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Application of postmodern strategy in researching search processes of knowledge production and innovation

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ABSTRACT

This paper aimed at bridging a literature gap in the application of postmodern research methods in investigating research processes. Having carried out a focused literature review on postmodern methodology as well as search processes of knowledge production and innovation, a model of application of postmodern methods and procedures to the study of research activities at individual level of analysis was developed. The paper, sought answers to key research questions of: what are the major areas of research interest in scientific research process? Where and how can the eclectic postmodern methodological canons and procedures be applied in researching the search process of knowledge production?

KEYWORDS: Search process, postmodernism, methodology, knowledge, production

1. INTRODUCTION

Research interest in issues of search processes of knowledge production and innovation is gaining greater attention within the scientific community as the body of knowledge available in literature is increasing by the day. Interest in this field includes the search by organizations for information to generate potential alternatives in their quest to innovate (Rosenkopf and Nerkar, 2001), and solve problems and reduce organizational performance gaps (Huber, 1991; March, 1991). Others include interests on search context, depth and scope of search including search at the organizational level. At this level, research interests have generally tended to center on issues of organization of research and science, research policy, practices, governance and scientific knowledge production, systems wide research and knowledge spillovers/diffusion, measuring scientific output and patenting scientific knowledge. However, very limited attention appears to be given in literature ‘’to the actual search processes and the underlying routines that organizations or individual organization members use to search’’ (Maggittia, et al. 2013:91). Greater part of literature on this topic focused almost entirely at organizational analysis of search process using quantitative methods, and very few at the individual level of analysis employing qualitative methods. In this context, Maggittia, et al. (2013:91) argued that ‘’while there exists a conceptual literature on search process, we are unaware of other empirical attempts to inductively model the search process’’. Consequently, in a context where most studies employed quantitative methods, it is evident that more innovative approach in studying the field is needed. Since the use of qualitative methods appears to be either lacking or limited in core areas of the search process, and considering the relevant contributions of positivist approach, mixed methods strategies seem warranted for the study of research related behaviors at the individual level of the researcher. In this context, this study examined the importance of postmodern methodological canons and procedures in researching the search process, and proposed a model of application of postmodern strategy in specific area of process based research field. Hence at the conceptual level, this paper further bridges the gap in literature providing useful guides for researchers as well as the impetus for future studies on methodological implications for study of search processes of knowledge production and invention.

2. METHODOLOGY

Drawing its strength from detailed review of literature, this study approach is essentially conceptual. A conceptual model of application of postmodern methodological principles and procedures is developed, which embodies key elements of mixed methods research suggested by Creswell (2007). The model indicates possible benefits and the specific areas in the search process where its application can possibly maximize results

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3. LITERATURE REVIEW OF SEARCH PROCESSES AND AREAS CURRENTLY ATTRACTING RESEARCH INTERESTS

Universities and research institutions as centers of knowledge production, have unique features, which include engagement with human resources development, intellectual property, spin offs, contract with industry and public agencies, participation in policy making, engagement in social and cultural life and public understanding of science. These institutions are influenced by historical conditions and their contexts and the functions, which they are able to perform, namely mass tertiary education, professional specialized higher education and research and academic training and research (Larédo, (2007). The milieu in which they operate, have meant that the study of research process must necessarily make use of the theoretical assumptions and framework of the system or stakeholder approach. It must also necessarily draw insights from the ecology approach to knowledge production to inform and justify the data collection design directed at considering data inputs from all relevant stakeholder sources.

Moreover, literature on research organization and governance is wide and diverse. However, recent empirical discussions on research governance focused mainly on structures of research teams, their responsibilities, and communication structures including intra- and inter-group collaborations. Another related concern in literature is on how collaborations affect the research output of research organizations. While research laboratories are the most complex and dynamic institutions (Crow and Bozeman, 1998), studies of research institutions in France, Germany, Italy, United States and United Kingdom show increasing interest in analyzing research productivity determinants (David, et al, 1999). Some studies have tended to analyze the link between size and research output (Marts, et al, 1993; Johnes and Johnes, 1993; Von Tuzelmann, et al, 2003) and most of them focused on returns to scale of production. On the other hand, Hicks and Skea, (1989) argued that while significant relationship may be found between size and output, characteristics that are not linked to size can explain scientific output. However, recent studies have focused on identifying determinants and hampering factors of the scientific output of researchers. In their study of French and Italian cases, Lissoni et al (2009) proved that factors like the size and the nature of projects, authors' age and gender (Horta, 2010) tend to influence scientific output. (Bresch et al. 2005; Van Looye et al. 2006; Stepha, et al. 2007) identified patenting activities as one of the determinants and factors hampering scientific output. Moreover, Carayol and Matt (2004:1100) analyzed the influence of research organization and academic production at Luis Pasteur University in France and found a significant but negative coefficient for size variable, suggesting that smaller laboratories are more productive and insisting that ''labs have different organizations, which influence their scientific performance''. Bonaccorsi and Daraio (2005) argued that ''size of laboratories is never positively related to productivity'' while Turner and Mairesse (2005) pointed out that the influence of size of laboratory on individual production (in number and quality) is significant but small. (Horta and Lacy, 2011) discussed the impact of research unit size on academics' scientific output and communication behavior, suggesting that larger units increase overall academics' communication with peers. The authors combined both individual and organizational determinants that affect research at the individual level. However, some studies looked for determinants of scientific productivity at the individual level (Gonzalez-Brambilla and Veloso, 2007; Von Tunzelmann *et al*., 2003; Long and McGinnis, 1981), others at the organizational/university level (Valadkhani and Ville, 2009) and laboratory levels (Carayol and Matt, 2004).

A budding literature on research governance and knowledge production suggests that hiring external researchers into existing environments is important for the ability of organizations to generate and access new knowledge. In this context, Song et al. (2003) demonstrated that researcher mobility is more likely to result in inter firm knowledge transfer. On the other hand, Lacetera et al (2004) suggested that hiring star scientists could reshape the direction of research organizations. Looking at academic inbreeding helps reflect on what may happen to practices and outcomes of scientists that never change their research environment, as compared to those that are mobile (Horter et al., 2007). The authors argued that collaboration and scholarly exchanges in the form exchange programs could increase rather

than slow the growth of externally leaned knowledge or new approaches to the generation of knowledge. Openness and collaboration are critical in the present day research environment (Adams et al. 2005). Research requires collaboration with colleagues outside the institution to maximize resources, achieve critical mass or find complementary skills (Thornsteinsdottir, 2000), which have become ever more relevant in the last decades (Adams et al., 2005).

