Contents lists available at GrowingScience

Management Science Letters

homepage: www.GrowingScience.com/msl

Theoretical foundations of organizational problem solving methodologies in Operational Research

Ali Mohaghar[a], Ahmad Jafarnejad[b], Seyyed Hasan Ghodsipoor[c] and Mohammad Hasan Maleki[d*]

[a]*Associate Professor of Dept. of Industrial Management, University of Tehran, Tehran, Iran*
[b]*Professor of Dept. of Industrial Management, University of Tehran, Tehran, Iran*
[c]*Professor of Dept. of Industrial Engineering, Amir Kabir University of Technology, Tehran, Iran*
[d]*Ph.d. Candidate of Faculty of Management, University of Tehran, Tehran, Iran*

C H R O N I C L E	A B S T R A C T
	Paradigms are some principles and assumptions, which define frameworks and research priorities in each discipline. Many believe that operational research (OR) is not a science and like many other sciences does not have any paradigm. However, since OR is committed to scientific methods, therefore it contains a methodological paradigm. The purpose of this paper is to consider theoretical methodologies in the field of OR. This paper performs a review on the existing literature based on interpretive hermeneutic approach. Based on literature review, the study determines four principles and assumptions for each OR paradigms and a classification of the methods are presented. The results show that OR has four main paradigms and there are many methods in OR fields to tackle a particular problem where each problem belongs to a particular paradigm. In addition, instead of using a particular method in problem situations, we can implement a combination of methodologies.

1. Introduction

Paradigms are considered as a pattern or model for investigating a particular problem, they can be specified as exemplar and they are universally recognized as scientific achievements that, for a time, give model problems and solutions for a community of researchers (Van Manen, 1990; Kuhn, 1996; Taket & White, 2000). Many people use a term of geology in paradigms for developing systems and they believe there are continues changing paradigms in developing different systems. In other words, the continuous change in paradigms, in turn, creates new ideas in science. In fact, geological aspects occur in development of most management systems and for some times, a paradigm influences a system and steadily, the effects disappear, at the same time, other paradigms start influencing the system, and their impacts increase, steadily. Jackson (2003) discussed four paradigms influencing OR

problems including functionalist, interpretive paradigm and critical paradigm and post-modern paradigm. A few years later, these paradigms were integrated with other soft systems (Raitt, 1979; Eden, 1983; Checkland, 1985; Pinkard, 2002). Shortly after, a new way of thinking called "critical systems thinking" emerged in United Kingdom and total systems intervention was introduced by Flood and Jackson (1991). There are also other areas of works including Pluralistic and Multi-paradigmatic (Mingers & Brocklesby, 1997). According to Ulrich (1987), city and regional planning, health care planning, energy and transportation planning, environmental design and other areas of social systems design are some of the most important issues for increasing concern to policy makers. These issues are normally encountered with complex steering problems, which may have far-reaching societal implications, they except assist from applied disciplines such as OR, systems science, technology assessment, program evaluation, etc. However, these techniques offer little help in critically representing on the normative implications of the problem definitions and solution proposals they inspire.

According to Dando and Bennett (1981) many of the features of debates outlined by Kuhn, seem to be present in the current controversy within OR. More specifically, it appears possible in OR and associated fields to detect three rival sets of proposals, which may be labeled official, reformist (e.g. Ackoffian) and revolutionary.

There are literally vast range of techniques and methodologies, both hard and soft, which are available to the OR/MS practitioner. According to Munro and Mingers (2002), there is a trend towards a pluralistic approach of combining, various methods within an intervention-multi-methodology. Munro and Mingers (2002) presented a survey of OR/MS practitioners to find the extent of multi-methodology usage and which particular combinations were most commonly utilized.

Mingers (2003) presented a classification of the philosophical assumptions of management science methods. The study presented a framework within which to investigate and evaluated the main philosophical assumptions underpinning management science methods. The purpose of the framework was to help in the process of multi-methodology, which is, combining different techniques in an intervention. In particular, it will also help users in understanding both the implicit or explicit assumptions underlying techniques.

Mingers and Rosenhead (2004) provided a comprehensive review and evaluation of the implementation of problem structuring methods (PSMs). The review started by explaining the origins of PSMs, the kind of problem situation for which they are applicable, and the characteristics of some leading techniques. They also provided some practical overview from a number of angles, including case studies and surveys of applications and discussed a number of issues in the application of PSMs. More specifically, they discussed on the success of PSMs, the selection of an appropriate method; multi-methodology; and characteristics of the maintenance of relationships with the client organization(s).

Mingers and White (2010) performed a review on various contribution that systems' thinking were making, more especially to OR applications. They explained that systematic thinking is a discipline in its own right, with various theoretical and methodological developments and it can be used to almost any problem area because of its generality. They looked at the literature in terms of both theoretical and applications figures. They concluded that while systems could not be well established, institutionally, in terms of academic departments, it is incredibly healthy in terms of the quantity and applications.

