Volume XLV, Number 2 Fall 2014

Journal of Research Administration

eVision

Advancing Research Admin

PROCESS AUTOMATION FOR SCIENTIFIC RESEARCH ADMINISTRATION

MyResearch
Research Team Portal

eREVIEWS
Science, Ethics & Compliance Review

eAWARDS
Awards/Grants Management System

eAWARDS

Full automation of research grants and awards management for research offices and funding agencies

eREVIEWS

Full automation of ethics and compliance management for ethics boards, compliance boards and research offices

MyResearch

One stop researcher portal to manage research projects including CVs, publications, research teams, tasks, milestones, collaborations and notifications

☎ 1 877 679 1113 info@evision.ca www.evision.ca

Journal of Research Administration

SRA International
Published by the Society of Research Administrators International

Prepared by Graphic Arts and Publishing Services
at The Henry M. Jackson Foundation
for the Advancement of Military Medicine, Inc.

6720A Rockledge Drive, Suite 100
Bethesda, Maryland 20817
Rick Crites, Art Director
240-694-2032

2014 Journal Editorial Board

The Journal of Research Administration

The Journal of Research Administration is published by the Society of Research Administrators International, Falls Church, Virginia 22046 USA. Founded in 1967, the Society of Research Administrators International is dedicated to the education and the professional development of research administrators and to enhance public understanding of research and its administration. Representing all disciplines and sectors in research administration, it serves as the international society to promote quality and innovation in research administration. USPS No. 008245. ISSN No. 1539-1590.

Correspondence

Manuscripts are to be submitted to the Editor. Submission of a manuscript is considered to be a representation that it is not copyrighted, previously published, or concurrently under consideration for publishing in print or electronic form. Consult the *Journal* web page (www.srainternational.org/journal) for specific information for authors, templates, and new material. The preferred communication route is through email at info@srainternational.org, Attention: JRA Editor.

Subscriptions

Subscriptions: $100 per year in the United States, Canada, and Mexico; $125 per year international. Make checks payable to *The Journal of Research Administration.* Subscriptions for SRA Members are included in an individual's annual dues. All subscriptions include electronic access to the two yearly print-editions mailed separately via USPS. Send change-of-address notices (together with your address label) and all other correspondence regarding subscriptions and purchase of back issues to Society of Research Administrators International, Executive Office, 500 N. Washington Street, Suite 300, Falls Church, VA 22046 USA. Phone: +1-703-741-0140. Periodicals are postage paid at Falls Church, VA and at an additional mailing office.

Table of Contents

FROM THE EDITOR'S DESK

From the Editor's Desk

Jeffrey N. Joyce, Ph.D.
Kansas City University of Medicine and Biosciences

The *Journal of Research Administration (Journal)* provides a scholarly forum for information and critical analysis of research administration topics to help our members meet their challenges in developing the research enterprise while assuring compliance with a myriad of agencies. This issue reflects the theme of the "inorms" meeting held April 10 – 13, 2014 in Washington, DC at the Washington Hilton. The International Network of Research Management Societies (INORMS) Congress addressed the theme, **"Enabling the Global Research Enterprise from Policy to Practice."** SRA International, a co-sponsor of the meeting along with the Canadian Association of University Research Administrators (CAURA) and the National Council of Research Administrators (NCURA), is a global research management society. The articles in this issue of the *Journal* again reflects the global aspects of our organization and the principles of research administration.

In this issue of the *Journal*, as with all issues, we endeavor to address these major themes, providing strategies for success, insight into regulatory compliance issues, research management, and research development. This issue includes six articles covering a broad range of topics. Derrick and Nickson writing "*Invisible intermediaries: A systematic review into the role of research management in university and institutional research processes*" explore in depth and breadth the literature regarding the definition of "research management" and the lack of empirical data on what are successful strategies for research management. Clearly, the historical and cultural considerations for a changing definition of research management have impacted how we view ourselves and the institutions we work in view us. The current and continually emerging pressures to raise the bar for a successful research enterprise require administrative strategies by "a group of fulltime, professional practitioners in research management/administration. However, the literature is unsure of how to perceive this role. In particular, it is unsure of whether the role of this professional lies as a partner, a servant or as a leader." As the authors point out, the lack of a clear understanding of the role of the research manager(s) within the academic research enterprise is compounded by a lack of empirical data of which strategies are successful.

A topic that is important for developing strategies to increase research capacity is the role of research management in supporting collaborative networks of scientists. However, little formal analysis of the theory of social networking has been applied to research management. In the paper by Huang "*Building Research Collaboration Networks - An interpersonal perspective for research capacity building*" he effectively argues that research collaboration networks are a form of research capacity at interpersonal level, able to complement capacity building at organizational and inter-organizational levels. Proactive development of collaborative networks can be a managerial tool but requires an understanding of social network theory and an evolution of new metrics for measuring success.

In *"Optimizing Institutional Approaches to Enable Research"*, Grieb and co-authors focus on a key requirement of research administrators, that of ensuring there is adequate infrastructure to

create the backbone for cutting edge research. Within the constraints of a university budget, core facilities must be sustained and replaced in order to compete for extramural funding. "The historic high-end, self-sufficient laboratories have been mostly replaced by laboratories that rely on institutionally supported infrastructure (i.e. core facilities)." Decision making about what to support, the cost of the support and the replacement of the core facilities is often not well managed. An institutional approach for enhancing the effectiveness of core infrastructure operations by implementing process improvements, managing the lifecycle of core facilities, and monitoring key core facilities' metrics is described. In doing so, it addresses one of the key concerns raised in the article by Derrick and Nickson, that strategies that engage researchers, promote communication between administrators and researchers, and lead to a collaborative approach to streamline bureaucratic processes engenders success. Michel writes in "*Liaison and Logistics Work With Industrial Advisory Boards*" about her experience with a an administrative operation to provide extraordinary service and support for the relationship between a university research center and an advisory board. While centered on a specific case, the paper provides an invaluable manual of best practices for operating more effective and streamlined advisory board meetings that are required as part of the many programs.

Two papers that were invited for publication after presentation at inorms2014 focus on rapidly changing research and research management in culturally different environments. Ivey and co-authors describe in "*Evaluating the Impact of Research Produced by a Mission-Directed Emergent University*" their institution's commitment to a strategy for a community impact requires a "fidelity-to-mission" of the research management. This focus on a strategy that supported research output that benefited proximate stakeholders ultimately increased the impact for several programs and the university within Jamaica. Finally, Sugihara and co-authors present in "*Development of a System of Strategic Research Administration at Kyoto University*" their strategies to establish an entirely new research capacity building team as part of a traditional research management operation. An entirely new area of research development and support was initiated at several universities simultaneously in Japan, and Kyoto University Research Administration was born almost overnight. How this was accomplished and solutions the team developed for overcoming barriers to success is informative for every university.

This issue of the *Journal* recognizes the strengths and expertise of our global community. We have much to learn from each other, and the *Journal* offers the opportunity to provide to the readership a level of scholarly expertise in our broadening field. I wish to remind all of the readers of the Journal that we want your contributions, and the Editorial Board is committed to helping each author or collaborating authors in the submission of a manuscript. It is your experience, point of view, or analysis of the literature that is important to our entire community.

Please send manuscripts to journal@srainternational.org

ARTICLES

Invisible Intermediaries: A Systematic Review into The Role of Research Management in University and Institutional Research Processes

Dr. Gemma Derrick
Health Economics Research Group (HERG)
Brunel University London
Middlesex, UK

Alicen Nickson, MA Hons, MBA, MSc
Brunel University London
Middlesex, UK

Abstract: *The introduction of competitive rankings and research assessment frameworks have necessitated that research organisations continually monitor their research strengths and weaknesses. Such monitoring is essential to be able to strategically respond in a competitive environment. There is little research on the role of research management in research organisations, including universities, but the literature suggests that when implemented well, research management is an essential component of the research process. Despite this, an evidence-based understanding of the strategies available for successful research management is lacking. In order for organisations to structure their research management strategies more efficiently, as well as to inform practitioners of the best way to deliver their service, an understanding of the evidence for successful research management strategies is needed. The aim of this article is to provide a systematic review to investigate the evidence base for successful research management strategies.*

Keywords: *research support, research management, technology transfer, knowledge transfer, commercialisation, research collaboration*

Introduction

In many countries the introduction of competitive rankings and assessment frameworks have necessitated that universities continually monitor and strategically promote their strengths. This management objective also requires that universities be able to promote and encourage research behaviour that increases the probability of research success using research administrators and/or managers as facilitators. Research administrators are now regarded as key participants in research planning at the department, college, and university levels to attract and manage strategically desirable research and researcher behaviour. In order for organisations to structure their research management strategies more efficiently, as well as to inform practitioners as to the best way to deliver their services, an understanding of techniques and state of the research administration role is needed.

The research management/administration profession has sought to define itself in recent years. In the UK, in 2009 the Higher Education Funding Council for England and Medical Research Council funded a study entitled 'Professionalising Research Management'. The study's main objective was to identify whether there was a demand for the development of a professional framework for the training of Research Managers and, if so, how this demand could be addressed. However, as part of this study, the authors articulated a range of work activities and skill requirements associated with research work. It also identified the variety of research management structures within universities, the levels at which research managers operate, and their involvement at strategic levels within the university. Building on such understandings of 'research management', the UK's National Association of Research Administrators (ARMA) has recently implemented a 'Professional Development Framework' which outlines the 'activities, knowledge, skills and behaviours required across the full range of research management and administration roles' (https://www.arma.ac.uk/professional-development/PDF). This framework describes the key activities at the operational, management and leadership levels. As a result of this framework, the Association has developed professional certificates in research administration, management and leadership. It could be suggested, therefore, that there is now a detailed understanding of the constituent parts that broadly make up 'research management'. However, as noted by Green and Langley (2009), the huge variety in how it is delivered across the sector, and the constant restructuring of research services within universities, suggests a lack of understanding regarding how it can most effectively be delivered. Indeed, recognition that 'research management' lacks the consistency and standardization of professions such as Finance and Human Resources means that it is more difficult for those outside of the profession to understand and value its function, and more complicated to define and situate in terms of its role within a university.

Hockey & Allen-Collinson (2009) state that formal research on administrative/management staff in higher education is lacking (McInnis, 1998; Whitchurch, 2006b; Allen-Collinson, 2006). Research management provides a balance between promoting the needs of institutions to meet their organisational objectives and the ability of academics to determine the best means of performing research. Despite the importance of research management as part of the modern university, there is little consensus within the literature available regarding what are the successful strategies for this profession. In particular, which management models and strategies specifically for the research management profession are the most effective? In addition to that, those outside of the profession are often unsure with regards to what constitutes 'research management', what value it adds, and how best it can be operationalised (Green & Langley, 2009). What is required, therefore, is an evidence-informed understanding of best practice for research management.

The aim of this review is to draw from the literature an understanding of how the role of research management is considered, as well as to investigate the evidence base for successful strategies of research management. By addressing this, this review provides one of the first investigations of both the academic and professional literature of the role of research management. The objective is to review the state of research management/administration research, and to provide a description of the effectiveness of strategies and structures investigated in the literature.