Some studies have described research collaboration as a research behaviour, or communication behaviour, which is important in knowledge generation process. ‘’Communication between researchers is considered an integral part of research organization… and for this reason, one may expect the amount of communication to be related to research output: by improving the overall organization of work and by facilitating coordination of tasks’’ (Vasileiadou and Vliegenthart, 2009:1261; Chompalov and Shrum, 2002; Shinn, 1982). However, today’s research environment appears to be changing increasingly towards collaborative research in all formats, especially bottom-up collaborative efforts (Sonnemwald, 2007; Shrum, et al., 2007) as well as institutionally instigated collaborations (Beaver, 2001). Investigating collaborations in the field of physics, Shrum et al. (2007:119) defined technology as ‘’the set of instruments and practices that researchers employ in the acquisition and manipulation of information”, and suggested that technology conditions the degree of interdependence in collaboration. But Hackett, (2005) observed that the social organization of collaboration has changed, as the traditional research groups are being complemented by episodic working groups, with contractual agreements between organizations, international collaborations, and interactions between scientists and non-scientists. Research collaboration may be useful for exchange of information and for substantive discussions including coordination of tasks among group/team members. Hara et al., (2003) drew a distinction between integrative and complementary collaborations. The authors argued that this distinction is based on the degree of interdependence between collaborators, which conditions the dynamics of research collaboration. In complementary collaboration, there is less need for intra-team communication and less need to work closely together as each partner is responsible for one stage of work. Integrative collaboration would involve allocation of non-specialized tasks to group members, with all partners involved in all stages of the research project and a high degree of interdependence among them. The link between the amount of communication and productivity in research collaboration would depend on the degree of interdependence between partners involved in a research project. Consequently, in integrative collaboration, where partners are all involved in all stages of work and so more interdependent, the link between communication and research productivity tend to be stronger than in complementary collaboration where collaboration appears to be less interdependent (Vasileiadou and Vliegenthart, 2009). However, in their study of the effects of co-authorship networks on scientific output, (Abbasi et al, 2012) added to literature showing that scholars with more co-authors and those who exhibit higher levels of ‘betweenness’ centrality (i.e., the extent to which a co-author is between another pair of co-authors) perform better in terms of research (i.e., higher g-index). Furthermore, the authors argued that scholars with efficient collaboration networks who maintain a strong co-authorship relationship with one primary co-author within a group of linked co-authors (i.e., co-authors that have joint publications) perform better. Social networks play a critical role in determining the way individuals and organizations resolve their problems and succeed in achieving their goals (Abbasi and Altmann 2011). Social networks in research can help in understanding how professionals share information, and generate and share knowledge. In addition, Ozor, (2013) argued that research related behaviours are multi dimensional and, apart from communication behaviour, other research related behaviours/practices (e.g. publication behaviour funding, choices about research priorities), could have profound impact on research performance. The scientist’s communication behaviour conditions and exerts moderating influence on other research related activities.

Another area of concern in literature is knowledge diffusion or spill over. According to (Aghion and Howitt, 1992; Grossman and Helpman, 1991; and Romer, 1986, 1990)**,** the research and development sector of a nation’s economy and knowledge spillovers within the sector have implications for long-term economic growth. For this reason, it would appear that quantifying the extent and impact of knowledge spillovers might be a key factor in designing an appropriate national science and technology policy. Knowledge spillovers describe increases (or additions) to 'knowledge poll' of a firm, which arise essentially from the theoretical assumption that knowledge has a public good character by virtue of its non-rivalry in consumption and non-appropriability of research returns. It further describes the transfer (or diffusion) of knowledge, which may occur through a variety of channels ranging from direct formal or informal exchanges, collaborative research, and network of inventors to scientific journal publications. Also found in literature are issues about measuring research output, which is usually defined in science literature for specific purposes of a study. The definition may compare the performance of research units or the ranking of universities or even of fields of sciences. Research output measurements are sometimes based on bibliometric indicators or proxies and in some cases on impact factors. Nevertheless, there is a persisting problem. Since reducing the complexity to a single number provides the basis for ranking, the weighting of different dimensions remains a problem in comparison. Leydesdorff, (2008) observed that clearly defined impact factors, though often for other purposes can vary in the order of magnitude between for instance mathematics and the life sciences. Rankings based on quantitative measures present a problem. It is not always easy to compare universities accurately because

the rate of publications and citations among fields of sciences differ significantly (Collins, 1985). In this context, Leydesdorff, (2008) observed that it is also not easy to decompose fields of science because journal sets often overlap. Consequently, technical problem that might heavily influence rankings surround field-normalization. The problem of developing balanced research output measures would arise from the fact that research institutions and universities often develop unique agendas and profiles (Enders, 2001). Jansen et al. (2007) identified four types of research units with distinct research output-profiles. These are research units specializing in certain activities and which focus on specific output bundles. Examples are units that publish many papers, those that write not as many but highly cited papers, units that engage in graduate teaching, and those that are concerned with transfer activities such as cooperation with companies or memberships in scientific advisory boards. It follows that some universities may emphasize graduate teaching while de-emphasizing publications. Others may pay greater attention to knowledge or technology transfer to companies. Schubert, (2009:1229) suggested that these unique output bundles might ''provide some indication [about] which output indicators should be included in order to measure output...However, the balanced scheme may not provide the only reasonable output definition''. Also found in literature is a wide range of research output indicators, which includes bibliographic measures such as publications, citations, conference articles, intentional job offers and co-authored publications. Other output measures often used in literature deal with knowledge transfer. These are such measures as intellectual/technical advisory services for firms, research cooperation with companies, and professional membership in advisory boards. The number of doctoral titles, editorships and scholarships/fellowships are yet other research output measures that relate to the task of education and qualification. In the matter of measurement of research output and ranking of universities, it is evident that there are several dimensions of, and complexity to, output indicators. However, ranking is based on reducing this complexity to a single number considered a balanced scheme, which seemingly represents straightforward indicators. Nevertheless, the fact remains that one-dimensional ranking based on a specific output cluster-bundle (e.g. knowledge transfer, publications and citations, for instance) is inadequate. For the same reason, institutional bias and programmatic preferences compound the question of funding decisions based on similar measures (Wenneras and Wold, 1997; Bornmann and Daniel, 2006). Besides, consideration of efficiency in terms of research productivity could raise questions about publications and citation per dollar. In this context, Dosi *et al*. (2006) suggested that European universities might be more efficient than American ones because of the huge differences in their budgets. Narin, (1995) further observed that evaluation of industrial research at many different levels of aggregation could rely on patent indicators. Such levels might include the level of applications to look at industrial research capability from a national or regional viewpoint comparing (for example, EU regional technology with that of Japan and North America). Another is the strategic level of applications. In this context, patent indicators could become standards for looking at industrial research from a company viewpoint. For example, CHI Research, Inc. used them to compare auto-company research output, company-by-company and technology-by-technology.

