
The importance of multimethods and mixed methods research in understanding complexity in leadership

Robert M. Yawson

Lender School of Business,
Quinnipiac University,
275 Mt. Carmel Ave., Hamden, CT 06518, USA
Email: robert.yawson@qu.edu

Abstract: The dominant approach to leadership research has been undergirded by linear epistemology and transcends many discourses, practice, and scholarship in the field of leadership and leadership development. Leadership research has a long history of a quantitative approach, and it remains the most commonly used approach among leadership researchers. Although the application of mixed methods research designs has been examined across many fields and disciplines, it has yet to be specifically addressed in the context of leadership research. There is, however, a rise in research grounded in nonlinear epistemology, although the underlying methodological approaches have not clearly been defined. In a multimethods mixed methods study to identify skill needs for agrifood nanotechnology, a comprehensive methodology was developed for a systems approach research in organisational leadership. In this paper, this multimethods mixed methods research study is used as an illustration to provide a template and an approach that can be adapted in other leadership research.

Keywords: complexity; epistemology; leadership; multimethods; mixed method; paradigm; nanotechnology; ontology; skills; workforce development.

Reference to this paper should be made as follows: Yawson, R.M. (2016) 'The importance of multimethods and mixed methods research in understanding complexity in leadership', *Int. J. Complexity in Leadership and Management*, Vol. 3, No. 4, pp.261–277.

Biographical notes: Robert M. Yawson is an Assistant Professor of Management at the Lender School of Business, Quinnipiac University, USA. He has a BS in Chemistry and MPhil in Biochemistry from University of Ghana; Post Graduate Certificate in Food Management from, Hebrew University of Jerusalem; MS in Science, Technology and Environmental Policy from Hubert H. Humphrey School of Public Affairs, University of Minnesota; and PhD in Organizational Leadership, Policy and Development from University of Minnesota. His current research is on using the 'wicked problem construct' of leadership for organisational development and change and also using a systems approach to human resource development for emerging technologies.

This paper is a revised and expanded version of a paper entitled 'The importance of multimethod and mixed methods research approach in HRD. A case of a 'skills needs identification study'' presented at the 23rd Annual AHRD International Research Conference in the Americas, Jacksonville, FL, USA, 18–21 February 2014.

1 A different approach to leadership research

The world is operating in a century of complexity, unprecedented interconnectivity, interdependence, radical innovation and transformation, and unforeseen new structures with unexpected new properties (Beinecke, 2009). Complex social problems are prevalent in all forms of organisations and social settings; they seep in and affect individual interactions, as well as organisations and are present worldwide. These problems are characterised by changing requirements and solutions that are difficult to recognise because of complex interdependencies (Connolly and Stanfield, 2006). These call for a different approach to how leadership research is conducted and thus the importance of mixed method research and multimethods approaches. This study is, therefore, a subsequent to this need, necessitating the main research question as follows: *What is the relevance of multimethods and mixed methods approaches to leadership research and scholarship?*

Researchers have studied leadership from a variety of viewpoints. Leadership theories and explanation of leadership practices either from the epistemological or ontological point of view is fraught with disagreements situated in deep-rooted ideological and paradigmatic positions. There is a battle for the soul of leadership. The dissonance as to whether leadership development, management development, and organisational development are the same or disparate human development approaches can all be traced to this paradigmatic battle within research and practice.

There is a profound divide in philosophical understandings – in the deep meanings – regarding what constitutes the nature of leadership and the research enterprise around it (Uhl-Bien and Ospina, 2014). This is because they have developed from contrasting philosophies of science, that is, contrasting answers to the ontological and epistemological questions that reflect the assumptions researchers bring to their work (Uhl-Bien and Ospina, 2014). The ontological justification of the linear approach to leadership has been the dominant premise on which leadership research has been conducted. However, starting from the early 1990s, there has been an emerging paradigmatic shift to the nonlinear epistemology of practice and the effect on 21st-century organisations. However, the emergence of this nonlinear epistemological approach to leadership research and practice has given rise to other problems. There has been a number of methods, techniques, and methodologies within the broad field of leadership all premised on the nonlinear approach to leadership research from a vast variety of approaches all having very varied characteristics and stemming from various paradigms based on divergent philosophical assumptions (Mingers and Brocklesby, 1997). “Whilst this plenitude can enhance practice, it also poses problems for practitioners who often tend to restrict themselves to one paradigm or even one methodology” (Mingers and Brocklesby, 1997). A review of articles published on leadership between 1990 and June 2012 revealed a slight occurrence of existing application of mixed methods designs to leadership research (Stentz et al., 2012).

It is the contention of this paper that in order to make the most effective contribution to leadership in this century of complexity, unprecedented interconnectivity, interdependence, radical innovation and transformation, and unforeseen new structures with unexpected new properties, it is important to go beyond using a single method to generally using multiple methods and combining several methodologies, in whole or in part, and possibly from different paradigms, and different disciplines. This is the underlying thesis of this paper based both on theoretical/philosophical grounds and on the

practical grounds that practitioners are increasingly doing this already. However, as Mingers and Brocklesby (1997, p.490) noted, “mixing methodologies, particularly from different paradigms, does present serious problems – philosophically in terms of paradigm incommensurability, theoretically in terms of effectively fitting methodologies together, and practically in terms of the wide range of knowledge, skills and flexibility required of practitioners”.

Research and practice in leadership are deeply seeped in the dynamic issues of individual, organisational and societal change. Leadership as discipline or field of study transcends disparate disciplines with diverse ideas, goals, and even philosophical orientations (Smith, 1988) and encompasses the exercise of influence (Yukl, 2012). Because of this, research and theory building in leadership has not been spared the so-called paradigm wars with a preponderance of empirical research in leadership being quantitative. Professionals and practitioners have either brought or developed their own methods of inquiry and attempted to define them as the mainstay of leadership research depending upon their background and training. However, the dominant epistemology in leadership has been the linear epistemology and transcend many discourses, practice and research in the field (Jayanti, 2011a, 2011b; Yawson, 2013b). There is, nonetheless, a rise in research grounded in nonlinear epistemology, although the underlying methodological approaches have not clearly been defined. Mixed methods and multimethods research approaches are therefore becoming important as a result of the epistemological shift. Yet, methodologies and concepts underlying the approach are not very well developed. In this paper, a multimethods mixed methods research (MMR) is described as systems approach research in studying complexity in leadership. A multiphase, multimethod, mixed method study (Yawson and Greiman, 2016) is used as an illustration and a case-in-point to provide a template and an approach that can be adapted in other leadership research.

