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An Evaluation Of Thomas S. Kuhn's Concept Of Paradigm

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Abstract: ***The term 'paradigm' features severally and very prominently in Kuhn's idea of scientific revolution. It seems to be the central concept in his philosophy of science. The basic questions are: What does Kuhn mean by paradigm? What role does it play during normal science and revolutionary science? Are successive scientific paradigms incompatible and incommensurable? What are the strengths and weaknesses of Kuhn's concept of paradigm? This article employs basically analytical method of philosophical investigation to examine Kuhn's concept of paradigm. Kuhn claims that scientific research is guided by paradigm. Scientists pay allegiance to the accepted paradigm during the period of normal science, but question it during the period of revolutionary science. The researcher discovers that Kuhn used the concept of paradigm in many as well as varied senses, and his idea of the concept is rather vague. Furthermore, his concept of paradigm led him into relativism which is a threat to objectivity in scientific investigation. This article also contains a critical assessment of the various criticisms given against Kuhn's concept of paradigm, and thus argues that despite the shortcomings of Kuhn's views, he has made remarkable contributions towards the growth of knowledge both in philosophy of science and in other disciplines. His concept of paradigm revolutionized philosophy of science, and at the same it is a landmark in the history of philosophy of science.***

Keywords: Paradigm, Science and Revolution

I. INTRODUCTION

T. S. Kuhn is a very influential American historian and philosopher of science. He is one of the remarkable and prominent scholars that revolutionized philosophy of science in the contemporary period. Kuhn's ideas gave philosophy of science a new direction. His most notable contribution to philosophy of science is his idea of scientific revolution as well as his concept of paradigm. Bird (2018) articulates similar idea thus:

> Thomas Samuel Kuhn (1922–1996) is one of the most influential philosophers of science of the twentieth century, perhaps the most influential. His 1962 book *The Structure of Scientific Revolutions* is one of the most cited academic books of all time. Kuhn's contribution to the philosophy of science marked not only a break with several key positivist doctrines, but also inaugurated a new style of philosophy of science that brought it closer to the history of science. (para.1)

His idea of scientific revolution is a landmark in the history of philosophy of science; and central to his idea of scientific revolution is the concept of paradigm, which is the major focus of the discourse in this article. In fact, Kuhn has a very unique idea of the term 'paradigm' in philosophy of science. However, his concept of paradigm remains a very controversial issue among philosophers of science. This is as result of the fact that it elicited varied and even conflicting reactions from different philosophers of science. Hence, this article aims at evaluating Kuhn's concept of paradigm. The basic questions are: What does Kuhn mean by paradigm? What role does it play during normal science and revolutionary science? What is the relationship between paradigm and scientific revolution? What is paradigm shift? Are successive scientific paradigms incompatible and incommensurable? What are the strengths and weaknesses of Kuhn's concept of paradigm? These and other related issues are to be given serious attention in this article.

This article is basically partitioned into three sections. The first section examines the background and context of

Kuhn's concept of paradigm. The second section focuses on analyzing Kuhn's concept of paradigm, bringing out very clearly the status of paradigm during normal science and revolutionary science (paradigm shift) as well as the controversy on the acceptance of a new paradigm after scientific revolution. The third section centers on the evaluation and conclusion of the article.

A. THE BACKGROUND/CONTEXT OF KUHN'S CONCEPT OF PARADIGM

Kuhn's concept of paradigm did not just emanate from nowhere or from a vacuum. It arose from a particular background as well as context. In order to appreciate Kuhn's concept of Paradigm, there is need to situate it into its proper context. It ought to be noted that the dominant orientation in philosophy of science, prior to Kuhn's idea of paradigm, was logical positivism or logical empiricism. This could be said to be the pioneer orientation in contemporary philosophy of science. Okasha (2002) notes that the original logical positivists "were a loosely knit group of philosophers and scientists who met in Vienna in the 1920's and early 1930's, under the leadership of Schlick." (p.78) The early members of this group, popularly known as the 'Vienna Circle', were Hans Hahn, Rudolf Carnap, Freidrich Waismann, Karl Menger etc. The logical positivists advanced a lot of controversial claims about science, among which is the claim that science develops in cumulative manner as well as the claim that new scientific theories are objectively better than old ones. Thomas Kuhn reacted against the controversial claims of the logical positivists, and argued consistently that scientific investigation is guided by paradigm. Kuhn maintains that scientific development is marked by revolution which comes after a period of 'normal science'. Obviously, his concept of paradigm, which is the topic of discussion in this article, is closely associated with his idea of scientific revolution. Hence, a good knowledge of Kuhn's idea of scientific revolution is of immense importance in understanding his concept of paradigm.