What then is the solution to these definitional and measurement problems of research output and ranking of research units and universities? For a solution, Schubert (2009) suggested the development of a balanced scheme or balanced output set defined as a set of output indicators consisting of the dimensions in the three sets of output bundles categorized as bibliographic indicators, knowledge transfer and tasks of education and qualification. The definition gives no special weight to any of the bundles. On the other hand, Leydesdorff, (2008) argued that since systems of scientific communication and technological innovation provide us with rich domains for studying the dynamics of science, technology, and innovation (Moed *et al*., 2004), one could measure, model and simulate the communication of knowledge. However, one needs models from non-linear dynamics because knowledge transfer is not linear. Considered as a meaning, knowledge makes a difference and potentially reduces uncertainty (Leydesdorff, 2006). Leydesdorff, (2008) further identified measurement tools for variables, which are used outside the context of analytical perspectives when legitimating research allocation decisions. By this the author implies that researchers can develop research output measures in a context consisting of peoples and institutions (*sociology of science*), content and theories (*philosophy of science and artificial intelligence*), and texts and journals (*scientometrics*). Apparently, these issues and concerns raised in literature have significant implications for research methods and data design. They underscore the relevance of context of research process as well as the fact that research takes place in varying though unique social contexts. In this context, the works of Schubert, (2009) and Leišytė, (2007) highlighted the methodological issue of achieving a broad and balanced output measure. Moreover, providing vital information on data design, Leydesdorff, (2006, 2008) and Moed et al., (2004) pointed to the intellectual caution needed in attempting to identify and use indicators to 'flag problems of organizations'. Such caution is necessary in attempting to categorize organization processes and, in research assessment exercises, to make deliberate distinction between the purposes of categorization of output measures. There is need for caution in making a distinction between improving the quality of people and their research and development and the citation impact of published output (Lawrence, 2007). Associated with these concerns is the suggestion to place the definition and measurement of

research output in the context of sociology of science, philosophy of science, and scientometrics outside of analytical perspectives (Leydesdorff, 2008).

The preceding review of literature highlighted important areas of research interest in the field. It is evident that core domain of concern in the study of research process include issues of organization of research and science, research policy, research practices and governance and, systems wide research and knowledge spillovers/diffusion, measuring scientific output and patenting scientific knowledge. A core area in this field appears to be the actual routines and processes involved in the search for new knowledge and invention, which are often complex and spanning over a relative long period of time. An invention could in fact take as long as a decade. In addition, research situation vary from one research institution to another while research behaviors are acted out within varying though unique social contexts. Postmodern, mixed methods strategies appear most suitable for the areas that are essentially process based. Hence in this context, it would appear that such process based search areas involve 'human interactions in specific settings/contexts' including interactions with structures of governance, relationships, communications, roles, and responsibilities of research actors. Examples of areas that fit into this description include research practices/behaviors, research governance, interactions with institutional condition for conduct of research and a host of other determinants of research performance, as well as research organization and policy. In addition, another justification is that evidence from review of existing research and science policy literature suggests that most studies focused on analysis of search processes at the organizational level employing quantitative methods (Werfel and Jaffe, 2013; Roessner, et al. 2013), while there is a relative death of studies at the individual level of the scientist (Maggittia et al. 2013). Very few studies on the topic employed qualitative methodologies. For these reasons, the study of search processes of knowledge production demands rather more innovative methodological approach, which focuses on actual research routines and processes in order to account for the complexities found in the process, the uniqueness of each research situation, and how the unique features of institutional research affect research practices and effectiveness of researchers. Thus, postmodern methodological canons and procedures involving constructivist qualitative induction and statistical/deductive methods are recommended. This could be useful in producing deeper understandings in researching the search process of knowledge production at the individual level of analysis. This is even more so as results could reveal meanings, traits and defining characteristics of events, people, interactions, settings/cultures and experiences involved in scientific research process. At the same time, the methodological practices and procedures of postmodern strategy inevitably demonstrate internal validity as well as high generalization utility of research results.

4. METHODOLOGICAL DEFICIENCY IN CURRENTLY APPLIED METHODOLOGIES IN THE STUDY OF RESEARCH PROCESS

Very limited attention is given in literature to search processes involved in the search for new knowledge. Studies in the field of search processes appear to be beset with lack of methodological variety. Most studies tended to focus mainly at organizational analysis of search process using quantitative methods, and very few at the individual level of analysis employing qualitative methods. In support of this later view, Maggittia, et al. (2013:91) observed that ''while there exists a conceptual literature on search process, we are unaware of other empirical attempts to inductively model the search process''. A few others have focused on search processes at team level and a handful within this category employed methodological triangulation. In this context, Konig, et al. (2013) in a study of interdisciplinary research collaborations, suggested the use of interdisciplinary research approaches, which permit analysis from different viewpoints and disciplines. According to the authors, such inter- and trans-disciplinary research process call for coordinated research management, if they must be successful and efficient (Pregerning, 2006). Yet there is limited evidence in literature of practical knowledge gained in this area (Dewulf et al., 2009). However, the overall methodological framework is project management anchored on content analysis of working documents and contracts (CEC, 2003), team-reflected experience and documented, and review of inter- and trans-disciplinary management and organization management literature. These methodological procedures reflect some aspects of action research, where researchers typically gain data from their involvement in the process (Avison et al., 1999). According to Klein, (2004), inter-disciplinary research program aims at achieving a holistic, comprehensive picture of the problem at stake, which is characterized by complexity and heterogeneity of researchers coming together with differing attitudes and from different disciplines, languages and cognitive systems. Nevertheless, since most studies employed quantitative methods and a few others mainly qualitative techniques in researching search processes at the individual

level, it is evident that there exists a gap in literature in taking advantage of benefits derivable from more innovative research strategy and methods of postmodernism in studying the field (Ozor, 2013).

5. WARRANTING APPLICATION OF POSTMODERN METHODOLOGIES IN RESEARCHING THE SEARCH PROCESS

Postmodernism is a research methodology, which historically is largely a response to modernity anchored on a worldview that challenges the old positivist philosophical assumptions underlying research. The historical connection between postmodernism and modernism has meant that positivist research methods cannot be excluded from postmodern agenda (Graham, 1992). Modernity is characterized by science based essentially on the positivist paradigm. Though the methods of positivism actually produced remarkable scientific breakthroughs, postmodern paradigm questions whether science alone can lead to scientific progress (Wilson, 1995). Developed as a philosophical and intellectual movement within the domain of knowledge production, the postmodern paradigm claims that there is no ultimate epistemology upon which to base the search for knowledge (Lyon, 1994). The methodology is not concerned with the 'truth' of research product rather it focuses on the pragmatic applicability of results (Annells, 1996). The ontological position of postmodern paradigm is that there is no single or even absolute representation of reality. For this reason, research cannot work towards the production of absolute truth (Rogers et al. 1995; cited in Bowker, 2001). This is because all forms of knowledge are socially, historically and culturally mediated (Charmax, 1995; Kvale, 1996). Implied in the postmodern philosophy is the notion of dissolving hierarchies of knowledge, which refers to the claim by positivists to be able to produce superior knowledge than anti-positivist or qualitative research can possibly do. Thus in reaction, while acknowledging the contribution of objectivism and numerical/statistical methods enthused by positivist research, postmodern methodology includes the constructivist emphasis of qualitative research tradition. It upholds the relevance of unique features of contexts, meanings as constructed by respondents, researcher involvement in the research process, and inductively building theory from data. It combines multiple methods of data collection and analysis, notably quantitative and qualitative methods, and focuses more on interpretation than prediction and control. As research methodology, it is closely associated with mixed methods research. To clarify distinctions often made between terms, a methodology refers to the philosophical framework and basic assumptions, which influence and relate to the entire research procedures and process. Research methods, which are more specific, refer to techniques for data collection and analysis e.g. qualitatively analyzing themes from text data or the use of quantitative standardized instrument such as questionnaire (Creswell, 2003). According to the author, research design is a plan of action that links philosophical assumptions to specific methods. Mixed methods research is thus both a methodology and method, and methods of data collection and analysis often mixed are those of quantitative and qualitative research. However, some mixed methods writers consider mixed methods research a methodology, which assumes a worldview or several worldviews emphasizing specific philosophical assumptions, while others (Creswell, Plano Clark, et al., 2003; Greene, Caraceli, and Graham, 1989; Onwuegbuzie and Teddlie, 2003; Elliot, 2005) emphasize the methods of data collection and analysis.