2. Paradigm

There are different reasons for using paradigm to solve scientific problems, for instance, Kuhn (1970) and Kuhn (1996) stated that paradigm were the basis of solving any issues arising in various sciences. Paradigms help scientists find some agreements on their activities while they solve their issues.

Paradigm is a set of theoretical assumptions and rules that guide the members of a scientific community. All activities associated with a paradigm setup a specific knowledge, scientists may face various problems, which threaten the existing paradigm, and whenever scientists are unable to find solution against existing threats, a revolution may happen. Kuhn (1996) explained there are different categories on knowledge including pre-knowledge, common knowledge, revolution, new knowledge and new crises. Neuman (2006) used paradigm in social sciences in terms of four categories including Worldview, Epistemological Stance, Examplar Model and common believes and this paper focuses more on Epistemological Stance. Burrell and Morgan (1979) defined paradigm as a combination of different characteristics including Ontological, Epistemological Stance and Methodological. Table 1 demonstrates details of various characteristics on paradigm (Newman, 2006).

Table 1
Different impressions of paradigm

	Worldview	Epistemological Stance	common believes	Examplar Model
Characteristics	All comprehensive aspects on social sciences	Worldview, Epistemological Stance	Having common believes on certain questions	Emphasizes on best solution strategies
Kuhn's perspective	Implicit	Explained but not used	Explained and implemented	Explained and implemented
Position in social science	Non-professional applications	Dominant approach	Rarely used	Seldom implemented
Advantage	Emphasis on individual works	Emphasis on well-known people	Applied by serious researchers	Explicit
Disadvantage	Widely distributed	Focused more on knowledge and less on research	Less influenced	Very limited

3. Paradigm assumptions

Epistemological paradigms are fundamental philosophical views. Paradigms are classified based on the positions of the ontology, epistemology and methodology. In fact, each major philosophical approach can be regarded as a research paradigm and it is based on ontology, epistemology and methodology of the analysis. Ontological questions are about the nature of reality while epistemological questions deal with the nature of the discussion. Finally, the research methodology is faced with the question of how to gain knowledge or wisdom.

In a very broad classification, realist ontology and ontological idealist ontology are classified into two categories. Idealist ontology assumes that the external world is not dependent of our mind and it relies more on the researcher's subjective opinion. People see realities as what they are interested and not as what they actually are (Pinkard, 2002). Nevertheless, realist ontology, which is the foundation of positive paradigms, post-positive and critical rationalism constitutes is based on the fact that they are observable from any one and acts independently. Epistemology is a theory on the nature of knowledge. Many people categorize social science methodologies into three groups of quantitative, qualitative and a combination of both.

4. Research Paradigms in social science

Paradigms traits are divided into four categories: 1 - positivism, 2 - Interpretation, 3 - Critical Theory, 4 - post–structuralism.

In terms of discoveries, no assumption depends on researcher and people must find everything by performing a research. In this paradigm, the nature of objective knowledge and values of the investigator, would not affect recognition of external reality. In this kind of paradigm, researchers sort all items in their questionnaires and try to measure them based on predefined specifications. In fact, researcher can find the answer for unknown questions thorough an investigation on different subjects.

5. Research Paradigms in operations research

This paradigm includes three subdivision including formal, reform and fundamental paradigms and these paradigms are associated with three paradigms including positivist, interpretive and critical social science. According to Fay (1975), we understand the concept of things based on the knowledge we have about it. Paucar-Caceres (2010) performed a review process and, using Jackson's idea, he categorized paradigms into four categories: optimization/Normative and solution procedures (1940-1970), interpretation and learning paradigms (1960-1980), criticizing paradigm, which is based on emancipatory, and finally, post modernism paradigms, which is based on systematic thinking. OR paradigms started in early 50th and the efforts were coordinated with systematic thinking methodologies. Systematic thinking can also be classified into hard and soft ones with different characteristics and Table 2 summarizes the results of our comparison.

Table 2
The summary of comparing soft and hard systematic thinking

Soft systematic thinking	Hard systematic thinking
It tries to learn	It tries to reach goals
It assumes the world is complicated and we may analyze it using systematic techniques.	It assumes the world consists of the systems, which could be analyzed using engineering systems.
The system is capable of providing necessary suggestions for all applications.	It uses different methodologies and techniques.
It does not provide unique solutions and believe the world is under continuous change.	It needs professionals for applications.

According to Ulrich (2003), professional competence in applied disciplines such as OR/MS needs both technical expertise and critically reflective skills. According to Mingers (2001), research results could be richer and more reliable if various research methods, preferably from various (existing) paradigms, were routinely combined together.