Kuhn claims that the history of science is marked by a long period of normal science as well as a short period of revolutionary or extraordinary science. Thus, he distinguishes between 'Normal Science' and Revolutionary Science'. Normal science, for Kuhn (1970b), means "research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice."(p.10) It is completely based on the accepted paradigm. Normal science is actually contrasted with revolutionary science or scientific revolution. According to Kuhn (1970b): "Scientific revolution are here taken to be those non-cumulative developmental episodes in which an older paradigm is replaced in whole or in part by an incompatible new one." (p.92) Hence, scientific revolution entails paradigm shift, that is, the replacement of the prevailing paradigm by a new different one. Watkins (1970) agrees with Kuhn that the history of science is marked by both normal and revolutionary sciences. In his words:

> … I shall suppose that the history of science does indeed display a Kuhnian pattern; that is, I shall suppose that a typical cycle consists of a longish period of Normal science, which gives way to a short and hectic bout of extraordinary science, after which a new period of normal science sets in. (p.31)

As was already demonstrated in this article, Normal science is a paradigm based research. In 'Normal Science', for Kuhn, Scientists accept the prevailing paradigm and solve various puzzles with it. However, the activities of the normal scientists may generate anomalies, which may come up when there are puzzles that may not be solved with the theoretical provisions and assumptions of the prevailing paradigm. The accumulation of anomalies as a result of malfunctioning of the accepted paradigm brings about 'crisis' which may eventually result in revolutionary science or scientific revolution. This ushers in a new paradigm for scientific research. Kuhn further argues that two successive paradigms are incompatible. This implies that the new paradigm that emerges after scientific revolution is not an extension of the old one, but is completely different from it. According to Kuhn (1970b) "...the successive transition from one paradigm to another via revolution is the usual developmental pattern of mature science." (p.12) It is obviously clear that Kuhn's idea of scientific revolution implies the replacement of the existing paradigm with an incompatible one. But the basic question is this: 'What actually does Kuhn mean by the term 'Paradigm'? This takes us to the central issue of our enquiry in this article. However, before delving into the analysis of Kuhn's concept of paradigm, it seems to the researcher that it is pertinent to first of all articulate the ordinary or general meaning of the term.

B. ORDINARY OR GENERAL UNDERSTANDING OF 'PARADIGM'

The term 'paradigm' is a commonly used term in contemporary philosophy of science. A proper understanding of the ordinary meaning of the term 'paradigm' would be of great importance in appreciating meaningfully the innovations Thomas Kuhn brought about in the usage of the concept. It was not Thomas Kuhn that coined or invented the term 'paradigm' in general. The term had been in existence prior to Kuhn's philosophy of science. However, Kuhn employed as well as popularized it in the domain of philosophy of science and gave it a specialized meaning. Etymologically, the term 'paradigm' was derived from the Greek word 'para-deigma' which means model, pattern, example, sample, precedent etc. Also, the Latin term 'Paradigma' means example or pattern. Thus, from etymological perspective, paradigm means a model or pattern of something. The understanding of paradigm as a pattern of something is very visible in the domain of Linguistics. Thus, it refers to the 'pattern' that can be used for declining nouns. Latin language offers us a very good example of this. The noun 'Mensa' (table) serves as a pattern for declining nouns of first declension.

A similar understanding of paradigm also exists in the domain of philosophy. Generally, it entails a yardstick or standard of measurement as well as an example of a dominant orientation or perspective. Bell (2013) describes paradigm as a "framework, model or pattern used to formulate generalizations and theories based on shared assumptions, concepts, methods, practices and values that structure

inquiry." (para. 1) Generally, paradigm connotes a 'dominant standard; a pattern or a 'model' of something. It entails an accepted view or approach to something.