Leadership is a complex, multi-faceted form of performance that is exhibited and comes into existence only when something happens (Mumford, 2011). It is the very quintessence of leadership as a complex, multi-level, and socially constructed process that makes it a phenomenon of great interest, but also one that is a challenge to study (Stentz et al., 2012). These complexities have generated both positive challenges and overwhelming impossibilities (Stentz et al., 2012). The complexities can be addressed through something more than a single approach, such as the use of multiple methods and mixed methods approaches. Yet, much of what is currently understood about leadership has been developed primarily through the linear epistemological orientation of quantitative, statistical approaches. Stentz et al. (2012, p.1173) have substantiated Bass’s (2008) argument that “methodological and substantive issues in leadership research are likely to broaden by presenting the possibility of a new paradigm for leadership that combines the use of both objectivist and subjectivist views toward a better understanding of leadership as a complex phenomenon”. Therefore, to best understand critical leadership processes and dynamics, the field of leadership research calls for the application of mixed methods and multiple research approaches. This study attempts to do just that using, as an illustration, an organisational leadership study that employed multiple methodologies including systematic reviews, stakeholder analysis, multicriteria value elicitation, strategic flexibility analysis (SFA), and systems dynamics modelling. The study used as an illustration in this article also used mixed methods through the integration and combination of both qualitative and quantitative data. Mixing in the illustrative study occurred during the research design process, data collection, data analysis, and interpretation.

This article follows a logical schema in the attempt to answer the main research question necessitating this study. Narrative literature reviews of both mixed method research and multimethods research approaches are conducted. A brief overview of the illustrative study used as a case in point is provided in an attempt to illustrate evidentially how mixed methods and multimethods can be used in leadership research. The article then discusses the implications of the study for practice and draws the relevant conclusions.

The reason for using the ‘skills needs identification study’ to illustrate the use of mixed methods in leadership research is that the study has a multidisciplinary focus, and provides a scholarly and applied orientation to meet the varied epistemological and ontological basis for a systems approach research. Thus a perfect template to illustrate the importance of mixed methods in complexity in leadership. It also addresses the epistemological and professional needs of scholar-practitioners of leadership.

Mixed methods and multimethods are two different research approaches but quite often some academics have used the other as the research approach and referred to the research erroneously as the other. In the literature, it is common to find the terms ‘mixed methods’ and ‘multimethods’ used interchangeably. However, it is important to distinguish these terms. It must be understood that MMR is not multimethods research and vice versa. Both can be used in concert to the other in the same research as was done in the case under illustration in this paper. Finally, the lessons learned in the use of both mixed methods and multimethods approaches in a single study are discussed and the implications and relevance of the approaches to leadership research and scholarship articulated.

2 Mixed methods research

Many definitions of mixed methods are available in the literature (Creswell et al., 2011; Johnson et al., 2007). The different definitions come with them different nomenclature or taxonomical tags. The tags include inter alia: blended research, integrative research, multi-method research, multiple methods, triangulated studies, ethnographic residual analysis, and mixed research (Johnson et al., 2007). The disagreements in how it should be defined and named are not necessarily semantic; they reflect substantive differences over the proper way to categorise and understand methods, theoretical and philosophical foundations, and where the mixing occurs (Small, 2011). MMR has become the most popular term used to describe this research approach. Johnson et al. (2007) analysed 19 different definitions from leaders in the field of MMR and offered the following general definition:

“Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration.” (p.123)

One of the most popular definitions in the literature was provided by Creswell and Clark (2011) as research with a methodology involving a philosophical assumption that guide the direction of the design, collection and analysis of data and the mixture of qualitative and quantitative approaches in many phases in the research process. The Office of

Behavioral and Social Sciences Research (OBSSR) of the National Institute of Health (NIH) commissioned a study to come out with *Best Practices for Mixed Methods Research in the Health Sciences* and the study proposed this definition which was accepted by the NIH as a research approach or methodology [Creswell et al., (2011), p.4]:

- focusing on research questions that call for real-life contextual understandings, multi-level perspectives, and cultural influences
- employing rigorous quantitative research assessing magnitude and frequency of constructs and rigorous qualitative research exploring the meaning and understanding of constructs
- utilising multiple methods (e.g., intervention trials and in-depth interviews)
- intentionally integrating or combining these methods to draw on the strengths of each
- framing the investigation within philosophical and theoretical positions.

MMR starts with the assumption that researchers gather evidence based on the nature of the question and theoretical orientation (Creswell et al., 2011). MMR has been described as “the third methodological movement” [Johnson and Onwuegbuzie, (2004), p.14] – a response to the age-old fruitless debates discussing the superiority and inferiority of quantitative versus qualitative research as a result of what has been termed the ‘paradigm wars’ [Feilzer, (2009), p.6]. Mixing methods are, however, not new, and one can find mixed methods studies throughout the history of the social sciences. Many commentators, however, trace the origins of the modern work to the 1950s with publications from several different perspectives employing multiple methods in single studies (Small, 2011).

The issue of paradigm wars has, however, not ended with MMR. Within MMR, there are a lot of differences and critiques on mixing of paradigms. The different epistemological and ontological assumptions and paradigms associated with both qualitative and quantitative research have had a major effect on discussions in MMR as to whether the integration of the two is feasible and desirable (Ostlund et al., 2011).

Mixed methods researchers apply and usually tend to make explicit diverse philosophical positions (Creswell et al., 2011). It has been argued that researchers who hold different philosophical positions may find MMR to be challenging because of the tensions created by their different beliefs (Greene, 2007). Table 1 adapted from Greene (2008) offers one way of portraying the conceptually different stances on these issues in the literature. Some communities of scholars have therefore tended to find a common epistemological foundation for MMR as a standalone or alternative research tradition to quantitative and qualitative research.