Methodology

The systematic literature review originated as an approach within medical science and healthcare as a way to ensure rigorous secondary research that could be used to inform practice. It is distinct from more narrative approaches to literature review as it adopts 'a replicable, scientific and transparent process, in other words a detailed technology, that aims to minimize bias . . . and by providing an audit trail of the reviewers' decisions, procedures and conclusions' (Tranfield, Denyer & Smart 2003, p.209). This approach is now being used more widely by researchers as a means of assimilating '"best practice" to provide insights and guidance for intervention into the operational needs of practitioners and policy makers' (Tranfield, Denyer & Smart 2003, p.208). As this study seeks to identify evidence to inform research management practice, the methodology is appropriate.

This research involved the key components of a systematic review (Spencer et al., 2003; Buchanan & Bryman, 2009), including:

1. Formulating a research question;
2. Locating studies with the aim of locating, selecting and appraising as many studies as possible that were relevant to the review;
3. Setting exclusion and inclusion criteria to inform study selection;
4. Critically evaluating and appraising the literature selected;
5. Drawing inferences from the literature's recommendations;
6. Making recommendations for future research.

The review model adopted prioritised a divergent/convergent approach which allowed the authors to remain open to the variety of research management literature sources available (initial diverging), but to also employ an empirically structured approach designed to identify the structures and strategies deemed successful by the academic evidence base (subsequent converging).

The diverse nature of the research management field, as well as a hypothesised separation between the academically- and professionally-based literatures, necessitated the adoption of such a semi-structured approach to the consideration of the literature.

Table 1. A Divergent/Convergent Review Process

	***Divergent* Scoping**	***Convergent* Systematic Review**
Aim	Broad	Tightly specified review question.
Scope	Wide	Narrow
Review Plan	Unplanned exploration.	Transparent process with audit trail.
Study identification	Probing selection informed by previous studies read.	Rigorous and comprehensive search using databases and cross referencing.
Study Selection	Studies chosen by reviewer.	Inclusion and exclusion criteria determine selection.
Quality Assessment	Limited critical appraisal.	Formulated assessment of methodological quality.

Adapted from a presentation by Professor Richard Wilding (2010).

Search Strategy

Between the authors, a definition was developed in order to guide the identification of suitable papers and to aid the development of relevant inclusion and exclusion criteria (described below). In addition, the development of a definition for this review was an attempt to maintain some of the characteristics of a systematic review, while adhering to the convergent-divergent model necessary for analysing the social science literature. The following question guided the selection of relevant literature for this review;

> *"What are the successes of different models and structures of research management within research organisations?"*

A list of journals was constructed by the authors that were considered as potential targets for research involving research management. These journals were drawn from the management, innovation, professional, and sociology literature in order to capture as many relevant articles as possible. Following the identification of potentially relevant journals, a series of key words were identified in order to develop suitable search strings. Articles included in the final sample id were:

1. Based on cases, policies or data generated in the US, UK, and Europe;
2. Published in English; and,
3. Published within 2003-2013.

Three unique search strings were employed independently to a representable sample of articles for the review. Each search string was run separately, with the results of each search string then combined and any repeated articles deleted. The number of articles resulting from each search string, with the total number of articles (minus repeats) identified, is shown below in Table 2.

Table 2. Number of articles from each search string run in Web of Science (WoS)

Search String	**Results from WoS**
(Research* OR universit*) AND (Management OR Administration or support)	5693
(Universit* OR research*) AND (knowledge OR technology) AND transfer) OR commercialisation)	927
(Universit* OR research*) AND ("business development" OR collaboration)	1521
Total (excluding repeated articles)	**4211**

The search string described above returned a total of 4211 articles. Articles were then manually checked by GD and AN to eliminate any irrelevant articles including those (i) not relevant to research management or administration, (ii) not focused on academic research either in universities or research organisations, and (iii) did not include a consideration of the structures and strategies of research management. This process successfully eliminated 3842 irrelevant articles.

At the same time, manual checks of the journals initially identified as potential targets, but not indexed by Web of Science, were conducted by GD. This process added a further 55 relevant

articles to the sample. A final, more in-depth consideration of the articles was conducted where each article's relevance to the central research question, according to a detailed analysis of its abstract and full papers, was determined. At the conclusion of this process, articles were automatically discarded if a conflict in classifications between AN and GD still existed. This resulted in 98 articles being included in the final review. A diagram of the above process and the number of articles included at each stage of consideration are included in Figure 1.

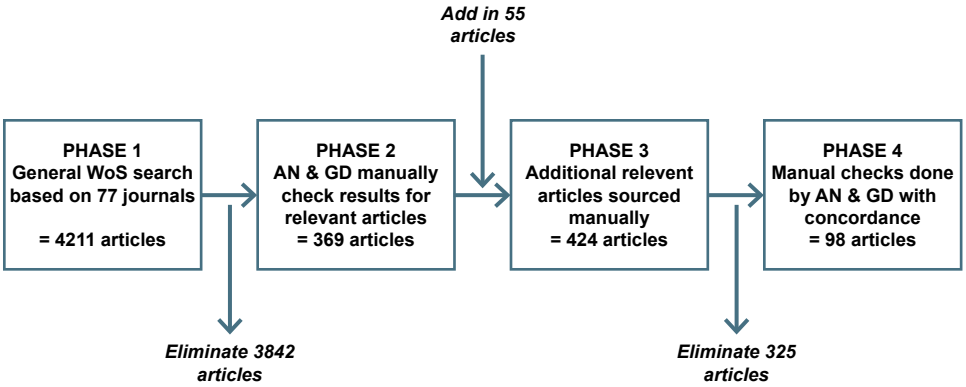

Figure 1. Summary of sources contributing to the systematic review

Analysing Article Characteristics

An analysis of the journals of the articles was performed. The purpose of this analysis stage was to guide the overall review of the literature, especially for the development of themes described in the critical analysis of the literature. A secondary purpose analysing the publication characteristics of the sample articles was to generate quantitative evidence related to the focus of the sample of articles identified.

Critical Appraisal of the Literature

Due to the broad nature of the articles under investigation, a similarly broad appraisal of each article's methodological strengths and weaknesses was adopted. This was especially important considering the sample included qualitative, quantitative, mixed-methods, commentary, and literature review articles. As such, adopting a broad approach to the appraisal of the literature was essential to assess the evidence presented in each article and therefore addressing the objectives of this review. For the empirically-orientated articles, however, the appraisal framework adopted was based on the guidelines presented by Spencer et al (2003) for systematic reviews in the social sciences. These guidelines were then adapted and applied as per the needs of this review relative to the research question and systematic review definition. This included an appraisal of how each article fulfilled its objectives, the representativeness of the sample used, the appropriateness of the methodology employed, and therefore the value of the conclusions. The results of this appraisal relative to the guidelines adopted from Spencer et al (2003), as well as an assessment of

the relevance of the article for addressing the objectives of this review, for each of the 98 articles under investigation are presented in Table 3.

Theme Development

Each paper was also reviewed to identify and understand a variety of themes that emerged in the literature. This approach was useful to address the review objective regarding the current extent of research management/administration literature.

Results

Methodological approaches

There was a relatively equal distribution between articles with a qualitative (44/98) and a quantitative (38/98) focus. These encompassed a variety of different approaches including the use of surveys, interviews, bibliometrics and the use of pre-existing databases for econometric analysis. About 11/98 of the articles in the sample used a combination of qualitative and quantitative (mixed-methods) approaches. The remaining articles did not include a classifiable qualitative or quantitative approach.

An analysis of the journals in which our selected group of 98 articles were published revealed that the majority of articles were published in two distinct journals, Research Policy, and the Journal of Research Administration. This was interesting as Research Policy is a high ranking, academically-focused journal in the innovation and science policy field. In contrast, the other popular journal, the Journal of Research Administration, is a journal that primarily targets research management professionals and is published by the Society of Research Administrators International.

The other journals identified in this analysis as publishing a high proportion of articles included in our sample include Higher Education Quarterly (n=9), and Higher Education Management and Policy (n=6), as well as some traditionally technical journals such as Technovation (n=5), and Technology Analysis & Strategic Management (n=6).

Theme Analysis

The many guises of the research manager in the literature

Many of the studies refer to *"research management"* as a new management profession that now includes its own professional organisations, means of communication and guidelines. In addition, the existence of *The Journal of Research Administration*, produced by the US-based Society of Research Administrators International, and *Research Global*, a magazine produced by the Association of Commonwealth Universities, demonstrate not only the increasing professionalisation of the industry, but the increasing interest in improving management practices and guidelines based on an increasing, empirical evidence base. However, one of the prevailing issues with providing a meaningful evidence base for improving policies and procedures is that

Table 3. Summary of the methodology of articles contributing to the convergent-divergent systematic review

Year	Author	Title	Journal	Qualitative or Quantitative	Approach	Objectives	Direct / Indirect	Country
2003	Drummond.	Strategic Planning for Research Administration	Journal of Research Administration	Qualitative	Literature based discussion	To describe a 7 step plan to implementing research administration professionals within research organisations	Direct	Global
2003	Jacob.	Organising the Academy: New Organisational Forms and the Future of the University	Higher Education Quarterly	Qualitative	Literature review based commentary	Discuss 3 new organisation methods that can be applied to European universities	Indirect	Europe (including UK)
2003	Krauser	The Research Administrator as Servant-Leader	Journal of Research Administration	Qualitative	Literature based analysis	Discussion of the purpose of research administration	Direct	
2003	Sanz-Menendez & Cruz-Castro.	Coping with environmental pressures: public research organisations responses to funding crises	Research Policy	Quantitative	Case study	To analyse how Spanish PROs have adapted to a reduction in the direct transfer of state funds	Indirect	Spain
2003	Siegel, et al.	Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study	Research Policy	Mixed methods	Survey and Interviews	To analyse the relative productivity, and reasons for this productivity, of university based TTOs	Indirect	US
2004	Morphew & Baker.	The cost of prestige: Do new research I universities incur higher administrative costs?	Review of Higher Education	Quantitative	Financial analysis of universities	To investigate the consequences of rising university administration costs	Direct	US
2004	Whitchurch, C.	Administrative Managers – A Critical Link	Higher Education Quarterly	Qualitative	Literature review	To consider the changing roles of university research managers	Direct	Global
2005	Audretsch & Lehmann.	Do University policies make a difference?	Research Policy	Quantitative	Economic analysis of IPOs	Investigate if the university type affects the performance of knowledge based start-ups	Indirect	Europe
2005	Chapple et al.	Assessing the relative performance of UK university technology transfer offices: parametric and non-parametric evidence	Research Policy	Quantitative	Survey	Investigate the efficiency of university technology transfer	Indirect	UK
2005	Ehrenberg.	Why universities need institutional researchers and institutional researchers need faculty members more than both realize	Research in Higher Education	Quantitative	Survey and literature review	To illustrate the importance of data provided by various institutional research administration offices	Indirect	US
2005	Goddard.	Institutional Management and engagement with the knowledge society	Higher Education Management and Policy	Qualitative	Literature case study	To argue that external engagement with business and community poses challenges for the management of Higher Education Institutions (HEIs)	Indirect	UK and Finland