From the foregoing, it is obvious that paradigm has varied, but related meanings. Having examined the etymological meaning of paradigm and the various nuances of its meaning, there is then need to look at what it means for Thomas Kuhn in the 'context of his idea of scientific revolution.

II. ANALYSIS OF KUHN'S CONCEPT OF PARADIGM

The term 'paradigm' appeared severally in Thomas Kuhn's philosophy of science. As was earlier stated in this article, Kuhn popularized the concept of paradigm and made it very significant in philosophy of science. It is the key and central concept in Thomas Kuhn's book *The Structure of Scientific Revolutions*. Paradigm, for Kuhn, determines the conceptual world-view of members of a particular scientific community, and it consists of a group of fundamental assumptions that form the shared conceptual framework of the members of a scientific community. Explaining what the term paradigm means, Kuhn (1970b) states:

> On the one hand, it stands for the entire constellation of beliefs, values, techniques and so on shared by the members of a given community. On the other hand, it denotes one sort of element in that constellation, the concrete puzzle-solutions which, employed as models or examples, can replace explicit rules as a basis for the solution of the remaining puzzles of normal science. (p.175)

Thus, the members of a given scientific community make use of a particular paradigm in their scientific investigations. It is very explicit from Kuhn's specification that paradigm has sociological sense, because a paradigm is what the members of a scientific community share in common. They do not question the accepted paradigm in their scientific investigations. The members of a scientific community pay allegiance to the paradigm and conduct their researches within its conceptual and theoretical provisions. The question that readily comes to mind at this juncture is this: What is a scientific community? A scientific community may be said to be a group of scientists who accept and share a particular paradigm or sets of paradigm in their scientific investigations. Hence, it is scientists' "possession of a common paradigm that constitutes a scientific community…" (Kuhn, 1977, p.294) The paradigm enables them "to solve puzzles, and that accounted for their relative unanimity in problem-choice and in the evaluation of problem solutions." (Kuhn, 1970a, p.271) It ought to be noted that professional communication between the members of a scientific community is relatively full, and as such they can understand one another. This is as result of the fact that they share a particular paradigm. This implies that communication between scientists of different communities who pay allegiance to different paradigms often results in misunderstanding and disagreement. This stems from his controversial claims on the incompatibility and incommensurability of different paradigms.

Furthermore, Kuhn (1970b) describes paradigm as "some accepted examples of actual scientific practice-examples which include law, theory, application and instrumentation…"(p.10) These accepted examples serve as models or patterns for scientific research. When judged from this perspective, paradigm could be said to be the generally recognized scientific achievements that provide model problems and solutions to a group of scientists in their scientific investigations.

In the period of normal science, scientists only refine and extend the theories as well as laws of the accepted paradigm, and conduct their researches in the context of its theoretical and conceptual assumptions. But in the period of revolutionary science, the prevailing paradigm undergoes some fundamental theoretical and conceptual changes which may eventually lead to paradigm shift. Two different paradigms, for Kuhn, are quite discontinuous. This is as a result of his claim that the new paradigm that comes up after scientific revolution is not in any way an extension of the old one.

Also, Kuhn (1970b) states that paradigm is "the source of the methods, problem-field and standard of solution accepted by any mature scientific community at any given time."(p.103) The immediate implication of this is that paradigm serves as a method of scientific investigation as well as a criterion for determining the problems and the accepted solutions to the problems which scientists encounter in scientific research. Thus, paradigm defines a particular science and the scientific research of the scientists that accept it. It is from this perspective that Okasha (2002) describes paradigm as "an entire scientific outlook…" (p.81)