In pursuit of that epistemological foundation, authors have increasingly turned to pragmatism (Small, 2011). In more recent years the MMR community has generally seemed to coalesce around a common understanding that the various articulated positions, referred to as dialectal stances, bridge post-positivist, and social constructivist worldviews, pragmatic perspectives, and transformative perspectives to create the opportunity to transform these tensions into new knowledge through a dialectical discovery (Greene, 2007).

Table 1 Mixing methods and mixing paradigms/mental models

<i>What is the character and value of traditional paradigms or mental models?</i>	<i>What most importantly guides practical inquiry decisions?</i>	<i>Mixed methods 'paradigm stance'</i>
The assumptions of different traditional paradigms are fundamentally incommensurable. Each paradigm represents a coherent whole, which must be respected and preserved.	Paradigmatic assumptions	Because the assumptions of different paradigms are incompatible, it is not possible to mix paradigms in the same study. PURIST STANCE (Lincoln and Guba, 1985)
The assumptions of traditional paradigms are not fundamentally incompatible, rather different in important ways. These differences are valuable and should be preserved to maintain methodological integrity while expanding the scope of the study.	Paradigmatic assumptions, as well as context and theory	Because the assumptions of different paradigms are importantly different, methods implemented within different paradigms should be kept separate from one another. COMPLEMENTARY STRENGTHS STANCE (Brewer and Hunter, 1989; Morse, 2003)
The assumptions of different traditional paradigms are different in important ways and remain valuable, but paradigms themselves are historical and social constructions and so are not inviolate or sacrosanct.	Paradigmatic assumptions, as well as context and theory	Engaging dialogically with paradigm differences can generatively yield new insights and understandings. DIALECTIC STANCE (Greene and Caracelli, 1997; Maxwell and Loomis, 2003)
Historical, philosophical incommensurabilities among paradigms are reconcilable through new, emergent paradigms, such as pragmatism, scientific realism, or transformation – emancipation.	The assumptions and stances of new paradigms that actively promote the mixing of methods, along with context and theory	ALTERNATIVE PARADIGM STANCE (Howe, 2003; Johnson and Onwuegbuzie, 2004; Mertens, 2003; Teddlie and Tashakkori, 2003; others)
The assumptions of various traditional paradigms are logically independent and, therefore, can be mixed and matched in varied combinations.	The practical characteristics and demands of the inquiry context and problem at hand Paradigms help us think better but do not themselves guide practice	A-PARADIGMATIC STANCE (Patton, 2002; Reichardt and Cook, 1979)
The assumptions of various traditional or emergent paradigms may well be embedded in or intertwined with substantive theories.	The substantive issues and conceptual theories relevant to the study being conducted paradigms help us think better but do not themselves guide practice	SUBSTANTIVE THEORY STANCE

Source: Greene (2008)

Trends in mixed data collection indicate that most contemporary empirical mixed methods studies have employed two or more different types of data or data collection techniques (Small, 2011). There are several categorisations of the different types of data collection in the literature e.g. Morse (1991), Fine and Elsbach (2000), Creswell et al. (2003), Johnson and Turner (2003), Leech and Onwuegbuzie (2007), Creswell and Clark (2011), and Small (2011). Small (2011, p.63) grouped them into three main categories using the following criteria: “the purported motivations to combine different types of data, the extent of the sequencing of the data collection, and the level of nesting of the multiple data sources”.

In an attempt to clearly identify the types of MMR, many authors have developed typologies or classification systems of mixed methods designs (Doyle et al., 2009). It has been contended that the main advantages of having a typology of mixed methods include: conveying rigor regarding the methodology, providing guidance and assisting in the development of language for MMR (Bryman, 2006; Teddlie and Tashakkori, 2006).

Creswell et al. (2011) have suggested that to evaluate a mixed methods study, the researcher needs to:

- collect both quantitative and qualitative data
- employ rigorous procedures in the methods of data collection and analysis
- integrate or mix (merge, embed, or connect) the two sources of data so that their combined use provides a better understanding of the research problem than one source or the other
- use a MMR design and integrate all features of the study with the design
- convey research terms consistent with those being used in the mixed method field.

These criteria are used by the NIH to evaluate MMR (Creswell et al., 2011).

3 The multimethods approach

Multimethods research has its origins from Campbell and Fiske’s (1959) groundbreaking article on measurement validation. It is a research approach to systematically employ different types of methods in concert with one another. “Multimethods research, considered in the broadest sense, includes any research that contributes in any way to gaining a multimethods view of social phenomenon” [Brewer and Hunter, (2006), p.14]. Tashakkori and Teddlie (2010, p.11) define multimethods as “research in which more than one method or more than one worldview is used”. Mingers and Brocklesby (1997) also describe multimethods as the utilisation of more than one method, or part thereof, possibly from different paradigms, within a single intervention. The relevance of multimethods, be it interpretive, or positivist, or even a plurality of paradigms within the discipline as a whole, or different methods from different disciplines to answer a research question is that research results will be richer and more reliable.

Leadership research as with all social science research is highly diverse in almost its entirety, including methodology. Leadership researchers study countless research problems from a myriad of theoretical perspectives and to some extent different types of research methods. The diversity of methods in social science research, in general, provides a fertile ground for cross-validation and cross-fertilisation of research procedures, findings, and theories (Brewer and Hunter, 2006). However, methods used in multimethods research may not be limited to a single discipline. The beauty of multimethods research approach is its ability to be multidisciplinary, interdisciplinary and transdisciplinary. This multi- and interdisciplinary approach is predicated on the conception that “disciplinarity is no longer the dominant system for creating and organizing knowledge, and that knowledge creation is now trans-disciplinary, more reflexive, non-linear, complex and hybridized” [Yawson, (2009), p.9]. Lubet (2009) in discussing his pioneering role in the field of disability studies in music described the transdisciplinary multimethods scholarly approach as the tenets of “epistemology of interdisciplinarity” (p.120). In order for leadership researchers to exploit these opportunities, there is the need to develop more cosmopolitan research strategies. “What is needed are approaches that systematically explore the new avenues of research that methodological diversity affords” [Brewer and Hunter, (2006), p.1]. Multimethods research is either single studies or more complex multiphase research which systematically employ various combinations of methods within the same discipline on multiple disciplines to address research questions.