6. Different categories of operations research

In this section, we present different paradigms into four categories of hard, interpretation, controversial and post-modern. We have considered different OR techniques and based on the characteristics we grouped them into four paradigms summarized in Table 3 as follows,

Table 3
The summary of OR categorization

Hard Paradigm, optimization based techniques Mathematical programming:	Controversial paradigm, Soft systems methodology	Interpretation paradigm, Soft	Post-modern paradigm
Linear programming, Non-linear programming, Integer programing, Dynamic programming, Stochastic programming, etc.	Systems Intervention Strategy, Interactive planning, Strategic Assumption, Surfacing and Testing, Systems Intervention Strategy, Social System Design	Critical Systems Heuristics, Critical Pluralism, Complementarism	Local Systemic Intervention

7. Conclusion

In this paper, we have discussed different perspectives of paradigms and we have categorized them into four various categories. We have explained that Kuhn's definition on paradigm is more associated with natural incidents and have nothing to do with operations research. Kuhn stated that paradigm were the basis of solving any issues arising in various sciences. Paradigms help scientists find some agreements on their activities while they solve their issues. Paradigm is a set of theoretical assumptions and rules that guide the members of a scientific community. All activities associated with a paradigm setup a specific knowledge, scientists may face various problems, which threaten the

existing paradigm, and whenever scientists are unable to find solution against existing threats, a revolution may happen.

This paper performed a review on the existing literature based on interpretive hermeneutic approach. Based on literature review, the study determined four principles and assumptions for each OR paradigms and a classification of the methods were presented. The results showed that OR had four main paradigms and there were many methods in OR fields to tackle a particular problem where each problem belongs to a particular paradigm. In addition, instead of using a particular method in problem situations, we can implement a combination of methodologies.

References

Blaikie, N. (2007). *Approaches to Social Inquiry*. 2nd ed., London: Polity Press.

Burrell, G., & Morgan G. (1979). *Sociological paradigms and organizational analysis*. London: Heinemman.

Checkland, P.B. (1985). From optimizing to learning: A development of systems thinking for the 1990s. *Journal of the Operational Research Society*, 36(9), 757-767.

Checkland, P.B. (1999). *Systems thinking, systems practice*. New York: Wiley.

Checkland, P.B., & Scholes, J. (1990). *Soft systems methodology in action*. New York: Wiley.

Dando, M.R., & Bennett, P.G. (1981). A Kuhnian Crisis in Management Science?. *Journal of the Operational Research Society*, 32, 91-103.

Eden, C., Jones, S., & Sims, D. (1983). Messing about Problems. Oxford: Pergamon.

Jackson, M.C. (2003). *Systems thinking: holism for managers.* Chichester: Wiley.

Fay, B. (1975). *Social Theory and Political Practice*. London: Allen & Unwin.

Flood, R., & Jackson, M.C. (1991). *Creative Problem Solving: Total systems intervention*. New York: Wiley.

Kuhn, T.S. (1970). *The Structure of Scientific Revolutions*. 2nd ed., Chicago, University of Chicago Press.

Kuhn, T.S. (1996). *The Structure of Scientific Revolution*. The Structure of Scientific Revolutions, 3rd ed. Chicago: University of Chicago Press.

Mingers, J., & Brocklesby, J. (1997). Multimethodology: towards a framework for mixing methodologies. *Omega*, 25(5), 489–509.

Mingers, J. (2001). Combining IS research methods: towards a pluralist methodology. *Information systems research*, 12(3), 240-259.

Munro, I., & Mingers, J. (2002). The use of multimethodology in practice-results of a survey of practitioners. *Journal of the operational research society*, 369-378.

Mingers, J. (2003). A classification of the philosophical assumptions of management science methods. *Journal of the Operational Research Society*, 54(6), 559-570.

Mingers, J., & Rosenhead, J. (2004). Problem structuring methods in action. *European Journal of Operational Research*, 152(3), 530-554.

Mingers, J., & White, L. (2010). A review if the recent contribution of systems thinking to operational research and management science. *European Journal of Operational Research*, 207(3), 1147-1161.

Neuman, L. (2006). *Social Research Methods: Quantitative and Qualitative Approaches*. 3rd ed., London: Allyn and Bacon

Paucar-Caceres, A. (2010). Mapping the changes in management science: A review of "soft" OR/MS. *Omega*, 38, 46-56.

Pinkard, T. (2002). *German Philosophy 1760-1860: The Legacy of Idealism*. Cambridge University Press.

Raitt, R. A. (1979). O.R. and science. *Journal of Operations Research*, 30, 835-836.

Taket, A. R., & White, L. (2000). *Partnership and participation: decision-making in the multiagency setting*. Wiley.

Ulrich, W. (1987). Critical heuristics of social systems design. *European Journal of Operational Research*, *31*(3), 276-283.

Ulrich, W. (2003). Beyond methodology choice: critical systems thinking as critically systemic discourse. *Journal of the Operational Research Society*, *54*(4), 325-342.

Van Manen, M. (1990). *Researching lived experience: Human science for an action sensitive pedagogy*. Suny Press.