One cannot adequately do justice to Kuhn's analysis of paradigm without making reference to what he terms 'disciplinary matrix'. In the actual sense, Kuhn explains paradigm as 'disciplinary matrix'. The terms 'disciplinary' and 'matrix' are of great importance for Kuhn in his concept of paradigm. Hence, paradigm is 'disciplinary' "because it refers to the common possession of the practitioners of a particular discipline" (Kuhn, 1970b, p.182), and it is a 'matrix' "because it is composed of ordered elements of various sorts, each requiring further specification" (Kuhn, 1970b, p.182). In some places, Kuhn used the terms 'paradigm' and disciplinary matrix' interchangeably. It ought to be noted that a paradigm or disciplinary matrix has some components, viz: (i) Shared symbolic generalizations (ii) Shared models (iii) Shared values and (iv) Shared exampler or examples. Kuhn refers to these examplers of good science as 'paradigms' in a narrow sense. In the later part of his article 'Reflection on My Critics', Kuhn identified paradigm with 'examplers'. Thus, he cites 'Aristotle's analysis of motion, Ptolemy's computations of planetary position, etc as examples of paradigms. Obviously, they are instances of exemplary scientific research. Okasha (2002) analyzes Kuhn's concept of paradigm thus:

> A paradigm consists of two main components: firstly, a set of fundamental theoretical assumptions that all members of a scientific community accept at a given time; secondly, a set of 'examplers' or particular scientific problems that have been solved by means of those theoretical assumptions and that appear in the textbooks of the discipline in question... When scientists share a paradigm they do not just agree on certain scientific

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> propositions, they also agree on how future scientific research in their field should proceed, on which problems are the pertinent ones to tackle, on what the appropriate methods for solving those problems are, on what an acceptable solution of the problems would look like, and so on. (p.81)

Kuhn's concept of paradigm in philosophy of science is quite controversial. This is as a result of the conflicting reactions it elicited from different philosophers of science. It ought to be noted that Karl Popper's usage of the term 'paradigm' is slightly different from that of Thomas Kuhn. For Popper (1970), paradigm "indicates not a dominant theory, but rather a research programme - a mode of explanation which is considered so satisfactory by some scientists that they demand its general acceptance. (p.55). However, Kuhn insists that paradigm guides scientific research in the course of normal science. It becomes necessary to examine at this juncture the role of paradigm during the period of normal science, and subsequently the issue of paradigm shift.

A. PARADIGM AND NORMAL SCIENTIFIC RESEARCH

During the period of normal scientific research, scientists accept completely the prevailing paradigm, and try to articulate and refine its theories as well laws. They do not in any way question the paradigm. Hence, scientists conduct their research within the conceptual framework and theoretical assumptions of the accepted paradigm. From the foregoing, it is obvious that paradigm is very important in normal scientific research, and it is quite inevitable. Thus, normal science consists in experimentations undertaken by the scientists in order to articulate the prevailing paradigm, and use it to make predictions. It also extends the knowledge of those facts that the paradigm propagates. In the words of Kuhn (1970b):

> Normal science consists in the actualization of that promise, an actualization achieved by extending the knowledge of those facts that the paradigm displays as particularly revealing, by increasing the extent of the match between those facts and the paradigm's predictions, and by further articulation of the paradigm itself. (p.24)

It seems to the researcher that every scholarly and detailed analysis of Kuhn's concept of normal science or paradigm-based research ought to include the issue of 'puzzle-solving' in such analysis. Normal science consists in solving puzzles within the conceptual framework of the accepted paradigm. Puzzle, in this context, refers to the problems that are necessary for testing the ingenuity of scientists. Ability to solve puzzles is the essence of normal scientific research. Paradigm sets up problems for scientists to solve in order to further expand the paradigm, and at same time the puzzles ought to be solved within the provisions of the paradigm. It becomes clear that normal science does not aim at inventing new theories, but rather tries to refine the accepted paradigm. According to Kuhn (1970b):

> No part of the aim of normal science is to call forth new sorts of phenomena; indeed those that will not fit the box are often not seen at all. Nor do scientists normally aim to invent new theories, and they are often intolerant of those invented by others. Instead, normal-scientific research is directed to the articulation of those phenomena and theories that the paradigm already supplies. (p.24)

It could be said that the activities of the scientists are restricted during normal science, since they work only within the provisions of a given paradigm and do not aim at novelties. The basic questions are: Is such restriction during the period of normal science beneficial to scientific progress? Does the restriction lead to dogmatism in scientific research? If scientists restrict themselves to the accepted paradigm, and do not aim at novelties, how then can science grow? In response to these questions, Kuhn argued that such restriction is essential to the development of science, because it enables the scientists to focus attention on a small range of hidden problems and also investigate some aspects of nature in greater detail. Hence, it gives room for specialization. However, the restriction does not last forever. It disappears whenever the paradigm ceases to function effectively.