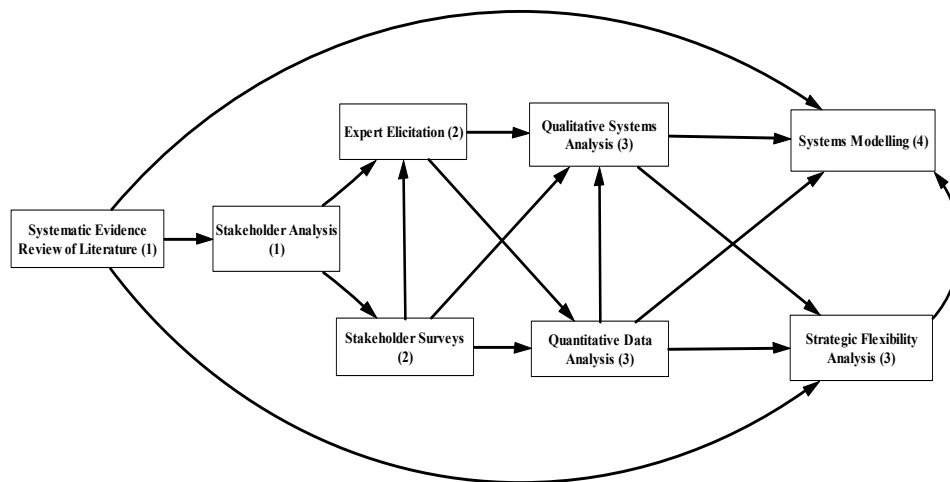
4 Brief overview and description of the ‘skills needs identification study’ used as illustration

The reason for using this study to illustrate the importance of mixed methods and multimethods research in understanding complexity in leadership is that the study takes a whole systems approach and uses both mixed methods and multimethods within a single intervention. The ‘skill needs identification study’ (Yawson and Greiman, 2016) was also predicated on the fact that there is the need for new leadership approaches in managing the future workforce in the face of advances in emerging technologies like nanotechnology. This multimethods mixed methods study which was designed as a systems approach methodology incorporated disparate fields of systems and complexity theories; nanoscience and nanotechnology; science policy; agricultural education; human resource development, and workforce education (Yawson, 2013a; Yawson and Greiman, 2014).

The study followed a four-step process involving different methods and approaches. The first phase involved a comprehensive systematic evidence review (SER) and analysis of the literature. A comprehensive stakeholder analysis was done using primary data obtained from experts. The second phase of the study used multi-criteria approaches for value elicitation (which included qualitative and quantitative data) from key stakeholders and experts to identify current and future skill needs in the agrifood nanotechnology sector. The third phase of the study included quantitative analysis, qualitative systems analysis (QSA) and SFA of evidence from the literature review and the multi-criteria value elicitation of experts and stakeholders. The final phase of the study created a

generic systems model from the quantitative analysis, QSA and SFA to describe holistically the current and future skill needs for agrifood nanotechnology workers as well as how educational practice and policy can meet these needs. The overall systems approach is as shown in Figure 1. This paper uses this ‘skills needs identification study’ as an illustration to describe the use of multimethods and the Mixed Method approaches and its implications for leadership research and practice.

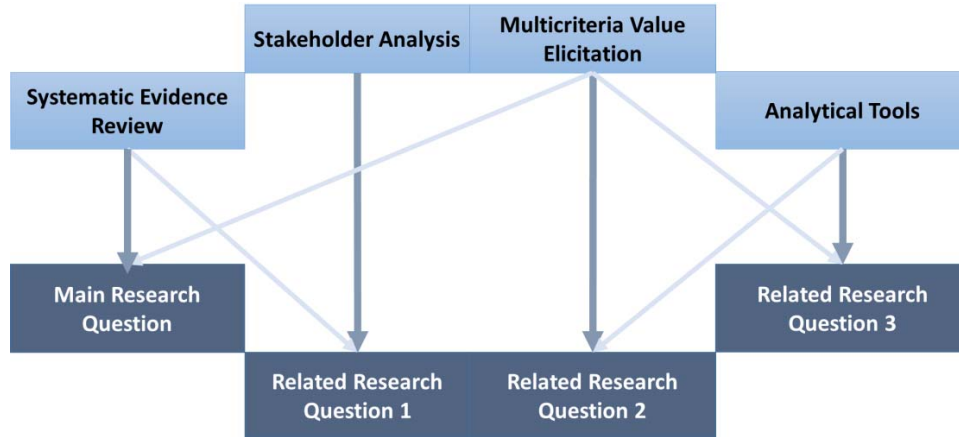
Figure 1 Schematic representation of research framework



The methods and data collection measures were designed to answer the research questions the study set out to address. The main research question that guided the study was: *What are the future skill needs in agrifood nanotechnology?* The study also addressed the following related questions:

- 1 Who are the key stakeholders in agrifood nanotechnology workforce development and how do they perceive skills shortages and gaps in the sector?
- 2 Based on an understanding of skill shortages and gaps, how can educational practice and policy meet these needs?
- 3 What policies and programmatic intervention points can serve as leverage points for increasing the likelihood of preventing skill gaps and shortages in the agrifood sector?

The research methodology designed to answer these questions was as follows: First, a SER of the literature was done to answer the main research question. A stakeholder analysis was conducted to identify the stakeholders directly affected and responsible for skill needs in agrifood nanotechnology and also to select the stakeholders from whom data will be collected. A multicriteria value elicitation of quantitative and qualitative evidence was then collected from the identified experts and stakeholders. Figure 2 shows the main methods used to answer specific questions.

Figure 2 Main methods answering specific research questions (see online version for colours)

4.1 SER of the literature

The overall approach to the SER for the study was adapted from the guidelines in the *Cochrane Handbook for Systematic Reviews* (Higgins and Green, 2011) and guidelines for systematic reviews in the social sciences (Petticrew and Roberts, 2006). Answering the research question on ‘what are the future skill shortages and gaps in agrifood nanotechnology’ involved synthesising quantitative and qualitative evidence (Harden and Thomas, 2010). The following steps were followed: search for materials, screen studies, extract data, summarise data, perform analyses, and write up results (CRD, 2009; Dixon-Woods et al., 2005; Pope et al., 2007; Thomas and Harden, 2008).