In this context, following on the heels of the usual arguments in favor of combining qualitative and quantitative methods, a number of postmodern claims justify the application of its methodological principles and procedures in researching the search process. First, according to the postmodern thinker, greater knowledge can be gained through multiple approaches to research. Firat and Venkatesh, (1995) argued that though postmodern research adopts a constructionist view, it does not deny the epistemology of positivism. Postmodern paradigm calls for wider pool of epistemological process. Charmax, (1995) further observed that affirmative postmodernism is concerned with widening the pool of approaches to knowledge beyond mere empiricism to include subjective approaches. Second, this approach assumes that paying attention to contextual aspects of research facilitates conceptualization of co-existing realities. In fact, the basic notion of postmodern methodology is that alternative approaches can produce wider perspectives from which to understand the social world. In this context, Fielding and Fielding, (1986) observed that multiple approaches to knowledge produce greater depth and breadth of understanding on a subject instead of focusing on objectivity and accuracy alone as positivism does. Third, the rigid procedures of positivist enterprise do not limit the methodology of postmodernism; rather it combines multiple methods in the search for knowledge (Firat and Venkatesh, 1995). Multiple methods approach to research could be useful not only for validating research results but also for enabling a more comprehensive interpretation because it could address the complexities that might be found in a research setting. It can also provide alternative answers as well as raise new questions and answers that

may lead to reformulation of old theories, which otherwise not possible through one approach. In this context, Mertens, (2007) argued that, in combining qualitative and quantitative methods, the qualitative dimension provides a platform to gather community views, socially constructed values and meanings at each stage of the research while the quantitative aspect offers the opportunity to establish valid findings acceptable to the community of scholars. The qualitative dimension can be highly relevant in researching the context of search process of knowledge production. In particular, out of the several qualitative methods, the Glaserian version of grounded theory canons and procedures appears to be most relevant in studying context focused problems found in search processes as it can reveal factors that affect research performance of scientists, explore the unique features as well as ways on how to improve institutional research. The search process of knowledge production and innovation is unique to the individual scientist who operates in a unique context defined by geography, demography, politics, culture and society. For this reason, the application of more inductive methods becomes appropriate in order to capture individual sensibilities and uniqueness of researchers as well as unique elements of context (e.g. constraints of culture, politics, administration and governance of research, and complexities of search process). Inductively developed theory from such data grounded study, which is based on the principles and methodological procedures of grounded theory, can produce not only practical solutions in the original setting/context, but also is capable of generating hypotheses that can be quantitatively tested to provide generalizable conclusions. Postmodern mixed methods design can achieve convergence and corroboration of results from different methods studying the same phenomenon as well as elaboration, enhancement, illustration, clarification, and expansion of the qualitative results from one method with results from the quantitative method (Greene, et al. 1989; Johnson and Onwuegbuzie, 2004; Creswell, 2007, 2009). It can provide a 'practical' means of addressing a research problem by allowing the use of words and numbers, inductive and deductive logics, multiple worldviews, and multiple modes and skills of observations. Data, methods, and perspectives can in fact be triangulated in social science inquiry. Triangulation involves the use of multiple methods and measures in order to ''overcome the problems of bias and validity'' (Blakie, 1991:115, 2000; Scadura and Williams, 2000). In this context, Flick, (2002:229) observed that ''the combination of multiple methodological practices, empirical materials, perspectives, and observations in a single study, is best understood… as a strategy that adds rigor, breadth, complexity, richness and depth to any inquiry''. The use of multiple methods provides an effective framework for observing phenomena in order to achieve a more accurate interpretation and analysis (Cox and Hassard, 2005). Triangulation of methods can serve as an effective means of observing and describing the comprehensive details of phenomenon and of confirming constructs and hypothesis (Eisenhardt, 1995). Therefore, the underlying assumption of triangulation is that the inquirer can get closer to a more comprehensive understanding of phenomenon by taking multiple measurements, using multiple methods and applying multi level analysis. Triangulation of methods in a single study is thus apt for exploring the search process, for theory development, testing some elements of the emerging theory of scientific knowledge production from a qualitative phase, and generalizing results to the study population.

Overall, the pragmatic thrust of postmodern research seems to provide a plausible justification for combing qualitative and quantitative methods in researching the search process of knowledge production. Morgan, (2007) discussed ways that pragmatism can provide new opportunities in social science methodology. The author argued that in combining qualitative and quantitative research, a pragmatic approach allows the researcher to use abduction, instead of the exclusive use of either inductive or deductive reasoning. Where qualitative and quantitative researches are combined in a sequential exploratory manner (Creswell, 2009), the adductive process permits '' the inductive results from a qualitative approach [to] serve as inputs to the deductive goals of a quantitative approach, and vice versa'' (Morgan, 2007:72). Since the study of search process of innovation is problem oriented, the pragmatic, result oriented emphasis of the postmodern approach becomes apt as it underscores in the observation that ''the proof of research conducted by whatever means resides in the pudding of its outcome'' (Howe and Eisenhart, 1990:6). On this background, a postmodern study design can be both qualitative and quantitative in thrust, the methodological procedures involving sequential collection of data in order to best describe, interpret and explain the research problem. By approaching the phenomena under investigation in different ways, from different worldviews, data could be triangulated to generate resources that otherwise could not easily be sighted from one source alone. A pragmatic approach permits the search for answers that work, and the search for what connects the different approaches to research. However, in the following sections the paper discusses qualitative research and quantitative inquiry in order to highlight their relative strengths and relevance in a single study.