Year	Author	Title	Journal	Qualitative or Quantitative	Approach	Objectives	Direct / Indirect	Country
2005	McAdam et al.	Defining and improving technology transfer business and management processes in university innovation centres	Technovation	Qualitative	Comparative case studies	To investigate how management inputs can be used to suggest improvements for 2 technology transfer processes	Indirect	UK
2005	Olsen.	Constructing a Grants Office Review: A Case Study	Journal of Research Administration	Qualitative	Literature based commentary	Describes a potential model to evaluate a university grants office	Direct	US (NJ)
2005	Porter.	Helpful Gatekeepers: Positive Management of the Limited Submission Process	Journal of Research Administration	Qualitative	Case study	Investigates one case for managing limited grant submission processes	Direct	US
2005	Sapienza.	From the inside: scientists' own experience of good (and bad) management	R & D Management	Mixed methods	Interviews, document analysis, participant observation and surveys	Investigate scientists opinions about effective management	Direct	Europe, Asia and US
2006	Casu & Thanassoulis.	Evaluating cost efficiency in central administrative services in UK universities	OMEGA-International Journal of Management Science	Qualitative	Literature based case study	To re-evaluate expenditure on central administration to identify efficient and inefficient universities	Indirect	UK
2006	Deem.	Changing Research Perspectives on the Management of Higher Education: Can Research Permeate the Activities of Manager-Academics?	Higher Education Quarterly	Qualitative	Comparative case studies	To analyse the extent to which manager-academics in universities use externally generated research in their roles, values and management policies	Indirect	UK
2006	Gjerding et al.	Twenty practices of an entrepreneurial university	Higher Education Management and Policy	Qualitative	Interviews	To analyse the characteristics of entrepreneurial universities in line with Clark (2004)	Indirect	Europe
2006	Mason & Learned.	The Role of "Development" in a Research Administration Office	Journal of Research Administration	Qualitative	Literature based commentary	To discuss how current challenges faced by universities are "development" activities that devises strategies to procure external funding for research administration activities	Direct	US
2006	Roberts.	Everyone's Mentor: Perceptions of Research Administrators on the Value of Certification	Journal of Research Administration	Quantitative	Survey	To investigate the value of certification in research administration	Direct	
2006	Sivrais & Disney.	Changing the Culture of Research Administrators at a Public University	Journal of Research Administration	Qualitative	Case study	Describe a case of how the University of Michigan changed and sustains a research administration culture	Direct	US

2007	Atkinson et al.	The Dimensions of Influence on Research Administrator Behavior: Toward a Theoretical Model of Research Administration as a Public Service Profession	Journal of Research Administration	Qualitative	Literature review analysis	Creates a theoretical model of the research administrator profession based on the literature of the sociology of "professions"	Direct	US
2007	Bartunek.	Academic-practitioner collaboration need not require joint or relevant research: Toward a relational scholarship of integration	Academy of Management Journal	Qualitative	Literature review analysis	How management research published in the AMJ influences practice	None	Global
2007	Cole.	Research Administration as a Living System	Journal of Research Administration	Quantitative	Delphi-survey study	Analyse the opinions about how changes in research administration stimulates growth and collaboration with researchers	Direct	US
2007	Decter et al.	University to business technology transfer - UK and USA comparisons	Technovation	Quantitative	Survey	To compare the function and successes of UK and US Technology Transfer Offices	Indirect	US and UK
2007	D'Este & Fontana.	What drives the emergence of entrepreneurial academics? A study on collaborative research partnerships in the UK	Research Evaluation	Quantitative	Existing data from the EPSRC collaboration grants 1991-2003	To study the patterns of engagement in collaborative , university-industry research among university researchers	Indirect	UK
2007	D'Este & Patel.	University-industry linkages in the UK: What are the factors underlying the variety of interactions with industry?	Research Policy	Quantitative	Existing data from the EPSRC collaboration grants 1991-2004	To examine the nature of channels used by researchers to interact with industry and the factors influencing researcher engagement with these interactions	Indirect	UK
2007	O'Shea et al.	Delineating the anatomy of an entrepreneurial university: the Massachusetts Institute of Technology experience	R & D Management	Quantitative	Case study	To describe the factors associated with successful academic entrepreneurship at MIT	Indirect	US
2007	Rutherford & Langley.	Implementation of Systems to Support the Management of Research: Commentary from a UK University Perspective	Journal of Research Administration	Qualitative	Case study	To comment on the implementation of a research management system in the UK university sector	Direct	UK
2007	Sousa & Hendriks.	That obscure object of desire: The management of academic knowledge	Minerva	Qualitative	Interviews	Explore how research management perceive research quality and how it is managed.	Direct	The Nether-lands
2007	Vargas & Hanlon.	Celebrating a Profession: The Servant Leadership Perspective	Journal of Research Administration	Qualitative	Commentary	To discuss the model of research managers as "servant leaders"	Direct	US
2007	Ward.	Academic values, institutional management and public policies	Higher Education Management and Policy	Qualitative	Literature based analysis	How new university revenue streams have influenced university management	Indirect	US
2008	Boardman & Corley.	University research centers and the composition of research collaborations	Research Policy	Quantitative	Survey analysis	Identifies how centre-level attributes affects research collaboration	Indirect	US

Year	Author	Title	Journal	Qualitative or Quantitative	Approach	Objectives	Direct / Indirect	Country
2008	Burnside & Witkin.	Forging successful university-industry collaborations	Research-Technology Management	Qualitative	Case study	To describe the establishment of a collaborative agreement between Hewlett-Packard, University of California Berkeley and the Bay Area Science and Innovation Consortium	Indirect	US
2008	Jong.	Academic organizations and new industrial fields: Berkeley and Stanford after the rise of biotechnology	Research Policy	Quantitative	Comparative case studies	Outlines how industry ties opens opportunities for scientific institutions builders to strengthen the legitimacy of their fields of scientific enquiry	Indirect	US
2008	Kirkland, J.	University research management: an emerging profession in the developing world	Technology Analysis & Strategic Management	Qualitative	Literature review	Investigate the importance of research management in developing countries	Direct	
2008	Lintz, E.	A Conceptual Framework for the Future of Successful Research Administration	Journal of Research Administration	Qualitative	Conceptual model	Presents a conceptual model for research administration	Direct	US based
2008	Mullen et al.	Listening to Those We Serve: Assessing the Research Needs of University Faculty	Journal of Research Administration	Quantitative	Survey	To identify the impediments, as perceived by university staff, that influence research	Direct	US
2008	Sá.	University-Based Research Centers: Characteristics, Organization, and Administrative Implications	Journal of Research Administration	Qualitative	Interviews and document analysis	Examine the characteristics and organisational values associated with university-based research centres	Indirect	US
2008	van der Heide et al.	The institutional organisation of knowledge transfer and its implications	Higher Education Management and Policy	Qualitative	Comparative case studies	Investigates how universities have embedded knowledge transfer activities	Direct	Europe
2008	van der Weijden et al.	Implications of managerial control on performance of Dutch academic (bio)medical and health research groups	Research Policy	Quantitative	Survey	To examine the relationship between managerial control and research performance of academic groups	Indirect	The Nether-lands
2008	Whitchurch.	Shifting Identities and Blurring Boundaries: the Emergence of Third Space Professionals in UK Higher Education	Higher Education Quarterly	Qualitative	Interviews	To understand university professional administration	Indirect	UK, US and Australia
2008	Woodfield & Kennie.	'Teamwork' or 'Working as a Team'? The Theory and Practice of Top Team Working in UK Higher Education	Higher Education Quarterly	Qualitative	Comparative case studies	To explore the different ways that universities organise their senior management teams	Indirect	UK
2008	Wright et al.	Mid-range universities' linkages with industry: Knowledge types and the role of intermediaries	Research Policy	Qualitative	Interviews	To examine the processes involved in universities' interaction with industry in mid-range European universities.	Indirect	Europe

2008	Young et al.	Intellectual Property management in publicly funded R&D centres - A comparison of university-based and company-based research centres	Technovation	Mixed methods	Survey and interviews	To explore the difference in IP management practices at PRCs in universities compared to firms, and how these influence knowledge spillover	Indirect	Northern Ireland
2009	Arena et al.	Developing a Performance Measurement System for University Central Administrative Services	Higher Education Quarterly	Mixed methods	Comparative case studies	Evaluate the success of a Performance Management System	Indirect	Italy
2009	Barboll & Corredera.	Critical factors for success in university-industry research projects	Technology Analysis & Strategic Management	Quantitative	Case study	Identify factors of successful and unsuccessful technology transfer	Indirect	Spain
2009	Blackman & Kennedy.	Knowledge management and effective university governance	Journal of Knowledge Management	Qualitative	Case study	To identify the relationship between knowledge processes and governance structures	Indirect	Australia
2009	Boardman.	Government centrality to university-industry interactions: University research centers and the industry involvement of academic researchers	Research Policy	Quantitative	Survey	Identify personal and professional characteristics that affect how scientists interact with private companies	Indirect	US
2009	Boardman & Ponomariov.	University researchers working with private companies	Technovation	Quantitative	Survey	How different types of university research centres affect individual level university-industry interactions	Indirect	US
2009	Geuna & Muscio.	The Governance of University Knowledge Transfer: A Critical Review of the Literature	Minerva	Qualitative	Literature based analysis	To critically discuss models of university knowledge transfer	Indirect	Global
2009	Heinze et al.	Organizational and institutional influences on creativity in scientific research	Research Policy	Mixed methods	Survey, interviews, archive and bibliometric analysis	To analyse the organisational factors that influence scientific creativity	Indirect	Europe (incl UK) and US
2009	Hockey & Allen-Collinson.	Occupational Knowledge and Practice amongst UK University Research Administrators	Higher Education Quarterly	Mixed methods	Surveys and interviews	Investigate what knowledge is required for research administration in UK universities	Direct	UK
2009	Nosella & Grimaldi.	University-level mechanisms supporting the creation of new companies: an analysis of Italian academic spin-offs	Technology Analysis & Strategic Management	Quantitative	Survey	To investigate the role of policies and strategies in Italian university TTOs in creating spin-off companies	Indirect	Italy
2010	Albors-Garrigos.	New R&D management paradigms: rethinking research and technology organizations strategies in regions	R&D Management	Quantitative	Survey	No firm conclusions drawn and no new R&D management paradigm constructed. A relationship between different variables conducted.	Indirect	Spain
2010	Auranen & Nieminen.	University research funding and publication performance-An international comparison	Research Policy	Quantitative	Bibliometric analysis	How funding systems vary between countries and whether more competitive systems produce more publications	None	Mixed

Year	Author	Title	Journal	Qualitative or Quantitative	Approach	Objectives	Direct / Indirect	Country
2010	Brostrom.	Working with distant researchers-Distance and content in university-industry interaction	Research Policy	Quantitative	Survey	Studies the role of geographical proximity for interaction on R&D for engineering	Indirect	Sweden
2010	Bruneel et al.	Investigating the factors that diminish the barriers to university-industry collaboration	Research Policy	Quantitative	Survey	Explore the effect of collaboration experience, breadth of interaction, and inter-organisational trust on barriers to industry collaboration	Indirect	UK
2010	Caldera & Debande.	Performance of Spanish universities in technology transfer: An empirical analysis	Research Policy	Quantitative	Survey	Investigate the role of university policies and science parks on technology performance	Indirect	Spain
2010	Chun.	Building a Research Administration Infrastructure at the Department Level	Journal of Research Administration	Qualitative	Case study	To investigate a university's reduction in its research administration burdens	Direct	US
2010	Cole.	Reframing Research Administration	Journal of Research Administration	Quantitative	Delphi-survey study	Compares the views received from research faculty and research administration about restructuring research administration	Direct	US
2010	Gururajan & Fink.	Attitudes towards knowledge transfer in an environment to perform	Journal of Knowledge Management	Mixed methods	Focus groups and survey	To determine the attitudes that impact knowledge transfer between academics in universities	Indirect	Australia
2010	Halilem.	Inside the Triple Helix: An Integrative Conceptual Framework of the Academic Researcher's Activities, a Systematic Review	Journal of Research Administration	Qualitative	Systematic review	To determine what are researcher activities, the institutional determinants of these activities, and the determinants of researcher roles	Indirect	Global
2010	Philbin.	Developing and Managing University-Industry Research Collaborations through a Process Methodology/Industrial Sector Approach	Journal of Research Administration	Qualitative	Case study	To describe a framework successfully employed at University College London to improve the research development and the management of industrially funded research collaborations	Indirect	UK
2010	Shelley.	Research Managers Uncovered: Changing Roles and 'Shifting Arenas' in the Academy	Higher Education Quarterly	Mixed methods	Survey and document analysis	To examine the changes in the role, status and professional identity of research managers in universities	Direct	UK
2010	Tello et al.	Individual choice or institutional practice Which guides the technology transfer decision-making process?	Management Decision	Qualitative	Interviews	To examine how technology transfer officer's heuristics and biases influence technology commercialisation.	Indirect	US