4.2 Stakeholder and expert identification analysis

The second task of the first phase of the study entailed stakeholder and expert identification analysis. From the SER some experts were identified purely based on their publications in peer-reviewed academic journals. Another source of Identification included nanotechnology conferences participants list. The study followed a four-step process of specification, prioritisation, mapping (visualisation) and engagement for the stakeholder analysis.

4.3 Multi-criteria value elicitation from key stakeholders and experts

There are a number of methods for stakeholder and expert value elicitation available. The actual methods that were employed in this study relied on a combination of different value elicitation processes. A methodology for the expert elicitation was developed based on Van der Fels-Klerx et al.’s (2002) and Yawson and Kuzma’s (2010a, 2010b) work using formal survey methods. The methodology involved both qualitative and quantitative elicitation. A four-step process: selection of stakeholders (study participants) including experts as described above, development of the elicitation survey instrument, administration of the elicitation survey, and analysis of the survey results was done. The

elicitation protocol developed for the study took into account the level of heterogeneity of relevant backgrounds seen in the disparate disciplines involved in agrifood nanotechnology (Yawson and Kuzma, 2010a, 2010b). Interviews to elicit experts' opinions were conducted by telephone following traditional social science interview methodologies. Interviews were recorded (with permission and following Institutional Review Board requirements) and transcribed for analysis.

4.4 Sampling and data collection/measures

The study used mixed methods sampling strategy combining the concurrent and sequential collection of quantitative and qualitative data (Creswell and Clark, 2011; Teddlie and Yu, 2007). Because different communities of stakeholders were surveyed and several of identified stakeholders in the agrifood system who were ready to discuss nanotechnology skill needs were small, the interest in the sampling was more to do with the representation of the stakeholders rather than actual sample sizes. As a result, the quantitative data analysis was limited to descriptive statistics.

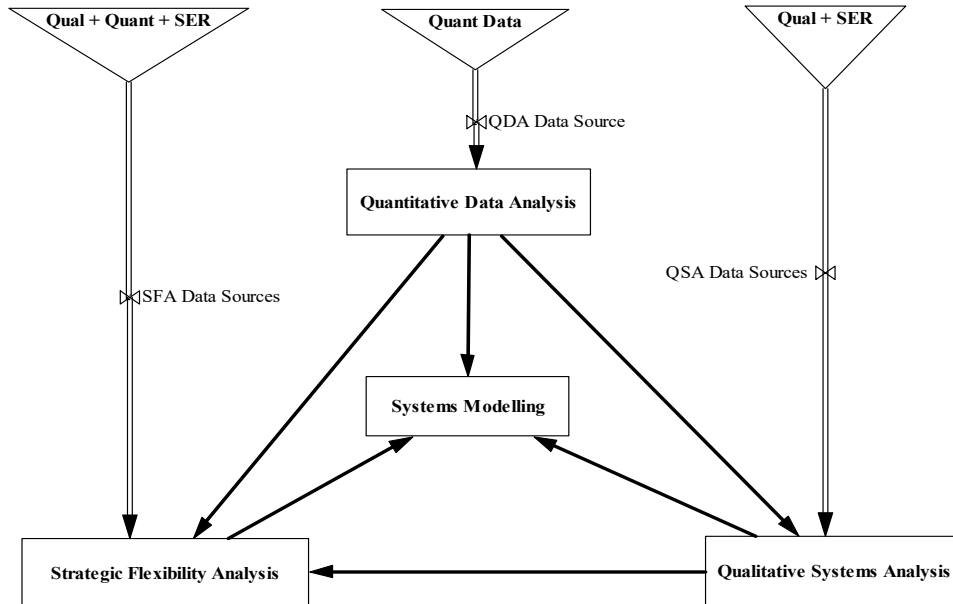
This multiphase mixed method design combined both sequential and concurrent strands within a particular timeframe (Creswell and Clark, 2011). The first phase of the data collection involved both qualitative and quantitative data which were collected through online surveys. Experts were first surveyed as part of the stakeholder analysis and then quantitative, and qualitative data were collected from both experts and stakeholders and analysed. The quantitative data included structured questions on ranking and Likert scales to augment the data obtained from the systematic review in answering the main research question. These quantitative questions were developed for the purposes of this study from evidence obtained from the systematic review of literature in answering the question.

The second phase of data collection involved additional qualitative data. Results of the stakeholder surveys were discussed with the experts through qualitative phone interviews (two local experts were interviewed in person). These semi-structured telephone interviews discussed key issues from phase one of the data collection to elicit opinions of experts on important systems variables that were identified from both the systematic review and the first level data collection to help answer the third and fourth research questions.

4.5 Analysis and discussion

The analysis phase of the study included the analysis of the SER, QSA and quantitative (QDA) data analyses; and also a SFA – a scenario analysis method. All the analyses ultimately culminated in the development of a generic systems model. “Scenario construction has been applied to the development of emerging technologies and socio-technical systems, including initial applications to nanotechnology” [Wiek et al., (2009), p.285], however, this study was the first to apply SFA to skill identification for any emerging technology. The use of QSA in the study was very relevant since skill needs identification for an emerging socio-technical system like agrifood nanotechnology is so complex that the analytical basis does not allow for only quantitative modelling (Wiek et al., 2008). Figure 3 shows the various analytical frameworks used and the sources of data that were used.

Figure 3 Data sources for the various analytic approaches



4.6 Systems dynamics modelling

The final phase of the analysis which is the fourth phase of the study was the development of a generic agrifood nanoskills systems dynamics model from the analytical results of the multicriteria elicitation, and the SER.

5 Implications of study to leadership research and practice

Many research questions and topics of interest in leadership lend themselves to mixed methods and multimethods approaches (Rocco et al., 2003). “Yet, current research training typically lacks the appropriate use of mixed methods in all but the most rudimentary ways (e.g., triangulation)” [Rocco et al., (2003), p.27]. Rocco et al. (2003) have concluded that the preponderance of leadership research reports do not discuss the broader philosophical and political level decisions that ultimately shape research agendas, as most research in leadership confines the discussions concerning research design and data interpretation to the rigidity of either qualitative or quantitative descriptions of technical level decisions about ‘methods and procedures’. This study as described seeks to address this gap in leadership scholarship.