6. QUALITATIVE RESEARCH

Qualitative inquiry is about exploring issues and as all scientific inquiries it seeks to understand phenomena from the perspectives of the local population involved in the inquiry. Tewksbury, (2009:38-9) argued that qualitative research ''focuses on the meanings, traits and defining characteristics of events, people, interactions, settings/cultures and experience''. Berg, (2007:3) stated that "Quality refers to the what, how, when, and where of a thing – its essence and ambience. It is concerned with using specific meanings, definitions, and contexts, not broad, general meanings. It is in this context that Denzin and Lincoln, (2005:3) observed that qualitative research ''is a situated activity that locates the observer in the world''. Qualitative research is particularly suitable for obtaining culturally specific data and information concerning the values, beliefs, behaviors, actions, and social contexts of a study population. It makes use of varied empirical material obtained from case study, personal experience, and life story interview, as well as introspective, observational, historical, interactive, and visual texts to describe social processes (Denzin and Lincoln, 2005). Thus, qualitative studies place greater emphasis on interpretation, produce comprehensive views on the object of study, look at contexts and search for a depth of understanding of concepts. They are characterized by an exploratory, descriptive, and humanistic focus as they provide information on the 'human' side of an issue thus reflecting the natural contradictions in human behaviors, emotions, beliefs, opinions and relationships.

The qualitative researcher acknowledges his personal involvement, bias, values and interest in the research process. This immersion and introspection represent the researcher's attempt to be open and honest, thus recognizing that all research is value laden (Mertens, 2003). The qualitative researcher filters through data and examines patterns of meanings emerging from close observations. Moreover, qualitative research takes multi methods focus (Flick, 2002:226-227). Multiple data collection methods enable the qualitative researcher to secure in-depth understanding of the phenomenon in question. Traditionally, data collection methods in qualitative research include interviews with individuals, observations of people, places and actions/interactions. However, in addition to these traditional data collection methods, new methods are emerging such as sounds, e-mails and scrapbooks (Creswell, 2009). Qualitative research is emergent as constructs, categories, theory and other aspects emerge during the study. This unfolding nature of qualitative research makes it impossible to predetermine or tightly set the initial research proposal. In addition, qualitative research makes use of multiple models of logic, though it is largely inductive. This means that the qualitative researcher uses both inductive and deductive reasoning, but his use of logical systems could also be repetitive and simultaneous. This is because the thinking process involving both induction and deduction slides back and forward during data collection and analysis; from data analysis to problem formulation and reformulation and back, which is most evident in doing a GT study. In brief, Creswell, (2009:29) described qualitative approach as,

> *One in which the inquirer often makes knowledge claims based primarily on constructivist perspectives (i.e., the multiple meanings of individual experiences meanings socially and historically constructed, with an intent of developing a theory or pattern) or advocacy/participatory perspectives (i.e., political, issue-oriented, collaborative, or change oriented) or both. It also uses strategies of inquiry such as narratives, phenomenology, ethnographies, grounded theory studies, or case studies. The researcher collects open-ended, emerging data with the primary intent of developing themes from the data.*

7. QUANTITATIVE RESEARCH

Quantitative studies on the other hand focus on phenomena, which are quantifiable and typically represented as statistics. Such studies are characterized by deductive-statistical orientation, and use such concepts as validity, reliability and objectivity to defend and empirically test generalizations or predetermined hypothesis. Quantitative methods define procedures for the selection of study elements, which involve random selection of a study sample drawn from, and representative of, a given population. Quantitative research makes use of standardized survey instruments aimed at collecting ''closed-ended'' data (Creswell, 2007:6). It specifies not only methods but also appropriate framework for statistical analysis right from the beginning. The parameter or estimation of numbers required to achieve statistically significant findings at acceptable level of statistical power determines the sample size.

Quantitative inquiry further specifies rigorous criteria for determining reliability of the measuring instruments employed, and its research findings must be replicable by other researchers. Quantitative approach to inquiry is theory driven. Weinreich, (2006) observed that quantitative research begins with identification of a research interest or topic and a theory.

Comparing and contrasting quantitative and qualitative researches have generated some debates among scholars amidst competing claims of superiority of one approach over the other as a more 'scientific' approach to doing social research. Tewksbury, (2009) argued for the superiority of qualitative research over quantitative inquiry. Mahoney and Goertz, (2006:227-228), describing the tension and debates arising from the distinction between quantitative and qualitative research, stated,

> *We prefer to think of the two traditions as alternative cultures. Each has its own values, beliefs, and norms. Each is sometimes privately suspicious or skeptical of the other though usually more publicly polite. Communication across traditions tends to be difficult and marked by misunderstanding. When members of one tradition offer their insights to members of the other community, the advice is likely to be viewed (rightly or wrongly) as unhelpful and even belittling*

However, Hanson and Grimmer, (2007:58-59) argued that the distinction between the two is only ''approximate'', merely imprecise and also blurred since a good number of research clearly focusing on one approach, ''nevertheless uses several techniques, often mixing the quantitative and the qualitative''. The authors suggested that rather than see each research approach as exclusive entities, the organizing notion of a continuum, with core positivism at one end and constructivism at the other, can be used to resolve the argument. Both research traditions are descriptive categories that cover many different actual methods (Gummesson, 2005; Long et al., 2000; Wilson and Natale, 2001). Though qualitative and quantitative researchers pursue different specific purposes that produce different set of values and norms shaping research practices, both research traditions share the common objective of producing valid descriptions and causal inferences (Grimmer and Hanson, 2006; Brady and Collier, 2004). Nevertheless, some discernible differences can be found between quantitative and qualitative inquiries based on their distinctive research purposes, practices and methods. Adopting a criteria approach (Brady and Collier, 2004), Mahoney and Goertz, (2006) identified ten areas across which quantitative and qualitative research can be contrasted. These areas include approaches to explanation, conceptions of causation, multivariate explanations, equifinality, scope and causal generalization, case selection practices, weighting observations, substantively important cases, lack of fit, and concepts and measurement. Besides, some scholars described each research tradition with reference to ontology, epistemology, and research purpose (Carson et al., 2001; Jean Lee, 1992; Healy and Perry, 2000; Kidd, 2002; Guba and Lincoln, 2000). Contrasting quantitative and qualitative inquiry, Denzin and Lincoln (2007:10) stated:

> *Qualitative researchers stress the socially constructed nature of reality, the intimate relationship between researcher and what is studied, and the situational constraints that shape inquiry. Such researchers emphasize the value-laden nature of inquiry. They stress answers to questions about how social experience is created and given meaning. In contrast, quantitative studies emphasize measurement and analysis of causal relationships between variables, not processes. Proponents of such studies claim that their work is done from a value free framework*

Overall, the strength of quantitative research seems to derive from the ability of its methods to produce quantifiable and reliable data that are generalizable to some larger population. However, its weakness appears to lie on the assumption that variables can be identified and relationships measured with some degree of precision. Besides, since a major purpose of quantitative inquiry is generalizability of results, it tends to de-contextualize social behavior in ways that rob it of its real world setting. Since quantitative research design is static, not emergent, it further tends to ignore the consideration of factors not accounted for at the beginning of the research. Weinreich, (2006) observed that quantitative approach to inquiry breaks down when the phenomenon under study is difficult to measure, when data cannot be reduced to numerical indices. A postmodern research, which posits mixed worldviews maximizes the strengths of both and overcomes their weaknesses.