2010	Vogelgesang et al.	What Determines Faculty-Engaged Scholarship?	Review of Higher Education	Quantitative	Survey	To explore faculty members' perceptions of institutional support and the increased likelihood of engaging in scholarship in local communities.	Indirect	US
2010	Zalewska-Kurek et al.	The impact of the autonomy and interdependence of individual researchers on their production of knowledge and its impact: an empirical study of a nanotechnology institute	Research Evaluation	Quantitative	Survey and bibliometric analysis	To discuss how to manage and organise research to maximise performance	Indirect	UK
2011	Conti & Gaule.	Is the US outperforming Europe in university technology licensing? A new perspective on the European Paradox	Research Policy	Quantitative	Survey	To investigate the "European Paradox" through analysis TTO activity in Europe and the US	Indirect	US and Europe
2011	Hall.	University Research Centers: Heuristic Categories, Issues, and Administrative Strategies	Journal of Research Administration	Qualitative	Interviews and survey	To illuminate centre types, issues and strategies used to address issues under each centre type	Indirect	US
2011	Johnson.	Managing university technology development using organizational control theory	Research Policy	Qualitative	Literature based theory	Discuss university-industry technology transfer processes	Indirect	Global
2011	Lam.	What motivates academic scientists to engage in research commercialization: 'Gold', 'ribbon' or 'puzzle'?	Research Policy	Mixed methods	Interviews, survey	To examine scientists' motivations to engage in commercialisation	Indirect	UK
2011	Leisyte & Horta.	Introduction to a special issue: Academic knowledge production, diffusion and commercialization: policies, practices and perspectives	Science and Public Policy	Introduction to a special issue	N/A	To review the papers related to, changing national science policies and their influence on knowledge management in universities, and the impact of policies on academic knowledge production, diffusion and commercialisation	Indirect	Europe
2011	Philbin.	An Investigation of the Development and Management of University Research Institutes	Journal of Research Administration	Qualitative	Case study	To discuss the management activity within the first two years of a research institute and any difficulties	Indirect	UK
2011	Waite.	Research Administrators as Servant Leaders	Journal of Research Administration	Qualitative	Literature review	Investigate how research managers can effectively facilitate successful grant applications	Direct	Global
2012	Berbegal-Mirabent et al.	Brokering knowledge from universities to the marketplace The role of knowledge transfer offices	Management Decision	Quantitative	Analysis of patents, revenues, number of spin offs	Investigate the role and factors related to successful knowledge transfer offices	Indirect	Spain
2012	Clausen et al.	Mobilizing for change: A study of research units in emerging scientific fields	Research Policy	Quantitative	Survey	Investigate the factors that influence the success of local research units	Indirect	Global

Year	Author	Title	Journal	Qualitative or Quantitative	Approach	Objectives	Direct / Indirect	Country
2012	Hewitt-Dundas.	Research intensity and knowledge transfer activity in UK universities	Research Policy	Quantitative	Use of Higher Education Business and Community Interaction Survey	To investigate the relationship between university research performance and their knowledge transfer activity	Indirect	UK
2012	Kenna & Berche.	Critical masses for academic research groups and consequences for higher education research policy and management	Higher Education Management and Policy	Quantitative	Bibliometric analysis	To explore the nature of critical mass in smaller, research-intensive universities in terms of research management and policy	Indirect	UK
2012	Martins & Meyer.	Organizational and behavioural factors that influence knowledge retention	Journal of Knowledge Management	Quantitative	Survey	To identify and explore organisational and behavioural factors that influence knowledge sharing.	Indirect	South Africa
2012	Mom et al.	The skills base of technology transfer professionals	Technology Analysis & Strategic Management	Mixed methods	Survey and interviews	To identify and assess the skills necessary for technology transfer professionals	Direct	European
2012	Sa & Tamtik	Strategic planning for academic research	Higher Education Management and Policy	Qualitative	Content analysis and interviews	To analyse how strategic planning has been applied to research	Indirect	Canada
2012	Teelken.	Compliance or pragmatism: how do academics deal with managerialism in higher education? A comparative study in three countries	Studies in Higher Education	Qualitative	Interviews	To explore the effect of managerial measures on European universities	Indirect	Europe
2012	Volberda et al.	Technology transfer: the practice and the profession	Technology Analysis & Strategic Management	N/A	Commentary (introduction to a special issue)	To introduce a special issue on Technology Transfer.	Direct	Global
2012	Wilbon.	Interactive planning for strategy development in academic-based cooperative research enterprises	Technology Analysis & Strategic Management	Qualitative	Case study	To evaluate the approaches taken by university-based research collaboratives to support strategic management	Indirect	US
2013	Amayah.	Determinants of knowledge sharing in a public sector organization	Journal of Knowledge Management	Quantitative	Survey analysis	Investigate factors that affect knowledge sharing	Indirect	US
2013	Ankrah et al.	Asking both university and industry actors about their engagement in knowledge transfer: What single-group studies of motives omit	Technovation	Qualitative	Comparative case studies	Examine the motives of academic and industry to engage in knowledge transfer	Indirect	UK

2013	Bosua & Venkitachalam.	Aligning strategies and processes in knowledge management: a framework	Journal of Knowledge Management	Qualitative	Comparative case studies	To illustrate the importance of aligning knowledge management strategies with processes.	Indirect	Australia and New Zealand
2013	Bozeman & Boardman.	Academic Faculty in University Research Centers: Neither Capitalism's Slaves nor Teaching Fugitives	Journal of Higher Education	Quantitative	Survey analysis	Investigate the effect of university and industry interactions on organisational outcomes	Indirect	US
2013	Chen et al.	A sustainable collaborative research dialogue between practitioners and academics	Management Decision	Quantitative	Survey and content analysis	To investigate the co-production of knowledge via the collaboration between management academics and practitioners	Indirect	Global
2013	Chirikov.	Research universities as knowledge networks: the role of institutional research	Studies in Higher Education	Qualitative	Comparative case studies	Investigate the best method for structure, staffing and responsibilities of the institutional research office	Indirect	Russia
2013	Derrick & Bryant.	The role of research incentives in medical research organisations	R & D Management	Mixed methods	Interviews and bibliometric analysis	Investigate institutionalised financial incentive programs to encourage high impact publishing and commercialisation engagement	Indirect	Australia
2013	Edgar & Geare.	Factors influencing university research performance	Studies in Higher Education	Quantitative	Survey	To identify the management practices associated with superior research performance	Indirect	New Zealand
2013	Freitas et al.	Finding the right partners: Institutional and personal modes of governance of university-industry interactions	Research Policy	Quantitative	Pre-existing survey data	To compare two forms of university-industry interaction (institutional and personal forms of governance)	Indirect	Italy
2013	Konig et al.	A framework for structuring interdisciplinary research management	Research Policy	Qualitative	Case study	To develop a framework for addressing the needs of interdisciplinary research management	Indirect	Europe
2013	Whitchurch & Gordon.	Reconciling Flexible Staffing Models with Inclusive Governance and Management	Higher Education Quarterly	Qualitative	Interviews	To investigate how institutional management and governance practices facilitate innovative developments	Indirect	UK

research management and/or administration is still regarded by the literature as an abstract concept. Indeed, even defining *"administrators"* as a distinct occupational group is problematic, as Dobson and Conway highlight:

> *"There is little recognition beyond administrators themselves that a definable occupational grouping exists. The existence of administrators with qualifications equal to those of a university's professors is a new phenomenon, and not all these 'super administrators' are simply academics who have transferred from academe."* (2003, p. 125; quoted in Whitchurch, 2006b, p. 11)

The above statement from an article within the literature sample demonstrates how a new professional base for "research administrators" has developed that includes professionals who do not necessarily possess an academic background or direct experience in academic research.

Within the literature analysed there was a lack of a single, definitive definition of what research management is and what it does. Kirkland (2008) provided a brief description of research management and how it relates to the research process within universities. According to Kirkland (2008), research management is an "activity institute" at the level of the institution which seeks to add value to the research activity of academic staff, without being part of the research process itself. This definition does indeed provide a description but it regards research managers as a passive group of professionals separated from the activity of researchers and yet members of the same institution. Further to Kirkland′s description, research management has been described in other abstract forms such as servant leaders (Krauser, 2003), gate keepers, intermediaries, facilitators, enablers, and in some cases, a broker. Siegel et al (2003) defined the role of research management as facilitators of technological diffusion. Carlsson & Fridh (2002) defined knowledge brokers as a subset of research management, as a role that assists researchers in the dissemination of research results for the public good. All of these descriptions suggest that, in contrast to Kirkland′s definition, research management is an active and important part of the research process, rather than a passive and separated group of non-researchers. This is not to say that Kirkland′s (2008) definition is not without merit, but to illustrate that within the literature the concept of the research manager is undefined and it is still unclear. Furthermore, it is clear from the variety of concepts used to define research management, that research management is involved in influencing many aspects of the research process. The literature suggests that research management plays an important role in the research processes that result in technology transfer, knowledge brokering and sharing, scientific collaboration, grant success, industry involvement, productivity through publications, and even university student outcomes. However, within these studies, although research management is regarded as a role that exists and is important, its specific nature and the characteristics of those who perform this role are overlooked. Issues associated with overlooking the direct consideration of research management as a dependent variable in the literature is discussed in detail below.

Atkinson et al (2007) attempted to define research management as a profession by creating a theoretical model based on the sociology of "professions". He argued that research administration represented a legitimate profession that supports a defined field of knowledge, protects individuals who are dependent on the profession (researchers), hosts a level of specialisation, and is guided

by a set of ethics. Although not empirically-based, Atkinson´s et al (2007) model provided a representation of a "research administrator" or "research manager". In addition, the resulting model proposed how many factors within the research environment, including the institution and professional organisations, dictate how the profession responds to issues. Hockey & Allen-Collinson (2009) provide a definition of research administration that regards the role as a partner in the research process. According to their 2009 article, research administrators play an important part in formulating, developing, supporting, monitoring, evaluating and promoting the research and research-degree activity of their universities. This recognition of research management as a partner in the research process was first brought to light as a result of universities' need to secure additional competitive research funding from a variety of sources (Hockey & Allen-Collinson, 2009) not traditionally considered by universities (Miller, 1995). This description reflects one of the five factors driving the institution-led research management that was proposed by Kirkland (2008). Whitchurch (2006a) has argued for the concept of a 'hybrid' or 'multi-professional' identity for those staff members who demonstrate the ability to cross functional boundaries. These professionals often perform translational and interpretive functions between different constituencies, and many research administrators appear to hold such a hybrid identity (Allen-Collinson, 2006). Whilst in the past a clear boundary was perceived between the 'academic administration' and 'academic staff', with the former being seen as 'serving' the latter, nowadays the term tends increasingly to refer to registry and secretariat functions (Whitchurch, 2006b) where administrators act as 'guardians of the regulations' (Barnett, 2000: 133).