Using the ‘skills needs identification study’ described above as an illustration of the use of multimethods and mixed methods approaches in leadership provides significant implications for leadership research and practice. The nature of the problem the skills needs identification study addressed was such that quantitative approach or qualitative approach, individually, will not be enough to develop multiple perspectives and a complete understanding of the problem. The research questions guiding the study required different methods of analysis from different disciplines. And finally,

dialecticisim represented the paradigmatic or philosophical orientation in which the research was grounded, a worldview that bridges post-positivist and social constructivist worldviews, pragmatic perspectives, and transformative perspectives (Greene, 2007). The choice of multimethods and mixed methods design for the study was therefore informed by dialecticisim and the complex set of theoretical and conceptual orientation.

The multimethods MMR as illustrated provides a template and an approach that can be adapted in other leadership research. The study as presented illustrates a quintessential multimethods and mixed methods study and meets the Creswell et al. (2011) criteria for a mixed method study. The illustrative study also shows how multiple methods from different disciplines were used to address a research problem in leadership. The study also used the full spectrum of MMR approach in terms of research design, methods, data collection and sampling, and analysis.

The illustrative study used as case-in-point in this paper collected both quantitative and qualitative data both concurrently and sequentially in a multimethods embedded design framework (Creswell and Clark, 2011). Both the quantitative and qualitative data are embedded in combination within a larger design. The methods of data collection and analysis were both very rigorous. Descriptive statistical analysis was used for the quantitative data. Qualitative data consisted of semi-structured stakeholder interviews and multi-criteria value elicitation of experts that were analysed using SFA to develop themes and scenarios.

From the design of the illustrative study, the integration of the multiple sources of data pointed to a clear use of combined data to provide a better understanding of the research problem. The integration of the quantitative and qualitative data in the study occurred between data analysis from one phase and data collection from a subsequent phase while analysing the data, and when reporting the results. The study did use a mixed method research design and clearly integrated all features of the study within this design. The rationale for the use of multimethods and mixed methods based on the need to develop a quantitative hypothesis from the qualitative data and also to converge information to best understand the research problem under study was provided. The integration is seen in the data collection, data analysis and discussion of results.

In terms of contribution to knowledge, the methods and approaches for this research were drawn from existing, and emerging methods within multiple disciplines in mixed methods approach creating a novel research framework.

6 Conclusions

Mixed methods and multimethods research approaches are uniquely important to leadership. Leadership is a multidisciplinary field of study. Without going into the debate as to whether it is a discipline on its own or a collection of fields of study, it is evidently clear that it is an area of study and practice that is transdisciplinary. Therefore understanding and the use of multimethods and mixed methods approaches and the perspectives from which they are used may help to demystify leadership research and to guard against tendencies toward naïve scientism in the use of business strategies and social science methods and in the interpretation of social science data or business phenomenon (Brewer and Hunter, 2006). Mixed methods and multimethods research approaches appear therefore to offer several merits to leadership scholarship and practice as has been demonstrated in this study. Combining various methods from disparate

disciplines to answer a research question mixing both qualitative and quantitative research design and analysis provides a systems approach to an evidential research outcome that satisfies the numbers and nuances. As with many leadership research, the nature of the problem the illustrative study addressed was such that quantitative approach or qualitative approach, individually, or mono-method research would not have been enough to develop multiple perspectives and a complete understanding of the problem. This research also helps to debunk the notion that systems theory and thinking in leadership has been reduced to just aphorisms (Dalton, 2010).

Mixed methods and multimethods research approaches can bring greater sophistication to the leadership research community in the understanding of social phenomena. These research approaches can reach out across divisions in the leadership research community, and they can strengthen the methodological arsenal of leadership researchers when they apply leadership to real-world social problems (Fielding, 2008). The research study used as an illustration in this paper combined mixed methods and multimethods research approaches to understanding a sociotechnical phenomenon – a skill needs identification for an emerging technology with much promise but also with high social and consumer unease in its application.

MMR in leadership is here to stay, and it will become increasingly used by leadership researchers especially those continually trying to innovate, add value and gain greater insights into increasingly complex social, business and leadership phenomena and transdisciplinary-based inquiry of the 21st Century (Cameron and Molina-Azorin, 2011). However, as it is with any form of shift in academic orientation as described by Kuhn (1996), it will be the early adopters who will have the hard task of laying the ground open for those who wish to follow into the brave new world of mixed methods (Cameron and Molina-Azorin, 2011) and multimethods and this paper has attempted to do just that. The use of mixed methods and multimethods research approaches in leadership should not be because they are becoming growing orthodoxy but because used independently or together they more effectively address critical issues leadership research and practice confront in the 21st Century.

References

- Bass, B.M. (2008) *The Bass Handbook of Leadership: Theory, Research, and Managerial Applications*, 4th ed., Free Press, New York, NY.
- Beinecke, R.H.R. (2009) 'Introduction: leadership for wicked problems', *The Innovation Journal: The Public Sector Innovation*, Vol. 14, No. 1, pp.1–17.
- Brewer, J. and Hunter, A. (2006) *Foundations of Multimethod Research. Synthesizing Styles*, SAGE Publications, Thousand Oaks, CA.
- Bryman, A. (2006) 'Integrating quantitative and qualitative research: how is it done?', *Qualitative Research*, Vol. 6, No. 1, pp.97–113, doi.org/10.1177/1468794106058877.
- Cameron, R. and Molina-Azorin, J.F. (2011) 'The acceptance of mixed methods in business and management research', *International Journal of Organizational Analysis*, Vol. 19, No. 3, pp.256–271, doi.org/10.1108/19348831111149204.
- Campbell, D.T. and Fiske, D.W. (1959) 'Convergent and discriminant validation by the multitrait-multimethod matrix', *Psychological Bulletin*, Vol. 56, No. 2, pp.81–105.
- Connolly, T. and Stanfield, M. (2006) 'Using games-based elearning technologies in overcoming difficulties in teaching information systems', *Journal of Information Technology Education*, Vol. 5, No. 1, pp.459–476, doi.org/10.1.1.151.3749.