8. APPLICATION OF POSTMODERN METHODS IN RESEARCHING THE SEARCH PROCESS

Three interrelated questions shape decisions about research design and the choice of research paradigm. These include knowledge claim, which is the broad claim or theory about knowledge that is brought into the research by the researcher including the element of perspective, i.e. the element of objectivity/subjectivity. Another is the question of methodology or strategy e.g. case study, ethnography, survey research, etc, which sets the stage, or determines the method of data collection. The third question is that of method, the tools and procedures for collection and analysis of data. With these considerations in mind, key questions for determination in this study are: In what area(s) of search process should postmodern research methods be best applied? What methodological model is most appropriate, and how should this model be applied?

Where, as in the area of study of actual routines and practices involved in search process of knowledge discovery and technological inventions (i.e. where research focus is on human interactions in specific settings), the research objectives are to explore and explain, postmodern strategy and methodological principles, procedures and practices involving both inductive and statistical methods could be most appropriate. In researching process based area of knowledge production, the object could probably include directing observations to informants on their experiences, feelings, beliefs and convictions about phenomenon under study. This would mean an attempt to understand what is happening in specific research situations and how research players manage their roles, and possibly also an attempt to understand how informants perceive their institutional research governance policy and structures, their beliefs and convictions about research processes and practices, and meanings that informants attribute to research outcomes. The study objectives could probably also include achieving a deeper understanding of core issues about research and developing theory of knowledge production that is grounded on data. In the circumstance where a research project includes both explorative and predictive objectives, multi or mixed methods strategy involving both qualitative and quantitative studies (Tashakkori and Teddlie, 2003) could be in order to better understand the research problem. The overall knowledge claim of postmodern research is pragmatic, which implies that a postmodern study is result or problem-oriented. For this reason, postmodern, mixed methods study design should necessarily take advantage of the strengths of both qualitative and quantitative research, while the order of data collection and analyses recommended is sequential exploratory, which is best suited to describe, interpret as well as explain the research problem (See Figure 1). Creswell, (2007:21) defined a mixed methods approach to inquiry as,

One in which the researcher tends to base knowledge claims on pragmatic grounds (e.g., consequence-oriented, problem-centered, and pluralistic). It employs strategies of inquiry that involve collecting data either simultaneously or sequentially to best understand research problem. The data collection also involves gathering both numeric information (e.g., on instruments) as well as text information (e.g., on interviews) so that the final database represents both quantitative and qualitative information.

Implementation	Priority	Integration (of results)	Theoretical Perspective
No Sequence Concurrent	Equal	At Data collection	Explicit
Sequential-Qualitative first (**Sequential exploratory**)	Qualitative	At Data Analysis	Explicit
Sequential-Quantitative first	Quantitative	At Data Interpretation	Implicit
Sequential-Quantitative first	Quantitative	With Some Combination	Implicit

Fig 1*: *Options for Determining Mixed Methods Strategy of Inquiry
Source: Adopted from Creswell, et al. (2003)

Creswell, (2003, 2007) described four kinds of decisions that could be made in selecting a mixed methods strategy of study indicating the sequence in which qualitative and quantitative phases of the study could be conducted, the priority or weight that might be given to either, the stage at which qualitative and quantitative data and results might be integrated, and what theoretical perspective to be used. Figure 1 presents a model of options for determining a mixed methods research strategy. In this context, since a postmodern study like all other inquiries have implicit theories, it could make theoretical perspective explicit regardless of the implementation, priority and integrative characteristics of the strategy. However, an overall, pragmatic knowledge claim is recommended, which could be either explicitly stated or implied.

Based on a postmodern epistemological stance, the author's model of postmodern, multi methods strategy consists of two phased mini studies, which sequentially combined qualitative methods in the first phase and quantitative methods in a second phase, a strategy described as sequential exploratory (Creswell, 2007). The first exploratory qualitative phase of the study could use grounded theory method for the purpose of exploring/discovering 'reality' through the informants' perspectives because, according to Oslon, (1999:3), ''the subjective researcher seeks to know reality through the eyes of the respondent''. It would begin inductively ''from observations and examination of particular instances; from facts/data to general principles'' (Beverridge, 1950:113). A major purpose of the qualitative phase of the study could be to generate logically built hypotheses and theory of search process of knowledge production, which is grounded on data. Since data collection plan is essentially inductive, observation instruments could include semi-structured (open ended) interviews and focus groups' discussions designed to collect initial data and information that might shed some light on concerns and issues of conducting original research by participants. The open-ended questionnaires could also generate initial data for instance on research practices/behaviors as well as governance factors that affect scientific performance at the individual level of the scientist. However, the survey instruments and other subsequent modes of observations used at this phase of the study must not be designed with or guided by any precise deductive theory in mind. Data emerging from these sources would be subjected only to qualitative analysis at this stage. However, themes and specific statements/views from participants in the first qualitative phase could provide the groundwork for development of subsequent survey questionnaires grounded on participants' views to be administered in the second quantitative phase. In discussing the procedures of data analysis and validation, and in particular, the development of survey instruments for a mixed methods approach to inquiry, Creswell, 2007:252-3 stated:

In a sequential approach, obtain themes and specific statements from participants in an initial qualitative data collection. In the next phase, use these statements as specific items and the themes for scales to create a survey instrument that is grounded in the views of the participants. A third, final phase might be to validate the instrument with a large sample representative of a population.

Nevertheless, testing or determining the validity of the qualitative data and findings is a subject of much debate in literature (Lincoln and Guba, 2000). The notion of validity as used in qualitative inquiry suggests determining whether the findings are accurate, authentic, trustworthy, or credible (Creswell and Miller, 2000). Though reliability and generalization play a minor role in qualitative research, validity is seen to be its strength (Creswell, 2007, 2009). In this context, the validity test strategy employed in the pilot or validation stage that precedes the quantitative phase (as modeled in Figure 2) could consist of member-checks by which, specific description, themes, or the final report are taken back to participants for their responses as to whether the participants' positions are accurately represented. In addition, the inquirer could develop a survey questionnaire with inputs from the first qualitative phase. This instrument would be field tested at the validation stage using a small sample of (about five) randomly selected participants in order to establish the content validity of an instrument and to improve questions, format, and the scales. Comments from these participants could be incorporated into a final questionnaire revision before administration. Above all, these measures are expected to provide a framework for accessing the trustworthiness of both qualitative and quantitative data and findings. Figure 2, which is a visual model of application of postmodern methodological procedures for studying process based search process of knowledge production, also provides a sketch of procedures involved in conducting a grounded theory research.