A polarising definition of research management was presented in Krauser (2003) and Vargas & Hanlon (2007). These articles referred to research managers as "servant leaders". Under this definition, the primary responsibility of the research manager was to *"to serve our researchers so they may concentrate on the research"*. Parolini (2004) suggested that, *"Servant leaders are defined by their ability to bring integrity, humility, and servanthood into caring for, empowering, and developing of others in carrying out the tasks and processes of visioning, goal setting, leading, modeling, team building, and shared decision-making"* (p. 9). This description of research management contrasts with those descriptions above that emphasise the importance of a partnership between researchers and research managers. In addition, Krauser's (2003) definition suggests a more manipulative role for research managers, where research managers must be kind, loving, attentive, intelligent, and reasonable towards researchers only so *"we can better accomplish that by serving first, teaching well and leading in such a manner that people aren't even aware that they are being led."* This definition also assumes that research managers, in other words, *"should serve so that they may lead."* Vargas and Hanlon (2007) described the primary goals of research administrators, *"to both serve and lead our researchers (faculty), while still keeping in mind our responsibilities to our institutions, sponsors, and community"* (p. 45). This hypothesised definition and goals, although not empirically tested by either Krauser (2003), or the later study by Vargas & Hanlon (2007), assumes that researchers view research administrators as troublesome, forcing the research administrators to win trust by *"serving as a resource to our researchers"* (Vargas & Hanlon, 2007). Although, Krauser (2003) did state that once trust was established, that researchers stopped viewing researcher administrators as *"troublesome"*.

The Technology Transfer Office and Research Management

A considerable amount (20/98) of the literature examined the role of the Technology Transfer Office (TTO) in a research organisations' and researchers' output production performance. Within this group of articles, a smaller group identified the personnel of these TTOs as an important variable to consider when investigating the production of research outputs. However, a number of other variables associated with the TTO were considered when investigating how characteristics of the TTO were associated with productivity, efficiency and research outcomes. These included the TTO size, TTO age, the volume of TTO activity and the degree of TTO specialisation.

From the literature analysed, an important mechanism by which it considers the role of research management is through their investigation of Technology Transfer Offices (TTO). Siegel & Wright (2007) explained how research organisations that established TTOs are keen to exploit the commercial products already embedded within their research that would perhaps not be exploited without the help of trained professionals and policies. As such, the specialisation and the professionalism of TTOs have become imperative for the success of organisational technology transfer. This is because organisations need to consider either developing or acquiring a broad range of capabilities that will allow them to commercialise a technological invention. As a response, a market for technology transfer training has emerged in which professional associations and private training providers have attempted to support the specialisation and professionalism of TTOs. The emergence of this market is reflected in how the academic literature perceives the activities of the TTO as related to the consideration of research management.

Many articles focused on technology transfer as reflective of research management. Despite the rather narrow consideration of research management as solely through technology transfer, there are important inferences that can be drawn regarding the strategies and structures considered successful by our article sample. Indeed, as suggested by Volberda et al (2012), understanding technology transfer raises questions with regard to the pool of capabilities organisations need to develop to ensure the successful commercialisation of a technological invention. This consideration is central to our research objective related to identifying strategies and structures of successful research management/administration.

Disguising the Role of Research Management

Within the literature, two levels of analysis of the role of "research management" were considered: the Direct (28%); and the Indirect (72%). For the purposes of this review, "indirect" research management is defined when the role of research management and/or the research manager, was considered as part of a larger, overarching variable such as, for example only: organisational culture, institutional support, the TTO, support services, and knowledge management. In contrast, "direct" research management was when the characteristics of research management were assessed directly and as the primary dependent variable, for example with Drummond (2003), Sousa & Hendrick (2007), and Shelley (2010).

It is interesting to note that over 60% of the articles that considered research management as a direct variable were from the Journal of Research Administration. This is not surprising as

the profession has better understanding of its own role than external actors and, possibly, more interest in exploring how best to operate. However, these studies tended to be more localised to particular experiences and not empirically tested. A majority of the research identified in this review visualised the interaction between research and non-research actors, such as industry, etc., as essentially a linear process. Hewitt-Dundas (2012) argues that the traditional conception of a linear innovation process has been adopted by the majority of the literature. This process assumes that two actors are involved in the research-industry relationship where the ability for research to be communicated to non-research actors is influenced primarily by the motivations, characteristics and values of the actors involved. The preoccupation with the linear model overshadows a more complex, multidirectional and iterative process that involves multiple actors. Although the field of research management is developing towards a perception that the process involves more than just the relationship between research and industry and research and society, unfortunately, it still overlooks the importance of research management as an independent system that determines knowledge transfer success, thereby considering the research management variable directly rather than indirectly. This continued overshadowing also overlooks the possibility that changes in research management structures and strategies can be an important avenue for research organisations wishing to push knowledge transfer outcomes in desired directions. As shown in the literature sample, very few research studies attempted to view this intermediary role directly as a physical actor or consider the characteristic motivations and values of these actors (direct). Instead, these variables are dissolved under macro-level variables (indirect) such as organisational culture, research climate, or the support structures of the university or knowledge transfer office. Therefore, this overlooks the value that research management adds to facilitate research outcomes within organisations. This conception by the innovation and research policy literature contributes to intermediary actors, such as research management personnel, remaining invisible.

Caldera & Debande (2010) consider the role of "intermediaries" to facilitate partnerships and knowledge and technology transfer. However, they fail to capture or consider the individual characteristics of these intermediaries beneath a surface-level definition of "research management". In addition, many of the studies assessing the effects of organisational and institutional attributes on research activity have focused on university-level characteristics (e.g., total research expenditures, quantity of faculty, institutional prestige) and aggregated, university-level production (e.g., of patents, Payne and Siow, 2003; Carlsson and Fridh, 2002; Coupe, 2003; Foltz et al., 2003; and of licensing agreements, Turk-Bicakci and Brint, 2005). Often these studies do not explain the effect of organisational policies or other indirect research management variables on less salient research outcomes such as grant success, publication numbers, university rankings etc. They also do not explain the impact of these policies on individual researchers and/or teams. In addition, as is discussed below, the indirect consideration of research management affects the types, and practical application, of many of the recommendations made by these articles about strategies associated with effective research management and managers.

Perhaps a reason that the explicit representation of research management has been neglected within the primarily academic literature lies in an explanation provided by Hockey & Allen-Collison (2009) where the possession of academic capital has elevated the status of the role of researchers

relative to other occupational groups within the social system. This, they argue, has allowed researchers to exclusively label themselves as central to the university mission to the detriment of other groups which are then labelled as peripheral (Kimber, 2003) and classified as "support staff". With the social system and the researchers perceiving support staff as secondarily influential to the organisational mission, there is no ability to consider their role as a direct influence. Furthermore, as research management does not always cohere into an independently distinct grouping (such as finance or human resources), it can be more complicated to separate out the activity within an organisation. Research managers' influence, therefore, is classified into descriptive, overarching and indirect variables such as "organisational climate."

Nonetheless, the analysis of the strategies and structures identified in the sample of literature described below will discuss those studies considering direct and indirect research management indirectly and directly together.

Success of Strategies and Structures Identified in the Literature

This section provides an overview of the strategies and structures presented in the literature, as well as a brief discussion regarding the relative success of these strategies, and an identification of the most frequently reoccurring strategies suggested within the literature.

Although only a few studies concentrated on the direct involvement of research administration/management professionals, a few common characteristics of successful practice did emerge. It must be noted, however, that within our sample the vast majority of these characteristics were presented as suggestions only and were not tested empirically regarding their level of success or any benefits to the organisation, researcher or professional. Indeed, the structures and strategies presented in the sample of research articles were frequently suggested by authors as potential avenues for research administration but not rigorously tested for their effectiveness. This was primarily the case for articles that were published in the practice-based journals, such as the Journal of Research Administration. On the other hand, in many cases where suggestions were based on the results of variables tested that were only indirectly related to research management, these occurred in the academic-based journals such as Research Policy, or Technovation.

One of the more popular strategies for research management explored in our sample of articles was the use of "incentives" or "rewards". The existence of incentive structures as a method to influence researchers towards desirable behaviour was described as a characteristic of entrepreneurial universities (Gjerding et al, 2006). So-described "desirable researcher behaviour" referred to management of incentive programs that rewarded engagement in knowledge transfer (Young et al, 2008), commercialisation (O'Shea et al, 2007; Derrick & Bryant, 2013), publication success (Derrick & Bryant, 2013), and knowledge sharing (Martins & Meyer, 2012). In addition, one case study included an incentive program for the activity of submitting grant applications, regardless of its success (Masen et al, 2006). The lack of properly-targeted incentive structures was identified as a major barrier to engagement (Siegel et al, 2003; Decter et al, 2007; and Guruajan & Fink, 2010). In particular, Siegel et al (2003) investigated the organisational factors associated with increased TTO productivity and found that interviewees identified the lack of rewards for TTO engagement as one of the major limiting factors to further engagement. Likewise, Decter

et al (2007) analysed the reasons for the success of TTOs in the US and the UK. As with Siegel et al (2003), the study suggested that a lack of an incentive structure in UK TTOs was a reason for their relative lack of success compared to their US counterparts. In total, 14 of our 98 studies included either a description or an analysis of an incentive structure. However, the incentive itself was not always financial, but also non-financial incentives such as special commendations (van der Weijen et al, 2008) and rewarding "individual merit" (Sa et al, 2008). Despite this, financial incentives were the more popular strategies investigated. However, the perceived benefit of financial incentives as motivators for desirable research behaviour is questioned by Martins & Meyer (2012). In this article, the variable "financial reward" was negatively associated with knowledge sharing. This questions the assumption that financial incentive policies work in all organisations as a motivational tool. Indeed, the study by Derrick & Bryant (2013) analysed a number of different incentive programs in research organisations that aimed to increase the number of publications in high impact journals, and success of commercialisation ventures. Using a mixed-methods framework, this study found that incentive programs were only successful when they aimed to reward already existing objectives of the researchers, such as high impact publishing. Conversely, success modifying behaviour and the update of incentivised programs were limited when researchers did not already consider those activities to be included in their roles (Derrick & Bryant, 2013).

Another major research administration strategy investigated was the flexibility of organisational policies governing the autonomy of researchers, and the perceived ease in which researchers can engage in desirable activities. Seyd (2000, p. 35) has portrayed how academics are typified by administrators as: *'unworldly, unreliable, incompetent at managerial and administrative tasks and never in the office when needed to deal with urgent student issues';* whilst from an academic's perspective, administrators may be viewed as *'rule-bound, bureaucratic, more concerned with process and systems than with the substance of issues and lacking in imagination'* (Seyd, 2000). Previous research has suggested that, where possible, a good research management strategy should not produce central control, or even supervision, but will combine a framework within which academics make their own decisions and a system to identify any emerging problems at an early stage. Hollingsworth (2000, 2002) and Hage (2006) have published on organisational structures that foster breakthrough research, however, the role of organisational structures on academic outputs is neglected by the literature.