- Creswell, J.W. and Clark, V.P. (2011) *Designing and Conducting Mixed Methods Research*, 2nd ed., Vol. 1, Sage Publications Inc., Thousand Oaks, CA.
- Creswell, J.W., Clark, V.P., Gutmann, M.L. and Hanson, W.E. (2003) 'Advanced mixed methods research designs', in Tashakkori, A. and Teddlie, C. (Eds.): *SAGE Handbook of Mixed Methods in Social & Behavioral Research*, 1st ed., pp.209–240, SAGE Publications, Inc., Thousand Oaks, CA.
- Creswell, J.W., Klassen, A., Clark, V.L.P. and Smith, K.C. (2011) *Best Practices for Mixed Methods Research in the Health Sciences*, Office of Behavioral and Social Sciences Research (OBSSR) – NIH, Washington, DC.
- CRD (2009) *Systematic Reviews: CRD's Guidance for Undertaking Reviews in Health Care*, Centre for Reviews and Dissemination (CRD), University of York, Layerthorpe, York, UK: York Publishing Services.
- Dalton, K. (2010) *Leadership and Management Development: Developing Tomorrow's Managers*, Financial Times Prentice Hall, Pearson Education Limited, Harlow, Great Britain.
- Doyle, L., Brady, a-M. and Byrne, G. (2009) 'An overview of mixed methods research', *Journal of Research in Nursing*, Vol. 14, No. 2, pp.175–185, doi.org/10.1177/1744987108093962.
- Dixon-Woods, M., Agarwal, S., Jones, D., Young, B. and Sutton, A. (2005) 'Synthesizing qualitative and quantitative evidence: a review of possible methods', *Journal of Health Services Research Policy*, Vol. 10, No. 1, pp.45–53.
- Feilzer, M.Y. (2009) 'Doing mixed methods research pragmatically: implications for the rediscovery of pragmatism as a research paradigm', *Journal of Mixed Methods Research*, Vol. 4, No. 1, pp.6–16, doi.org/10.1177/1558689809349691.
- Fielding, N. (2008) 'Analytic density, and applied multiple method research', in Bergman, M.M. (Ed.): *Advances in Mixed Methods Research*, pp.37–52, SAGE Publications, Thousand Oaks, CA.
- Fine, G.A. and Elsbach, K.D. (2000) 'Ethnography and experiment in social psychological theory building: tactics for integrating qualitative field data with quantitative lab data', *Journal of Experimental Social Psychology*, Vol. 36, No. 1, pp.51–76, doi.org/10.1006/jesp.1999.1394.
- Greene, J. (2007) *Mixed Methods in Social Inquiry*, John Wiley & Sons, Inc., Jossey-Bass, San Francisco, CA.
- Greene, J.C. (2008) 'Is mixed methods social inquiry a distinctive methodology?', *Journal of Mixed Methods Research*, Vol. 2, No. 1, pp.7–22, doi.org/10.1177/1558689807309969.
- Harden, A. and Thomas, J. (2010) 'Mixed methods and systematic reviews: examples and emerging issues', in Tashakkori, A. and Teddlie, C. (Eds.): *SAGE Handbook of Mixed Methods in Social Behavioral Research*, 2nd ed., pp.749–774, Sage, Thousand Oaks, CA.
- Higgins, J. and Green, S. (2011) *Cochrane Handbook for Systematic Reviews of Interventions. The Cochrane Collaboration*, Version 5, Vol. Vers5.1.0, John Wiley & Sons, Ltd., Chichester, UK.
- Jayanti, E.B. (2011a) 'Through a different lens: a survey of linear epistemological assumptions underlying HRD models', *Human Resource Development Review*, Vol. 10, No. 1, pp.101–114, doi.org/10.1177/1534484310386753.
- Jayanti, E.B. (2011b) 'Toward pragmatic criteria for evaluating HRD research', *Human Resource Development Review*, Vol. 10, No. 4, pp.431–450, doi.org/10.1177/1534484311412723.
- Johnson, R. and Turner, L. (2003) 'Data collection strategies in mixed methods research', in Tashakkori, A. and Teddlie, C. (Eds.): *SAGE Handbook of Mixed Methods in Social & Behavioral Research*, 1st ed., pp.297–320, SAGE Publications, Inc., Thousand Oaks, CA.
- Johnson, R.B. and Onwuegbuzie, A.J. (2004) 'Mixed methods research: a research paradigm whose time has come', *Educational Researcher*, Vol. 33, No. 7, pp.14–26, doi.org/10.3102/0013189X033007014.
- Johnson, R.B., Onwuegbuzie, A.J. and Turner, L.A. (2007) 'Toward a definition of mixed methods research', *Journal of Mixed Methods Research*, Vol. 1, No. 2, pp.112–133, doi.org/10.1177/1558689806298224.