Though normal scientific research is not directed to novelties, Kuhn acknowledges that it can be effective in causing novelties. Hence, it can give rise to revolutionary science. Obviously, Kuhn's claims on this issue are very controversial. This explains why Watkins (1970) argues that "Normal science cannot have the character Kuhn ascribes to it, if it is to be capable of giving rise to Extraordinary (or Revolutionary) science" (p.31). However, Kuhn insists on the possibility of normal science being effective in causing extra-ordinary science or revolutionary science. This revolves around the issue of paradigm shift, and what actually necessitates such shift. Paradigm shift is very central to Kuhn's idea of scientific revolution.

B. KUHN'S ANALYSIS OF PARADIGM SHIFT

The concept of paradigm shift is very popular in philosophy of science and other disciplines as a result of Kuhn's idea and influence. Paradigm shift, for Kuhn, means a change from an old paradigm to a new and incompatible one, that is, when the existing paradigm is overthrown by a new and different one (eg. from Ptolemaic astronomy to Copernican astronomy). This is the essence of what Kuhn calls Scientific Revolution. He further argues that successive paradigms are quite incommensurable. Paradigm shift entails change in the conceptual worldview of scientists and change in their perception of their environment. This change is as a result of the fact that the prevailing paradigm has been completely overthrown by a new and different one. The pertinent question is this; how can paradigm shift come about since scientists in normal science concentrate on puzzle-solving within the conceptual framework of the prevailing paradigm, and do not question or test the existing paradigm? In response to this, Kuhn argues that in the course of normal scientific research, scientists may come across puzzles that cannot be solved using the existing paradigm. Kuhn called this type of observation 'anomaly'. Elaborating on this, Kuhn (1970b) states:

> Discovery commences with the awareness of anomaly, i.e., with the recognition that nature has somehow violated the paradigm-induced expectations that govern normal science. It then continues a more or less extended exploration of the area of anomaly. (pp. 52-53)

It becomes obvious that anomalies are phenomena or puzzles that are irreconcilable with the theoretical assumptions of the accepted paradigm. Kuhn (1965) further argues that at times "an anomaly will clearly call into question explicit and fundamental generalizations of the paradigm…" (p.84) Hence, discovery of anomalies is basic in the process of paradigm shift. Accumulation of anomalies triggers a 'crisis' in a particular scientific community. At this point of crisis, the accepted paradigm is called to question. Such 'crisis' may be resolved by the normal scientific research or may eventually be resolved by a revolution in which the old paradigm is replaced by new and incompatible one. The latter option is central to Kuhn's idea of paradigm shift. This marks the beginning of a period of what Kuhn calls 'revolutionary science'. As it is obvious from Kuhn's specification, 'crisis' is a necessary precondition for the emergence of new paradigm because it loosens the rules of normal science in ways that allow a different paradigm to emerge. Though crisis is a pre-requisite for the emergence of new paradigm, Kuhn argues that not all crises result in paradigm shift. For him, 'crisis' can end in any of the following three ways:

> Sometimes normal science ultimately proves able to handle the crisis - provoking problem despite the despair of those who have seen it as the end of an existing paradigm. On other occasions the problems resist even apparently radical new approaches. The problem is labeled and set aside for a future generation with more developed tools. Or finally…a crisis may end with the emergence of a new candidate for paradigm and with the ensuing battle over its acceptance (Kuhn,1970b, p.84)

Granted the fact that 'crisis' can end in any of the three ways as specified by Kuhn, the interest of the researcher in this article is on the third option in which the crisis ends with the emergence of a new paradigm. On this, Kuhn further argues that the transition from a paradigm in crisis to a new one is not a cumulative process. Rather, it involves a total reconstruction that changes the field's fundamental theoretical assumptions and methods. For him, science progresses through revolutions, and the essence of this revolution is paradigm shift in which the old paradigm is replaced by a new and incompatible one.