Within the sample of articles, the concern of overly-restrictive bureaucracy was highlighted as a barrier. Siegel et al (2003) used a mixed-method approach which includes interviews with industry entrepreneurs, scientists and research administrators at five US research universities. One of the major barriers identified by all three groups of interviewees was restrictive university bureaucracy and the inflexibility of research administrators. This concern of overly bureaucratic university policies was echoed in McAdam et al (2005), Cole (2007), Mullen et al (2008), Bruneel et al (2010), Philbin (2010), and Edgar & Geare (2013). Indeed, Gjerding et al (2006) singled out "administrative flexibility" as a component that characterised a university as entrepreneurial. Other research articles referred to the importance of good organisational structure (Boardman, 2009) and recommended that research administration central offices, including TTOs, continue to maintain a large level of autonomy (Decter et al, 2007). In one study, the level of autonomy

was discovered to be a major determinant of research performance, as greater autonomy of research departments was found to be associated with greater research performance (Zalewska-Kurek et al, 2010). For the research projects that focused on surveying or describing the concerns of university researchers, overly cumbersome research policies or a large level of bureaucracy governed by research administration and management, were perceived as the main barriers for researchers to engage. Indeed, Teelken (2012) found that the presence of research management, and the university's increased focus on its importance, were perceived negatively by researchers. Regarding specific policies, Cole (2010) stated that "researchers need more financial support and less paperwork", while more empirical studies identified that researchers needed specific policies that provided a separate university grants approval process that was independent of the TTO (McAdam et al, 2005), linking this with Dector et al's (2007) issue of autonomy. In addition, external firms that wish to collaborate with universities also highlighted overly cumbersome university research administration policies and procedures as a major barrier to engagement. All studies identified the issue of university bureaucracy as a limiting factor from a number of angles (researcher opinions, external firms, and research administrators themselves). Therefore, maintaining streamlined, easy to interpret university policies regarding the research process is a major recommendation of this review.

The above suggestions regarding the existence of research incentives and the streamlining of university policies, however, originated from studies that referred to the research administration and management variable indirectly. For those research articles directly referring to research administration and management, a set of more practical, micro-level strategies emerged. These included both a description of the personal qualities research administrators must possess, as well as the skills necessary for individuals to have or obtain to ensure effective research administration and management.

According to a range of the studies, there are a number of personal and professional qualities that research administrators possess. These qualities are particularly important when interacting with university researchers. Sapienza (2005) investigated the opinions of researchers about what constitutes good management. Using a combination of document analysis and interviews, it was found that researchers valued managers that were technically accomplished, but that also maintained a balance between being caring, to foster greater engagement, and being forceful, to ensure that targets were met. These personal qualities were reflected in Hockey's & Allen-Collinson's (2009) interviews of research administrators themselves, and what qualities they considered essential to be able to fulfil their responsibilities. Hockey & Allen-Collinson (2009) recommended that research administrators be "available" to researchers and "informal" in how they interacted. However Hockey & Allen-Collinson (2009) also recommended that to foster a higher level of engagement with researchers, research administrators should obtain a formalised higher degree. This element, they argued, allowed research administrators to promote a "professional image" of themselves and their role, fostering an equal partnership between themselves and university researchers. This recommendation echoes Sapienza's (2005) recommendation that researchers value managers that are "technically accomplished" and also that of Chun (2010) that recommends continued professional development for research administrators. In addition, Roberts (2006) found that the concept of certification of research

administrators a worthy recommendation to increase the professionalisation of the field. A number of the personal qualities necessary for a research administrator were also suggested. These include being "attentive and loving" which stem from the studies that describe research administrators as acting as "servant leaders" (Krauser, 2003; Vargas & Halon, 2007). In addition, Whitchurch (2004) described this as a move from a regulatory model to a more civil-service model of research administration, and Cole (2007) described it as offering research administration. However, the value of the evidence for these skills and qualities and the papers presented in the practice-based literature were relatively low.

More salient recommendations were made by studies where research managers promote shared values between researchers (Drummond, 2003), foster greater communication (Porter, 2005; Cole, 2010; Mom et al, 2012), and build a sense of community (Sirvais & Disney). Other studies focused on the success of more specialised strategies such as building contingency plans and having flexible deadlines when dealing with university researchers (Porter, 2005; Cole, 2007; Rutherford & Langley, 2007; Hockey & Allen-Collinson, 2009; Mom et al, 2012). These recommendations, however, can be interpreted as components of a wider consideration of maintaining a good working relationship with researchers. Although neither one of these more specific working-style recommendations were tested empirically there is no doubt in their validity. In particular, there is validity in the recommendations that emerge from studies of viewpoints of researchers, external companies, and even research administrators themselves. Most notably are the recommendations stemming from Cole's (2010) Delphi survey of opinions from both researchers and research administrators about the restructuring of research administration at a US university. Cole (2010) found that both researchers and research administrators believed that improved communication and collaboration between researchers and research administrators was important. In addition, both parties felt that is was important for research administrators to understand the motivations, strengths and weaknesses of research faculty in order to work more effectively towards achieving common organisational goals. Likewise, Mom et al (2012) used surveys and interviews to identify a number of essential "soft" skills for TTO-based research administrators (networking, communications, etc.), as well as to re-state the importance of "hard" skills which are primarily associated with a manager's technical competence (domain knowledge, commercial awareness). Both studies demonstrate that in different organisational settings (universities and TTOs) skills associated with promoting a workable organisational climate are an essential strategy for research management and managers.

Finally, both researchers and researcher administrators indicated guidance from research management was most useful in the financial preparation (pre-award) and management (post-award) areas of grant applications and successful grants (Mason & Learned, 2006; Cole, 2007; Kirkland, 2008; and Mullen et al, 2008). No distinction was given between the time when research managers had the most influence (pre- or post-award).

Conclusions and Recommendations for Future Research

Although the original aim of this report was to investigate the existing knowledge base regarding the strategies and structures of research management, the major finding of this study was the lack of evidence regarding successful research management. Currently, there is a strong divide between

the practice- and academic-based literature cultures. In these parallel worlds, there exists a research culture that has a strong methodological basis, but with little relevance to practice; alongside a practice culture with practical experience, but limited culture of methodologically-sound research. These findings call for future research that combines a strong empirical basis with existing practical questions. Indeed, future research should aim to empirically analyse the characteristics of successful research management, identify those strategies and structures that are deemed successful, and how this might vary between different types of research organisations. This is essential for establishing a reliable evidence-base for evidence-informed research management practices.

There is no denying that research management plays an important role in the research process. This role is becoming more pronounced and important as universities and researchers increasingly compete for limited funding, and where an organisation's prestige (even more so for universities) is linked to their performance on international league tables and in national research evaluation exercises. Performing well in these competitive environments is increasingly becoming related to the organisation's ability to successfully design, implement and alter strategies, incentive programs, etc. rather than the reputation of the research alone and its ability to achieve in traditionally academic channels. These strategies require administration by a group of fulltime, professional practitioners in research management/administration. However, the literature is unsure of how to perceive this role. In particular, it is unsure of whether the role of this professional lies as a partner, a servant or as a leader. Indeed, the majority of the literature discussed in this review prefers to comprehend the role of the research manager as a small, indirect part of a larger, overarching variable.

Despite widespread agreement about the importance of research management in the research process, there is a lack of evidence within the literature about effective research management strategies. There is some weak evidence for strategies such as incentives (both financial and non-financial) as well as evidence for the benefits associated with more streamlined, less bureaucratic university policies and practices to encourage both researchers and external bodies to engage in knowledge production activities. This lack of an empirical evidence base for effective research management strategies, combined with a lack of a firm definition for the role of the research manager, highlight the need for more targeted research in this area. In particular, there is a need for future research that encompasses the following themes.

First, there is a need for a stocktake of the characteristics of current research management teams and how they differ, if at all, between universities and other research organisations. Such research should aim to investigate the capacity of such teams, as well as the skills and knowledge base of the individual members of these teams relative to their role. This research would not only, for the first time, describe the characteristics of a research management role and that of research management teams, but also work towards understanding what components of research management teams, relative to the type of organisation, are more efficient. This research could also work towards understanding how research management differs from other, more general management roles, in line with Atkinson's et al (2007) description of research management as a stand-alone profession.

Second, in line with the finding of this review that there is weak evidence for the success of incentives as a research management strategy, further research should concentrate on expanding this evidence base. In particular, there is a need for an empirical understanding of the nature

of incentives (financial and various non-financial incentives) that are successful in rewarding or encouraging certain research behaviours. This research should start with a broad scale description of the various incentives currently offered by a random sample of universities and/or research organisations, and characterise them according to what behaviour they aim to reward or encourage (i.e. publishing, grant success and industry engagement). Further, once this has been characterised, their success can be measured by indexing the incentive against the type of activity it aims to encourage. For example, such as was attempted by Derrick & Bryant (2013), the success of incentives for publishing can be measured against an organisation's members' publishing activity in order to measure its effectiveness. Indeed, this type of empirical investigation should also aim to investigate what types of incentives are most successful and, for financial incentives, at what level the incentive is most effective and at what level do incentives fail to incentivise the desired behaviour. In addition, the literature appears to suggest that 'incentives' (particularly financial) as a management strategy have tended to be applied to technology transfer type activity, as opposed to purely research activity. It could be questioned whether taking this strategy from commercialisation to research activity will motivate the desired research behaviour. A recent study (Nickson, 2014) highlights the particular nature of research 'work', and that it does not fit the assumptions upon which strategies, such as financial incentives, are based. Such incentive structures should be based on an evidenced understanding of the nature of the work, and the individuals who undertake it.

Finally, as one of the major barriers identified in this review was overly bureaucratic university and research organisation policies and practices, a similar understanding of the nature of existing policies and practices is required to identify those that are the most effective. Such research would, of course, take into account confounding variables such as the strategic implementation gap, and focus not only on a description of the policy, but also investigate how, and if, this policy is implemented on the ground level. For example, the recent study by Nickson (2014) found that academic autonomy and control was vital to individuals' motivation and work achievement. However, where university policies were found to be supportive of academic autonomy and control, a strategic implementation gap meant that such policies did not translate into successful management practices 'on the ground'. Therefore, the issue is not only about having appropriate policies and strategies in place, but ensuring that they are effectively implemented. Future research should, therefore, investigate how university policies and practices manifest themselves within the research management team, and how their operationalisation impacts researchers. This research should combine an understanding of the nature of the research management team, described above, with a firm understanding of how top-level management policies are implemented within and by individuals on these research management teams.

The above suggestions are made in line with the findings of this review. It is hoped that by addressing the concerns highlighted in this review that the field of research management will work towards establishing a firm, research-informed evidence base for successful and efficient research management strategies.

Author Note

The contacts for this article are Dr Gemma Derrick Tel: +44 1895 265454, Email: gemma.derrick@brunel.ac.uk, and Alicen Nickson, MA (Hons), MBA, MSc. Tel: +44 1895 265730, Email: alicen.nickson@brunel.ac.uk. This paper reports the findings of an independent literature review. Correspondence concerning this article should be addressed to Alicen Nickson.

Dr. Gemma Derrick
ESRC Future Research Leader Fellow
Health Economics Research Group (HERG)
Brunel University London
Middlesex, UK
Tel: +44 1895 265454
Email: gemma.derrick@brunel.ac.uk

Alicen Nickson, MA Hons, MBA, MSc
Deputy Director, Research Support and Development
Brunel University London
Middlesex, UK
Tel: +44 1895 265730
Email: alicen.nickson@brunel.ac.uk

References

Albors-Garrigos, J; Zabaleta, N; Ganzarain, J. (2010) New R&D management paradigms: rethinking research and technology organizations strategies in regions. *R&D Management, 40*(5): 435-454.