- Kuhn, T.S. (1996) *The Structure of Scientific Revolutions*, 3rd ed., University of Chicago Press, Chicago, IL.
- Leech, N.L. and Onwuegbuzie, A.J. (2007) 'A typology of mixed methods research designs', *Quality & Quantity*, Vol. 43, No. 2, pp.265–275, doi.org/10.1007/s11135-007-9105-3.
- Lubet, A. (2009) 'Disability, music education and the epistemology of interdisciplinarity', *International Journal of Qualitative Studies in Education*, Vol. 22, No. 1, pp.119–132, doi.org/10.1080/09518390802581935.
- Mingers, J. and Brocklesby, J. (1997) 'Multimethodology: towards a framework for mixing methodologies', *Omega*, Vol. 25, No. 5, pp.489–509, doi.org/10.1016/S0305-0483(97)00018-2.
- Morse, J.M. (1991) 'Approaches to qualitative-quantitative methodological triangulation', *Nursing Research*, Vol. 40, No. 1, pp.120–123.
- Mumford, M.D. (2011) 'A hale farewell: the state of leadership research', *The Leadership Quarterly*, Vol. 22, No. 1, pp.1–7, doi.org/10.1016/j.leaqua.2010.12.001.
- Ostlund, U., Kidd, L., Wengström, Y. and Rowa-Dewar, N. (2011) 'Combining qualitative and quantitative research within mixed method research designs: a methodological review', *International Journal of Nursing Studies*, Vol. 48, No. 3, pp.369–383, doi.org/10.1016/j.ijnurstu.2010.10.005.
- Petticrew, M. and Roberts, H. (2006) *Systematic Reviews in the Social Sciences. A Practical Guide*, Vol. 11, Blackwell Publishing Ltd., Oxford, UK, doi:10.1027/1016-9040.11.3.244.
- Pope, C., Mays, N. and Popay, J. (2007) *Synthesizing Qualitative and Quantitative Health Evidence: A Guide to Methods*, Open University Press, Maidenhead, UK.
- Rocco, T.S., Bliss, L.A., Gallagher, S. and Pérez-Prado, A. (2003) 'Taking the next step: mixed methods research in organizational systems', *Information Technology, Learning, and Performance Journal*, Vol. 21, No. 1, pp.19–29, doi.org/10.1.1.122.1050.
- Small, M.L. (2011) 'How to conduct a mixed methods study: recent trends in a rapidly growing literature', *Annual Review of Sociology*, Vol. 37, No. 1, pp.57–86, doi.org/10.1146/annurev.soc.012809.102657.
- Smith, R.L. (1988) *Human Resource Development: An Overview*, ERIC Clearinghouse on Counseling and Personnel Services, Office of Educational Research and Improvement U.S. Department of Education, Ann Arbor, MI.
- Stentz, J.E., Plano Clark, V.L. and Matkin, G.S. (2012) 'Applying mixed methods to leadership research: a review of current practices', *Leadership Quarterly*, Vol. 23, No. 6, pp.1173–1183, doi.org/10.1016/j.leaqua.2012.10.001.
- Tashakkori, A. and Teddlie, C. (2010) *SAGE Handbook of Mixed Methods in Social & Behavioral Research*, 2nd ed., SAGE Publications, Inc., Thousand Oaks, CA.
- Teddlie, C. and Tashakkori, A. (2006) 'A general typology of research designs featuring mixed methods', *Research in the Schools*, Vol. 13, No. 1, pp.12–28.
- Teddlie, C. and Yu, F. (2007) 'Mixed methods sampling: a typology with examples', *Journal of Mixed Methods Research*, Vol. 1, No. 1, pp.77–100.
- Thomas, J. and Harden, A. (2003) 'Practical systems for systematic reviews of research to inform policy and practice in education', in Anderson, L. and Bennett, N. (Eds.): *Developing Educational Leadership*, pp.39–53, SAGE, London, UK, doi:10.4135/9780857024381.
- Uhl-Bien, M. and Ospina, S. (2014) *Advancing Relational Leadership Research: A Dialogue among Perspectives*, Uhl-Bien, M. and Ospina, S. (Eds.), IAP – Information Age Publishing, Inc., Charlotte, NC.
- Van der Fels-Klerx, I.H.J., Goossens, L.H.J., Saatkamp, H.W. and Horst, S.H.S. (2002) 'Elicitation of quantitative data from a heterogeneous expert panel: formal process and application in animal health', *Risk Analysis: An Official Publication of the Society for Risk Analysis*, Vol. 22, No. 1, pp.67–81.

- Wiek, A., Gasser, L. and Siegrist, M. (2009) 'Systemic scenarios of nanotechnology: sustainable governance of emerging technologies', *Futures*, Vol. 41, No. 5, pp.284–300, doi.org/10.1016/j.futures.2008.11.016.
- Wiek, A., Lang, D.J. and Siegrist, M. (2008) 'Qualitative system analysis as a means for sustainable governance of emerging technologies: the case of nanotechnology', *Journal of Cleaner Production*, Vol. 16, Nos. 8–9, pp.988–999, doi.org/10.1016/j.jclepro.2007.04.009.
- Yawson, R.M. (2009) 'The ecological system of innovation: a new architectural framework for a functional evidence-based platform for science and innovation policy', in Huizingh, K.R.E., Conn, S., Torkkeli, M. and Bitran, I. (Eds.): *Future of Innovation: Proceedings of the XX ISPIM 2009 Conference*, pp.1–16, Wiley Education, Vienna, Austria, doi.org/10.2139/ssrn.1417676.
- Yawson, R.M. (2013a) *A Systems Approach to Identify Skill Needs for Agrifood Nanotechnology: A Mixed Methods Study*, A Dissertation Submitted to the Faculty of The Graduate School of the University of Minnesota, University of Minnesota [online] http://conservancy.umn.edu/bitstream/11299/163533/1/Yawson_umn_0130E_13793.pdf (accessed 28 January 2016).
- Yawson, R.M. (2013b) 'Systems theory and thinking as a foundational theory in human resource development – a myth or reality?', *Human Resource Development Review*, Vol. 12, No. 1, pp.53–85, doi.org/10.1177/1534484312461634.
- Yawson, R.M. and Greiman, B.C. (2014) 'Stakeholder analysis as a tool for systems approach research in HRD', in Gedro, J., Chapman, D.D. and Guerdat, K. (Eds.): 'Leading human resource development through research', *Proceedings of the 21st Annual AHRD International Research Conference in the Americas*, Academy of Human Resource Development, Houston, Texas, pp.1–28.
- Yawson, R.M. and Greiman, B.C. (2016) 'A systems approach to identify skill needs for agrifood nanotechnology: a multiphase mixed methods study', *Human Resource Development Quarterly*, online first, pp.1–29 [online] <http://dx.doi.org/10.1002/hrdq.21266> (accessed 28 September 2016).
- Yawson, R.M. and Kuzma, J. (2010a) 'Evidence review and experts' opinion on consumer acceptance of agrifood nanotechnology', *International Conference on Food and Agricultural Applications of Nanotechnologies*, MPRA, Sao Carlos, Brazil, p.24.
- Yawson, R.M. and Kuzma, J. (2010b) 'Systems mapping of consumer acceptance of agrifood nanotechnology', *Journal of Consumer Policy*, Vol. 33, No. 4, pp.299–322, doi.org/10.1007/s10603-010-9134-5.
- Yukl, G. (2012) *Leadership in Organizations*, 8th ed., Pearson Prentice Hall, Upper Saddle River, NJ.