C. CONTROVERSY ON THE ACCEPTANCE OF NEW PARADIGM AFTER SCIENTIFIC REVOLUTION

The new scientific paradigm that emerges after scientific revolution is quite not easily accepted by the scientific community. There are a lot of controversies surrounding such acceptance. Traditionally, it was assumed in philosophy of science "that when scientists trade their existing theory for a new one, they do so on the basis of objective evidence" (Okasha, 2002, p.83). Actually, this is the argument of the logical positivists. Against this view, Kuhn (1970b) argues consistently that "the transfer of allegiance from paradigm to paradigm is a conversion experience that cannot be forced" (p.151) and even claimed that adopting a new paradigm involves a certain act of faith on the part of the scientists. Certainly, he acknowledges that a scientist could have good reasons for abandoning an old paradigm for a new one, but insists that logic (reasons) and experiment alone could not compel a paradigm shift. He further argues that persuasion is necessary in compelling a paradigm shift, and in the paradigm debate, scientists try to 'convert' the others to their mode of conceiving their science. Hence, Kuhn insists that sociological and historical factors play prominent role in paradigm choice.

Kuhn's claims were criticized by many philosophers of science. Many critics like Karl Popper, Stephen Toulmin etc argued that if paradigm shift works the way Kuhn explained, it will succeed in making science an irrational activity. This is as a result of the fact that Kuhn brought in subjective factors in paradigm choice. A more detailed attention would be given to this in later part of this article.

D. INCOMMENSURABILITY OF SUCCESSIVE OR RIVAL PARADIGMS

Kuhn argues that competing paradigms are both incompatible and incommensurable. Incompatibility of paradigms implies that they are totally different from each other. In the words of Kuhn (1970b):

> Let us, therefore, now take it for granted that the differences between successive paradigms are both necessary and irreconcilable. Can we then say more explicitly what sorts of differences these are?...Successive paradigms tell us different things about the population of the universe and about that population's behavior.(p.103)

On its part, incommensurability entails that the theories of rival paradigms are so different that it renders very difficult any direct comparism between them. Kuhn argues that two different paradigms have different conceptual world views, because every new paradigm necessitates a redefinition of the corresponding science. Hence, the theories of rival paradigms are incommensurable. According to Kuhn (1970b):

> To the extent, as significant as it is incomplete, that two scientific schools disagree about what is a problem and what a solution, they will inevitably talk through each other when debating the relative merits of their respective paradigms. In the partially circular arguments that regularly result, each paradigm will be shown to satisfy more or less the criteria that it dictates for itself and to fall short of a few of those dictated by its opponent. (pp. 109-110)

Hence, he denies the existence of any common framework or common language for comparing and evaluating two different paradigms. Besides, in the transition from one paradigm to another, words change their meanings, and this renders any direct comparism between the theories of successive paradigms very difficult. Elaborating on this, Kuhn (1970a) states:

> The point-by-point comparison of two successive theories demands a language into which at least the empirical consequences of both can be translated without loss or change... Philosophers have now abandoned hope of achieving any such ideal, but many of them continue to assume that theories can be compared by recourse to a basic vocabulary consisting entirely of words which are attracted to nature in ways that are unproblematic and, to the extent, independent of theory... Feyerabend and I have argued at length that no such vocabulary is available. In the transition from one theory to the next, words change

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their meanings or conditions of applicability in subtle ways. (p.266)

The implication of Kuhn's claim is that the new paradigm that emerges after revolutionary science cannot be proven or disproven by the theories of the old paradigm and vice versa. Thus, each scientific paradigm has completely different scientific world-view, and the scientists subscribing to different paradigms may not completely understand each other when debating on the merits of their respective paradigms. As a result of this, there can be no 'full' but rather 'partial' communication between the proponents of different paradigms, and there is no neutral set of observations or experiments that could help scientists determine which paradigm is better than the other. Scientists subscribing to different paradigms speak different languages. Thus, incommensurability implies that there is no neutral language for different scientific paradigms. In the words of Kuhn (2000):

> Applied to a pair of theories in the same historical line, the term meant that there was no common language into which both could be fully translated. Some statements constitutive of the older theory could not be stated in any language adequate to express its successor, and vice versa. (p.60)

This is as a result of the fact that paradigm shift alters the way terminology is defined as well as how the scientists in a particular community view their subject. All these render direct comparism of different paradigms very difficult. Obviously, Kuhn's theory of incommensurability of successive paradigms was an offshoot of his conviction that a 'scientific concept' means different things in different paradigms, and can only be explained within the context of its paradigm. Incommensurability thesis renders objective comparism of different paradigms and 'paradigm choice' very difficult. Furthermore, it questions the issue of objective truth. Thus, truth in science becomes paradigm-relative. What may be true in one paradigm may not be true in another paradigm. This becomes a very big threat to scientific objectivity.