Amayah, A.T. (2013) Determinants of knowledge sharing in a public sector organization. *Journal of Knowledge Management, 17*(3): 454-471.

Ankrah, SN; Burgess, TF; Grimshaw, P; Shaw, NE. (2013) Asking both university and industry actors about their engagement in knowledge transfer: What single-group studies of motives omit. *Technovation, 33*(2-3):50-65.

Arena, M., Arnaboldi, M., Azzone, G., Carlucci, P. (2009) Developing a Performance Measurement System for University Central Administrative Services. *Higher Education Quarterly, 63*(3):237-263.

Atkinson, T.N.,Gilleland, D.S., Barrett, T.G. (2007) The Dimensions of Influence on Research Administrator Behavior: Toward a Theoretical Model of Research Administration as a Public Service Profession. *Journal of Research Administration, 38*(1):9-30.

Audretsch, D.B.; Lehmann, E.E. (2005) Do University policies make a difference? *Research Policy, 34*(3): 822-834.

Barbolla, A.M.B., Corredera, J.R.C. (2009) Critical factors for success in university-industry research projects. *Technology Analysis and Strategic Management, 21*(5): 599-616.

Bartunek, J.M. (2007) Academic-practitioner collaboration need not require joint or relevant research: Toward a relational scholarship of integration. *Academy of Management Journal, 50*(6):1323-1333.

Berbegal-Mirabent, J, Sabate, F, Canabate, A. (2012) Brokering knowledge from universities to the marketplace The role of knowledge transfer offices. *Management Decision, 50*(7-8):1285-1307.

Blackman, D., Kennedy, M. (2009) Knowledge management and effective university governance. *Journal of Knowledge Management, 13*(6):547-563.

Bolden, R., G. Petrov and J. Gosling (2008). "Tensions in Higher Education Leadership: Towards a Multi-Level Model of Leadership Practice." *Higher Education Quarterly 62*(4): 358-376.

Boardman, P.C. (2009) Government centrality to university-industry interactions: University research centers and the industry involvement of academic researchers. *Research Policy, 38*(10):1505-1516.

Boardman, P.C., Corley, E.A. (2008) University research centers and the composition of research collaborations. *Research Policy, 37*(5): 900-913.

Boardman, P.C., Ponomariov, B.L. (2009) University researchers working with private companies. *Technovation, 29*(2): 142-153.

Bosua, R., Venkitachalam, K. (2013) Aligning strategies and processes in knowledge management: a framework. *Journal of Knowledge Management, 17*(3): 331-346.

Bozeman, B., Boardman, C. (2013) Academic Faculty in University Research Centers: Neither Capitalism's Slaves nor Teaching Fugitives. *Journal of Higher Education, 84*(1): 88-120.

Brostrom, A. (2010) Working with distant researchers-Distance and content in university-industry interaction. *Research Policy, 39*(10):1311-1320.

Bruneel, J., D'Este, P., Salter, A. (2010) Investigating the factors that diminish the barriers to university-industry collaboration. *Research Policy, 37*(7):858-868.

Buchanan, D., Bryman, A., (2009) *The SAGE Handbook of Organizaional Research Methods*, SAGE Publications Ltd, London.

Burnside, B., Witkin, L. (2008) Forging successful university-industry collaborations. *Research-Technology Management, 51*(2): 26-30.

Caldera, A., Debande, O. (2010) Performance of Spanish universities in technology transfer: An empirical analysis. *Research Policy, 39*(9):1160-1173.

Castro, D., Tomàs, Marina (2011). "Development of Manager-Academics at Institutions of Higher Education in Catalonia." *Higher Education Quarterly 65*(3): 290-307.

Casu, B., Thanassoulis, E. (2006) Evaluating cost efficiency in central administrative services in UK universities. OMEGA – *International Journal of Management Science, 34*(5): 417-426.

Chapple, W., Lockett, A., Siegel, D., Wright, M. (2005) Assessing the relative performance of UK university technology transfer offices: parametric and non-parametric evidence. *Research Policy, 34*(3):369-384

Chen, CY., Wu, Y.C.J., Wu, W.H. (2013) A sustainable collaborative research dialogue between practitioners and academics. *Management Decision, 51*(3):566-593.

Chirikov, I. (2013) Research universities as knowledge networks: the role of institutional research. *Studies in Higher Education, 38*(3):456-469.

Chun, M. B. (2010). "Building a Research Administration Infrastructure at the Department Level." *Journal of Research Administration 41*(3): 77-84,75.

Clausen, T., Fagerberg, J., Gulbrandsen, M. (2012) Mobilizing for change: A study of research units in emerging scientific fields. *Research Policy, 41*(7):1249-1261.

Cole, S. S. (2007). "Research Administration as a Living System." *Journal of Research Administration 38*(2): 14-27,18

Cole, S. S. (2010). Reframing Research Administration. *Journal of Research Administration 41*(1): 11-21,15.

Conti, A., Gaule, P. (2011) Is the US outperforming Europe in university technology licensing? A new perspective on the European Paradox. *Research Policy, 40*(1):123-135.

Creso, M., Sa, M, T. (2012) Strategic planning for academic research. *Higher Education and Management Policy, 24*(1): 1-20.

Decter, M., Bennett, D., Leseure, M. (2007) University to business technology transfer - UK and USA comparisons. *Technovation, 27*(3): 145-155.

Deem, R. (2006). "Changing Research Perspectives on the Management of Higher Education: Can Research Permeate the Activities of Manager-Academics?" *Higher Education Quarterly 60*(3): 203-228.

Derrick, G.E., Bryant, C. (2013) The role of research incentives in medical research organisations. *R&D Management, 43*(1):75-86.

D'Este, P., Fontana, R. (2007) What drives the emergence of entrepreneurial academics? A study on collaborative research partnerships in the UK. *Research Evaluation, 16*(4):257-270.

D'Este, P., Patel, P. (2007) University-industry linkages in the UK: What are the factors underlying the variety of interactions with industry? *Research Policy, 36*(9):1295-1313.

Drummond, C. N. (2003). "Strategic Planning for Research Administration." *Journal of Research Administration 34*(2): 4-10.

Edgar, F., Geare, A. (2013) Factors influencing university research performance. *Studies in Higher Education, 38*(5): 774-792.

Ehrenberg, R.G. (2005) Why universities need institutional researchers and institutional researchers need faculty members more than both realize. *Research in Higher Education, 46*(3):349-363.

Freitas, I.M.B., Geuna, A., Rossi, F. (2013) Finding the right partners: Institutional and personal modes of governance of university-industry interactions. *Research Policy, 42*(1): 50-62.

Geuna, A., Muscio, A. (2009) The Governance of University Knowledge Transfer: A Critical Review of the Literature. *Minerva, 47*(1):93-114.

Gjerding, A.N., Wilderom, C.P.M., Cameron, S.P.B., Taylor, A., Scheunert, K-J. (2006) *Twenty Practices of an Entrepreneurial University, 18*(3): 1-28.

Goddard, J. (2005) *Institutional Management and Engagement with The Knowledge Society, 17*(1):23-44.

Green,J., Langley, D. (2009) *Professionalising Research Management*, Report prepared for Higher Education Funding Council England & Medical Research Council.

Greenbaum, D., Scott, C. (2010) Hochschullehrerprivileg-A Modern Incarnation of the Professor's Privilege to Promote University to Industry Technology Transfer. Science, *Technology and Society, 15*(1):55-76.

Gururajan, V., Fink, D. (2010) Attitudes towards knowledge transfer in an environment to perform. *Journal of Knowledge Management, 14*(6):828-840.

Halilem, N. (2010). "Inside the Triple Helix: An Integrative Conceptual Framework of the Academic Researcher's Activities, a Systematic Review." *Journal of Research Administration 41*(3): 23-50,25.

Hall, K. P. (2011). "University Research Centers: Heuristic Categories, Issues, and Administrative Strategies." *Journal of Research Administration 42*(2): 25-41,25.

Heinze, T., Shapira, P., Rogers, J.D., Senker, J.M. (2009) Organizational and institutional influences on creativity in scientific research. *Research Policy, 38*(4):610-623.

Hewitt-Dundas, N. (2012) Research intensity and knowledge transfer activity in UK universities. *Research Policy, 41*(2):262-275.

Hockey, J., Allen-Collinson, Jacquelyn (2009). "Occupational Knowledge and Practice amongst UK University Research Administrators." *Higher Education Quarterly 63*(2): 141-159.

Jacob, M., Hellström, T. (2003). "Organising the Academy: New Organisational Forms and the Future of the University." *Higher Education Quarterly 57*(1): 48-66.

Johnson, W.H.A. (2011) Managing university technology development using organizational control theory. *Research Policy, 40*(6):842-852.

Jong, S. (2008) Academic organizations and new industrial fields: Berkeley and Stanford after the rise of biotechnology. *Research Policy, 37*(8):1267-1282.

Kenna, R., Berche, B. (2012) Critical masses for academic research groups and consequences for higher education research policy and management. *Higher Education Management and Policy, 23*(3):1-21.

Kirkland, J. (2008) University research management: an emerging profession in the developing world. *Technology Analysis & Strategy, 20*(6):717-726.

Konig, B., Diehl, K., Tscherning, K., Helming, K. (2013) A framework for structuring interdisciplinary research management. *Research Policy, 42*(1): 261-272.

Krauser, P. A. (2003). "The Research Administrator as Servant-Leader." *Journal of Research Administration 34*(1): 14-18.

Lam,A. (2011) What motivates academic scientists to engage in research commercialization: 'Gold', 'ribbon' or 'puzzle'? *Research Policy, 40*(10):1354-1368.

Leisyte, L., Horta, H. (2011) Introduction to a special issue: Academic knowledge production, diffusion and commercialization: policies, practices and perspectives. *Science and Public Policy, 38*(6):422-424.

Lintz, E. (2008). "A Conceptual Framework for the Future of Successful Research Administration." *Journal of Research Administration 39*(2): 68-80,67.

Locke, W. (2007). "Higher Education Mergers: Integrating Organisational Cultures and Developing Appropriate Management Styles." *Higher Education Quarterly 61*(1): 83-102.

Magalhães, A., Veiga, A., Amaral, A., Sousa, S., Ribeiro, F. (2013). "Governance of Governance in Higher Education: Practices and lessons drawn from the Portuguese case." *Higher Education Quarterly 67*(3): 295-311.

Martins, E.C., Meyer, H.W.J. (2012) Organizational and behavioral factors that influence knowledge retention. *Journal of Knowledge Management, 16*(1): 77-96.

Mason, E., Learned, L. (2006). "The Role of "Development" in a Research Administration Office." *Journal of Research Administration 37*(1/2): 23-34,29-10.

McAdam, R., Keogh, W., Galbraith, B., Laurie, D. (2005) Defining and improving technology transfer business and management processes in university innovation centres. *Technovation, 25*(12):1418-1429.

Molfese, V., Chronister, L., Kulakowski, E. C., Slocum, J., Michael J. D., Studman, C., Waugaman, P.(2008). "When Leadership Changes: Reflecting on the Way Forward In Research Administration." *Journal of Research Administration 39*(2): 103-108,105-108.

Mom, T.J.M., Oshri, I., Volberda, H.W. (2012) The skills base of technology transfer professionals. *Technology Analysis and Strategic Management, 24*(9):871-891.