The quantitative and deductive phase must be designed to explain and expand findings from the qualitative phase. Quantitative data collection would involve the use of standardized survey questionnaire administered to samples drawn from the study population while analysis involves the application of statistical tools (e.g. frequency

distributions, means or modes, standards deviation/standard error of a sampling distribution, percentage tables) and other numerical measures to test predetermined hypotheses developed around themes and issues considered important to research experiences of participants. Research findings from both phases of the study could be integrated in a postmodern framework at the level of data interpretation and discussion of results to produce deeper insights.

9. INTEGRATING RESULTS FROM A POSTMODERN STUDY

Since the *etic* analysis of a quantitative study based on a researcher's imposed conceptual frame of reference differ significantly from the *emic* analysis in a qualitative inquiry, which is aimed at understanding the participants' frame of reference (Fielding and Fielding, 1986; Denzin, 1994; Morris et al., 1999), results of each may or may not converge. However, according to Cox and Hassard, (2005:122) convergence of results from different methods could mean that ''consensus exists on how reality is viewed, or that a common reality is shared and a lack of convergence may reflect legitimate and different views of reality, or the habituation of different social worlds''. Nonetheless, the authors argued that a postmodern approach must necessarily be sensitive to both context and content of research results. Where however findings conflict, the postmodern researcher would regard diverging results as alternative explanations. In practice, the use of multiple data collection methods, multiple methodologies, and multiple levels of analysis could produce divergent research findings, considered dual instances of reality (Cox and Hassard, 2005). Though discovered through different sources, these results could offer greater depth and breathe of understanding from analyses of research experiences, practices and processes. Quantitative results could be used to expand the qualitative findings producing thereby a richer and more indebt understanding of the phenomenon under study. Integrating results of a postmodern study involves a process that transcend beyond mere validation of the results obtained separately from qualitative and quantitative mini studies. Rather results could be presented as complementary in which case results from a first quantitative study could expand understanding and enrich interpretation of research finding produced from the second quantitative phase.

In practice, how can these findings be integrated and presented as a singular conclusion? In the search for a common ground in face of possible conflicting 'understandings' from disparate theoretical and epistemological perspectives, some authors have suggested the application of ''multiple paradigms to explore their disparity and interplay and, thereby, arrive at an enlarged and enlightened understanding of the phenomena of interest, as well as the paradigms employed'' (Lewis and Grimes, 1999: 676). However, the aim of eclectic or multi methods research is not simply a search for corroboration, but rather achieving expanded understanding of the phenomenon under study. Greater confidence can be held in a singular conclusion where findings are corroborated across the different approaches but if findings conflict, then greater knowledge can be gained and interpretations and conclusion may be modified accordingly (Onwuegbuzie and Leech, 2004). The findings from both phases of a postmodern study could be integrated at point of interpretation/discussions of results, though the qualitative phase must be designed to explore while the quantitative phase offered explanations, which complement and expand qualitative results in a sequential exploratory model (QUAL**------**QUAN). Squaring results therefore would involve exploring and harmonizing the differences and similarities as well as interfacing findings from one approach to the other within the theoretical and paradigmatic framework of the two approaches. In the search for a common ground, one could use what Lewis and Grimes, (1999: 675) called '*meta-theorizing'* in order to ''explore patterns that span conflicting understandings''.

At this point, it is important to address the questions: Why apply Grounded theory methods and procedures, especially the Glaserian version in the first qualitative phase? What are the potential gains of applying the Glaserian version of Grounded Theory in an institutional science and research context? Grounded theory approach to research uses inductive logical system to empirically discover theory, which is grounded on data (Glaser and Strauss, 1967; Goulding, 2000). Thus, the approach fits into the immediate situation under consideration. The emergent nature of Grounded Theory means that data collection and analysis occur simultaneously, permitting the inquirer to discover trends as they emerge, and to further explore and observe variations and relationships in these trends (Villani et al. 2010). The responsiveness of Grounded Theory is meant to focus inquiry towards local understandings or contextual values of respondents so that theories developed would minimally fit into the situation being investigated. Though the emergent theory remains largely contextualized, the introduction of grounded theory approach presents possibilities for generalizable findings (Egan, 2002). The Glaserian version of GT method is appropriate for studying the search

process for a number of reasons. First, grounded theory methodology permits understanding of given social situations by examining processes operating in them. The focus on processes allows the researcher to discover the participants' major concerns, what is going on. Thus, grounded theory strategy of inquiry is appropriate for seeking answers to questions of what are the participants' main problems and how are they trying to resolve them. The approach permits the conceptualization of what is going on in a natural setting and the development of concepts that explain people's actions, which relate to a given phenomenon (Glaser and Strauss, 1967; Egan, 2002). It permits the discovery of local understandings, which without grounded theory inquiry could remain unexplained. According to Devadas et al., (2011), Glaserian version is more appropriate for the study of explicit phenomenon (e.g. socially constructed meaning). This is because the Glaserian approach can generate the highest level of validity (or fit between what data postulate to study and reality that was/is in existence) since ''the study object does not have a self modifying component like cognition involved in behavior'' (p. 326). Thus in this context, Glaserian version of grounded theory methodology allows the inquirer to step out of the overused conventional methodologies to deal with such research routines and processes as how governance of research, behavior of scientists or research practices and other causal and motivational factors actually affect scientific knowledge production. The approach has potential to produce deeper and richer insights into research behaviors/practices that have significant implications for scientific performance. It can further uncover previously unexamined knowledge about the complex interrelatedness of causal factors of performance at the individual level of the scientist. Second, grounded theory methodology makes use of incidents as units of analysis, rather than the individual's characteristics as in behavioral sciences. This feature of Grounded Theory permits the researcher to observe and analyze contextual influences and issues. This is because grounded theory procedures require honestly taking all data as it comes, figuring it out and then conceptualizing it (Glaser, 1998, 2004). Concepts and their relationships emerge as these incidents are compared in a given area so that broader contextual issues are accounted for in the developing theory. According to Seidel et al. (2009), Grounded theory methodology can enable researchers gain contextualized, rich descriptions of phenomena under study. Further, as a theory of action, Grounded Theory makes its greatest mark in exploratory research particularly in unexplored research areas. However, there is limited evidence in literature of work in the area of institutional research using grounded theory to generate and develop concepts and theory. A grounded theory approach would therefore explore and uncover local understandings about research experiences of scientist and provide support for developing previously undiscovered theory of scientific knowledge production. Grounded theory inquiry is particularly useful when the research objective is theory building. Thus in the case where a principal research objective is to generate new knowledge that can inform public research policy, Grounded theory methodology could be an appropriate and effective strategy for theory building, which is a crucial basic step in an unexplored area (Villani et al. 2010).