III. EVALUATION

This article has actually analyzed Kuhn's concept of paradigm in the context of his idea of scientific revolution. In the course of the discourse, concerted effort was made to examine what paradigm means for Kuhn, its role during the periods of normal science and revolutionary science, paradigm shift as well as Kuhn's idea of the incompatibility and incommensurability of successive scientific paradigms. Though Kuhn made remarkable contributions toward the understanding of what paradigm is all about in scientific investigations, some of his claims are very controversial, and have been subjected to severe criticisms. Kuhn's most influential book *The structure of scientific Revolutions* was criticized by many philosophers of science. As was earlier stated in this article, the concept of paradigm seems to be the central issue in the afore-mentioned book. As a result of the controversial nature of Kuhn's ideas on paradigm, a special symposium on Kuhn's *The Structure of Scientific Revolutions* was held at an international colloquium on philosophy of science that took place at Bedford College London under the leadership of Karl Popper. Most criticisms given against Kuhn's concept of paradigm revolve around the broadness and vagueness of his concept of paradigm. Masterman (1970) identified not less than twenty-one different senses in which Kuhn used the term paradigm, and noted that Kuhn, with "quasi-poetic style of his, makes paradigm-elucidation genuinely difficult for the superficial reader."(p.61) This goes a long way to disclosing lack of definiteness in Kuhn's usage of the term 'paradigm'. Hence, it could be argued that Kuhn's definition of paradigm is imprecise because of the vagueness that surrounds it as well as its wide range of application. It seems to the researcher that Masterman is quite right in her observations because Kuhn used the concept in various senses. The researcher subscribes to the view that Kuhn's concept of paradigm is very broad and vague. This is as a result of the fact that Kuhn's concept of paradigm is surrounded with many ambiguities to the extent that one wonders what exactly Kuhn means by the term. Besides, he used the term in many and often conflicting senses. Obviously, this leaves much to be desired.

Kuhn was also accused of making science an 'irrational activity'. This was as a result of his claim on the controversy surrounding the acceptance of a new paradigm after revolutionary science. Obviously, Kuhn acknowledges that a scientist could have good reasons for abandoning an old paradigm for a new one, but he insists that reasons alone could not compel a paradigm shift. Hence, he argues that 'persuasion', 'faith' as well as 'peer pressure' influence of scientists are necessary in the struggle for the acceptance of new paradigm after revolution. He even went to the extent of describing such process as a 'conversion experience'. Some philosophers of science like Karl Popper and S. Toulmin argue that Kuhn, by such claim, has succeeded in making science an irrational activity. Karl Popper insists on rational and critical evaluation of the theories of two different paradigms in order to make a rational choice. According to Popper (1970):

> I admit that an intellectual revolution often looks like a religious conversion… But this does not mean that we cannot evaluate, critically and rationally, our former views, in the light of new ones... It would thus be simply false to say that the transition from Newton's theory of gravity to Einstein's is an irrational leap, and that the two are not rationally comparable... (p.57)

Popper argues consistently that critical and rational discussions between proponents of different paradigms are quite possible. In agreement with Karl Popper, Stephen Toulmin was also not comfortable with Kuhn's claims on this issue. Hence, he states:

> ...but we must beware of going all the way with Kuhn's original revolutionary hypothesis. For the displacement of one system of concepts by another is itself something that happens for perfectly good reasons, even though these particular 'reasons' cannot themselves be formalized into still broader concepts, or still more general axioms.(Toulmin, 1970, p.44)

