resulted solution managerially

6. Conclusion

The paper introduced a comparative presentation to the concept of *Quantitative Decision Making* from both mathematical and managerial perspectives comparing the rule of this concept in each of mathematical and managerial sciences. Also the paper presented the description and main results of the case study of teaching this notion to students in each of mathematics and management sciences concluding the difference responses of students of each background.

After completing the course and according to discussions with the students from both the two groups we can conclude

the following:

1. Almost all the students of the two groups gained good knowledge about the importance of the quantitative decision making techniques and the deference it makes in the result of decision making process and also the rule of each mathematics and management sciences in it
2. About 50% of the students of management sciences group were interested in seeing some examples of the mathematical proofs for the results that they use in decision making.
3. About 70% of the mathematics students were attracted to see the more managerial applications of the mathematical facts that they study.
4. After knowing the importance of the field of decision making, about 30% of the mathematics students mentioned that they may make their future career in it.
5. About 20% of the management sciences students mentioned that they will read more in the mathematics of decision making.
6. The researchers think that it will be good idea if we gather students in the both category in some common session to discuss and exchange their opinions about the quantitative decision making.

7. A Recommendation Post an Educational Conference at MSA University

Researchers presented this case study and its results in an educational conference between MSA university and Greenwich university in April 2017 at MSA campus. The audience consisted of individuals from different fields and colleges (management, economics, mathematics, pharmacy and languages). After the presentation, they addressed several questions such as:

How to quantify the managerial decision making in real life problems and be solved by the mathematical quantitative methods?

Are the quantitative techniques useful to solve decision making in fields like pharmacy? And, can we design quantitative decision making courses from other perspectives to be suitable for other fields?

These questions opened a wider view; and we believe it needs deeper thinking and preparations hoping to find suitable time and resources to come up with further results and answers. It will be also very beneficial if it is possible to gather students from both majors (mathematics and management) to exchange opinions and show how to look to the topic from another point of view and also see how can both parties cooperate to perform complete real life cases hybridizing the mathematical and managerial work. This suggestion will be taken in consideration from the next semester.

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