Moreover, since grounded theory makes use of all conceivable data resources, the theory that emerges 'will be abstract enough and include sufficient variation to make it applicable to a variety of contexts related to that phenomenon' (Strauss and Corbin, 1990:23). It means also that the substantive theory developed from data could provide insights, which other researchers doing work on research process of scientific knowledge production could find useful.

Qualitative Phase Quantitative Phase

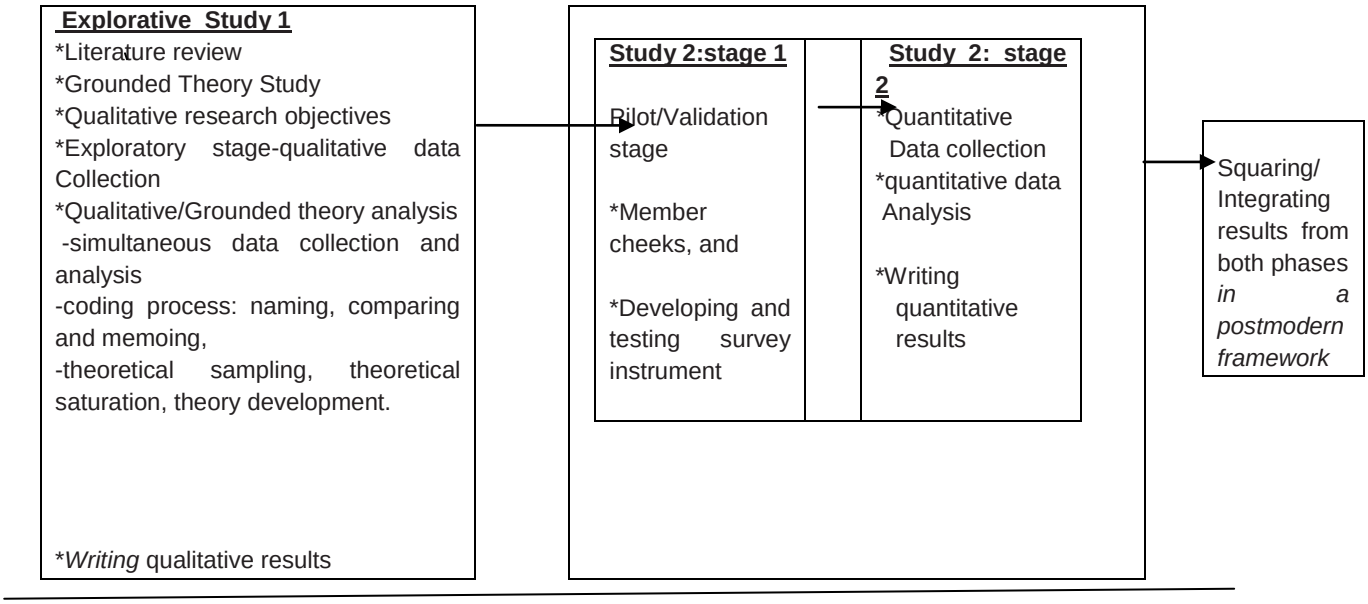

Fig. 2: Model of application of postmodern strategy in studying a search process

10. CONCLUSION

The rationale for combining qualitative and quantitative researches in a single postmodern study is to better understand the phenomenon under investigation by means of triangulating both broad numeric trends from quantitative research and the details of qualitative research. This strategy further provides the platform for exploring participants' views in a first qualitative phase for the purpose of using these views to develop and test survey instrument with a sample from the study population. Johnson and Onwuegbuzie, (2004:17) argued that the approach ''is inclusive, pluralistic, and complementary and it suggests that researchers take an eclectic approach to method selection and the thinking about and conduct of research''. The authors suggested that the logic of mixed methods inquiry is to use induction in the discovery of patterns, deduction in testing of theories and hypotheses, and abduction in uncovering and relying on the best of a set of explanations for understanding one's results (e.g. de Waal, 2001). Abductive reasoning, which is evident in recent literature about grounded theory (Charmaz, 2006; Reichertz, 2009; Richardson and Adams St Pierre, 2005), occurs at all stages of analysis, though more evident during the constant comparative analysis of categories to categories that end up with theoretical integration. According to Reichertz (2007: 220), the researcher using the logic of abduction ''has decided … no longer to adhere to the conventional view of things … Abduction is therefore a cerebral process, an intellectual act, a mental leap, that brings together things which one had never associated with one another: A cognitive logic of discovery''. By combining the two major research paradigms, mixed methods research is often seen, in philosophical terms, as a third research movement ('a third wave'), which goes beyond the paradigm wars to offer a logical and more pragmatic alternative (Johnson and Onwuegbuzie, 2004). Consistent with the principles of mixed research, the researcher, using different strategies, approaches, and methods, can collect multiple data ''in such a way that the resulting mixture is likely to result in complementary strengths and non-overlapping weaknesses''(Johnson and Onwuegbuzie, 2004:18). Mixed methods study can produce superior results because it provides a more comprehensive evidence for investigating a research problem than either traditional qualitative or quantitative study can possibly do. This is because mixed methods can answer research questions which qualitative or quantitative study cannot answer alone. Moreover, qualitative data may explain quantitative results, or results from both studies may be converged. In practice, qualitative observations (themes and views of participants) could be added to a quantitative survey instrument and analysis. This measure could serve first as a manipulation check (as in the pilot/validation stage), clarification, elaboration or complementary strategy to overcome some potential problems of interpretations of results found in positivist studies. Second, it is possible to use qualitative interviews to tap onto participants' views and meanings in order to overcome some of the potential weaknesses of the quantitative phase In this context, postmodern research is often designed not only to

achieve convergence and corroboration of results from different methods and designs studying the same phenomenon but also elaboration, enhancement, illustration, clarification, and expansion of the qualitative results from one method with results from the quantitative method (Greene, et al. 1989; Johnson and Onwuegbuzie, 2004; Creswell, 2007, 2009). Hence, a postmodern study can provide 'practical' means of addressing a research problem by allowing the use of words and numbers, inductive and deductive logics, multiple worldviews, and multiple modes and skills of observations. Besides, triangulation of methods appears to be a suitable strategy for exploring the search process phenomenon. In terms of paradigm emphasis, giving equal status to each approach is recommended. The time order could be sequential, from qualitative to quantitative study. The validation steps at the pilot stage are based on assessment of the trustworthiness of both the qualitative and quantitative data and findings. Mixture of methods can in fact occur at any of the levels of research objectives, data collection, and of data analysis and interpretation. Modelling application of principles and procedures of a postmodern method can in fact provide a useful guide in making important decisions in selecting a multi methods strategy of studying the search process of knowledge production and innovation. It is evident that appling a wrong or inproper mixture of methods would probably produce invalid results or findings that do not reflecting both context and content. Besides, researchers are quided on how best to apply the methodological priciples and procedures of a postmodern study of process based phenemenon. However, this paper believes that there are several other possiblitites open to further improve postmodern methods of researching the search process, which thus constitutes an area for future empirical study.

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