Many other critics also pointed out this issue of 'irrationality' in Kuhn's idea, and insisted that rational comparisons and choice are always possible between competing paradigms. It ought to be noted that some of the

critics seemed to have misinterpreted Kuhn's idea. This explains why in his article 'Reflections on My Critics', Kuhn (1970a) states "...l have not previously and do not now understand quite what my critics mean when they employ terms like 'irrational' and 'irrationality' to characterize my views."(p.263) Thus, he argues that he never identified the adoption of new paradigm with an intuitive or mystical affair. It seems to the researcher that Kuhn never made science an irrational activity as some critics argued, but was only trying to identify the factors that could hasten the transfer of allegiance to a new paradigm. Besides, Kuhn did not ignore completely the influence of good reasons in compelling paradigm shift. Though he argued that good reasons are not enough in the debate over the acceptance of new paradigm, he did not neglect the role of reason entirely as some critics noted. In the words of Okasha (2002):

> But Kuhn himself was unhappy with this interpretation of his work. In a Postscript to the second edition of *The Structure of Scientific Revolutions* published in 1970, and in subsequent writings, Kuhn moderated his tones considerably – and accused some of his early readers of having misread his intentions. His book was not an attempt to cast doubt on the rationality of science, he argued, but rather to offer a more realistic, historically accurate picture of how science actually develops…He was not trying to show that science was irrational, but rather to provide a better account of what scientific rationality involves. (pp. 90-91)

Be that as it may, Kuhn's idea of paradigm choice as well as paradigm shift seems irreconcilable with the logical positivists' image of science as an objective and rational activity.

The most controversial aspect of Kuhn's concept of paradigm is his claim on the incommensurability of successive or competing paradigms. By denying the existence of any common standard or language for evaluating the theories of different paradigms, Kuhn landed into relativism. Hence, everything in science becomes paradigm-relative. From this perspective, truth in science is paradigm relative. This implies that what may be true in one paradigm may be false in another paradigm. Such relativism renders objective choice between rival paradigms very difficult. Obviously, Kuhn's insistence that there is no common standard or language for evaluating the theories of different Paradigms made Karl Popper and some other philosophers of science as well as the researcher to label Kuhn a 'relativist". Certainly, his relativism is a threat to scientific objectivity.

Furthermore, the researcher is not completely comfortable with Kuhn's claim that paradigm shift as well as scientific development is always discontinuous. It seems that such shift can both be continuous and discontinuous at different periods. It can build on the previous one and also can be destructive of the previous one. Kuhn's insistence that paradigm shift can only involve total abandonment or destruction of the previous paradigm leaves much to be desired.

A. CONCLUSION

Serious attention has been given to Kuhn's concept of paradigm in his idea of scientific revolution in this article. It is very obvious that Kuhn's claims were subjected to severe criticisms. This is not out of place because it is difficult to see any philosophical claim that has not been criticized in one way or the other. It ought to be noted that despite the shortcomings of Kuhn's ideas, he has made great contributions towards the growth of knowledge in philosophy of science. Kuhn popularized the usage of the term 'paradigm' in philosophy of science. With him, the term 'paradigm' becomes very significant even in social sciences. Actually, he made it part of the general intellectual discourse. It is now very fashionable to talk about paradigm as well as paradigm shift in scientific research.

Kuhn's concept of paradigm highlights the historical context of scientific investigation. This is as a result of the fact that Kuhn is a historically-minded philosopher of science. Prior to Kuhn, much attention was not paid to the historical context of scientific investigation, but he emphasized the importance of history in scientific research. This explains Watkins (1970) states that "Kuhn enjoys a unique position in the English speaking world as a philosophically-minded historian and historically-minded philosopher of science" (p.25) Due to Kuhn's influence, many contemporary philosophers of science now take the historical context of scientific research very seriously.

Furthermore, Kuhn's concept of paradigm called attention to the social context in which scientists function. This is as a result of the fact that he emphasized the existence of a scientific community that pay allegiance to a given paradigm. During the period of normal science, scientists conduct their research within the conceptual and theoretical provisions of the accepted paradigm. It becomes obvious from Kuhn's specification that scientists do not work in isolation, but rather work in social context under the guidance of a particular paradigm.

Indisputably, Thomas Kuhn made immense contributions towards the growth of knowledge in philosophy of science through his analysis of the concept of paradigm. In fact, he revolutionized philosophy of science. His unique idea on the concept of paradigm could be said to be a landmark in the development of philosophy of science.

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