Morphew, C.C., Baker, B.C. (2004) The cost of prestige: Do new research I universities incur higher administrative costs? *Review of Higher Education, 27*(3):365-366.

Mullen, C. A., Murthy, U., Teague, G. (2008). "Listening to Those We Serve": Assessing the Research Needs of University Faculty. *Journal of Research Administration 39*(1): 10-31,17-18.

Nickson, A. (2014). A qualitative case study exploring the nature of New Managerialism in UK Higher Education and its impact on individual academics' experience of doing research. *Journal of Research Administration, 45*(1): 47-80.

Nosella, A., Grimaldi, R. (2009) University-level mechanisms supporting the creation of new companies: an analysis of Italian academic spin-offs. *Technology Analysis and Strategic Management, 21*(6):679-698.

Olsen, B. (2005). "Constructing a Grants Office Review: A Case Study." *Journal of Research Administration 36*(2): 23-27,23.

O'Shea, R.P., Allen, T.J., Morse, K.P., O'Gorman, C., Roche, F. (2007) Delineating the anatomy of an entrepreneurial university: the Massachusetts Institute of Technology experience. *R&D Management, 37*(1):1-16.

Philbin, S. P. (2010). "Developing and Managing University-Industry Research Collaborations through a Process Methodology/Industrial Sector Approach." *Journal of Research Administration 41*(3): 51-68,56.

Philbin, S. P. (2011). "An Investigation of the Development and Management of University Research Institutes." *Journal of Research Administration 42*(1): 103-122,106.

Porter, R. (2005). "Helpful Gatekeepers: Positive Management of the Limited Submission Process." *Journal of Research Administration 36*(1): 26-31,23.

Roberts, T. (2006). "Everyone's Mentor: Perceptions of Research Administrators on the Value of Certification." *Journal of Research Administration 37*(1/2): 87-99,81.

Rutherford, S., Langley, D. (2007). "Implementation of Systems to Support the Management of Research: Commentary from a UK University Perspective." *Journal of Research Administration 38*(1): 49-60,13.

Sá, C. M. (2008). "University-Based Research Centers: Characteristics, Organization, and Administrative Implications." *Journal of Research Administration 39*(1): 32-40,37.

Sanz-Menendez, L., Cruz-Castro, L. (2003) Coping with environmental pressures: public research organisations responses to funding crises. *Research Policy, 32*(8):1293-1308.

Sapienza, A.M. (2005) From the inside: scientists' own experience of good (and bad) management. *R&D Management, 35*(5):473-482.

Shelley, L. (2010). "Research Managers Uncovered: Changing Roles and 'Shifting Arenas' in the Academy." *Higher Education Quarterly 64*(1): 41-64.

Siegel, D.S., Waldman, D., Link, A. (2003) Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study. *Research Policy, 32*(1):27-48.

Sivrais, S. E., Disney, C. (2006). "Changing the Culture of Research Administrators at a Public University." *Journal of Research Administration 37*(1/2): 130-137,182.

Sousa, C.A.A., Hendriks, P.H.J.(2007) That obscure object of desire: The management of academic knowledge. *Minerva, 45*(3):259-274.

Spencer, L., Ritchie, J., Lewis, J., & Dillon, L. (2003). *Quality in qualitative evaluation: A framework for assessing research evidence*. London: Government Chief Social Researcher's Office.

Teelken, C. (2012). Compliance or pragmatism: how do academics deal with managerialism in higher education? A comparative study in three countries. *Studies in Higher Education, 37*(3):271-290.

Tello, S., Latham, S., Kijewski, V. (2010) Individual choice or institutional practice Which guides the technology transfer decision-making process? *Management Decision, 48*(7-8):1261-1281.

Tranfield, D., Denyer, D., Smart, P. (2003) Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. *British Journal of Management, Vol. 14*, 207-222.

van der Heide, S., van der Sijde, P.C., Terlouw, C.(2008) The institutional organisation of knowledge transfer and its implications. *Higher Education Management and Policy, 20*(3):1-13.

van der Weijden, I., de Gilder, D., Groenewegen, P., Klasen, E. (2008) Implications of managerial control on performance of Dutch academic (bio)medical and health research groups. *Research Policy, 37*(9):1616-1629.

Vargas, P., Hanlon, J. (2007). Celebrating a Profession: The Servant Leadership Perspective. *Journal of Research Administration 38*: 45-49,11,13.

Vogelgesang, L.J., Denson, N., Jayakumar, U.M. (2010) What Determines Faculty-Engaged Scholarship? *Review of Higher Education, 33*(4):437-438.

Volberda, H., Oshri, I., Mom, T.J.M. (2012) Technology transfer: the practice and the profession. *Technology Analysis and Strategic Management, 24*(9):863-869.

Waite, J. M. (2011). Research Administrators as Servant Leaders. *Journal of Research Administration 42*(2): 64-77,67.

Ward, D. (2007). Academic values, institutional management and public policies. *Higher Education Management and Policy, 19*(2):1-12.

Whitchurch, C. (2004). Administrative Managers – A Critical Link. *Higher Education Quarterly 58*(4): 280-298.

Whitchurch, C. (2008). Shifting Identities and Blurring Boundaries: the Emergence of Third Space Professionals in UK Higher Education. *Higher Education Quarterly 62*(4): 377-396.

Whitchurch, C., Gordon, G. (2013). Reconciling Flexible Staffing Models with Inclusive Governance and Management. *Higher Education Quarterly 67*(3): 234-255.

Wilbon, A.D. (2012) Interactive planning for strategy development in academic-based cooperative research enterprises. *Technology Analysis and Strategic Management, 24*(1): 89-105.

Wilding R (2010) *From Medicine to Management: Building foundations of evidence with systematic literature reviews*. In: Brunel University Research Colloquium, Uxbridge, 16.6.2010 - 16.6.2010.

Woodfield, S., Kennie, T. (2008). 'Teamwork' or 'Working as a Team'? The Theory and Practice of Top Team Working in UK Higher Education. *Higher Education Quarterly 62*(4): 397-415.

Wright, M., Clarysse, B., Lockett, A., Knockaert, M. (2008) Mid-range universities' linkages with industry: Knowledge types and the role of intermediaries. *Research Policy, 37*(8):1205-1223.

Yang, Y.J.; Wang, C.C. (2010) Creativity among R&D Professional: Supervisory Support and Personality Traits. *Asian Journal of Technology Innovation, 18*(1): 229-248.

Young, B., Hewitt-Dundas, N., Roper, S. (2008) Intellectual Property management in publicly funded R&D centres - A comparison of university-based and company-based research centres. *Technovation, 28*(8):473-484.

Zalewska-Kurek, K., Geurts, P.A.T.M., Roosendaal, H.E. (2010) The impact of the autonomy and interdependence of individual researchers on their production of knowledge and its impact: an empirical study of a nanotechnology institute. *Research Evaluation, 19*(3):217-225.

Optimizing Institutional Approaches to Enable Research

Teri Grieb, Ph.D.
Office of Research, University of Michigan Medical School

Jeffrey R. Horon
Elsevier Research Intelligence

Cassandra Wong
Office of Research, University of Michigan Medical School

Jessica Durkin, Ph.D.
Office of Research, University of Michigan Medical School

Steven L. Kunkel, Ph.D.
Office of Research, University of Michigan Medical School

Abstract: *Challenges that face the academic research enterprise are numerous. These concerns include, but are not limited to: declines in extramural funding for investigator-initiated research, an aging faculty workforce (the average age of securing a faculty's first R01 is over 42), insufficient funds to support faculty laboratories, and limited access to cutting-edge, next generation infrastructure and methods to support research. This manuscript describes an institutional approach to providing leading-edge core facilities and enhancing the effectiveness of their operations by implementing process improvements, managing the lifecycle of core facilities, and monitoring key core facilities' metrics. This approach has created a number of standardized, transparent processes to effectively manage central infrastructure that enables enterprise-wide research, including a process for capital equipment planning, a procedure to evaluate new cores, a method for reviewing and managing the lifecycle of existing cores (invest, maintain, or sun-down), an investment in the administration and operational efficiencies of the cores, and support for the development and implementation of new methodologies for our investigators. The execution of these processes has provided faculty with forward-looking technologies to facilitate innovative research and provide a competitive edge for extramural support.*

Keywords: *core facilities, infrastructure, strategy, governance*

Introduction

Within the past two decades, the complexity of biomedical science has provided the impetus to design increasingly sophisticated and innovative instrumentation and services, thus enabling faculty to dramatically advance research along the entire spectrum of basic and clinical investigations. While the infrastructure for and enablers of research continue to provide the basis for these cutting-edge investigations, they come with a price to individual investigators regarding both instrumentation expense and technical expertise. As acknowledged by Angeletti, Bonewald, Jongh, Niece, Rush, and Stults (1999) over fifteen years ago, the model of an individual investigator possessing a self-sufficient single laboratory, including all the necessary modern equipment to conduct competitive science, is a distant memory. The historic high-end, self-sufficient laboratories have been mostly replaced by laboratories that rely on institutionally supported infrastructure (i.e. core facilities). These core facilities enable scientific discovery by providing the latest technology, instrumentation, and technical expertise. However, those institutions that invest in enabling infrastructure are often faced with additional conundrums. These include the cost associated with maintaining/replacing existing services (Haley, 2011), developing new technologies (Slaughter, 2009), identifying highly trained faculty/staff to serve as core directors (Rey, 2007), and integrating a system to effectively monitor services that need to either grow, be maintained, or be dismantled (Haley, 2009). This manuscript addresses the enterprise-level challenge of keeping pace with and effectively managing cutting-edge, next generation infrastructure that supports the needs of scientists, allowing them to remain competitive in securing extramural funding and publishing novel discoveries. An institutional approach for enhancing the effectiveness of core infrastructure operations by implementing process improvements, managing the lifecycle of core facilities, and monitoring key core facilities' metrics is described.

In 2010, the Office of Research at the University of Michigan Medical School conducted a thorough business review of its centrally managed biomedical research core facilities. As a result, the Office of Research has implemented an institutional approach to effectively manage the supporting infrastructure of our central core facilities. This includes: 1) a process for core facility capital equipment planning and acquisition, 2) a method for reviewing and managing the lifecycle of existing core facilities (invest, maintain, or sun-down), 3) a process to evaluate whether department-based core facilities should transition into the central, school-wide core facilities, 4) an investment in the administration and operational efficiencies of the core facilities, and 5) support for the development and implementation of new methodologies to make the latest techniques available to our investigators. The optimization of this approach to infrastructure management has allowed the Medical School to replace obsolete equipment, introduce new technologies and platforms, increase scientific capability and capacity, reduce turnaround times, create standardized and sustainable oversight, create core evaluation processes and metrics, and pilot an outsourcing model (to eliminate capital investments when appropriate). While this business strategy was developed as a platform to specifically manage the functional units of the core facilities, it also is structured to provide a broad governing system that guides key "lifecycle" decisions of the core facilities.

A Business Review

The University of Michigan is home to 92 core facilities or shared resources that facilitate the pace of both broad and specialty research for our scientists. Due to a decentralized environment, most of these core facilities or shared resources are created and maintained at a department or programmatic center level, often characterized by serving a limited, targeted population of investigators. Eleven institution-wide core facilities are housed under the Office of Research in the Medical School and are collectively administered as the Biomedical Research Core Facilities (BRCF) with an operating budget funded by the Dean of the Medical School. The BRCF is managed by a single administrative director and provides central support for "in demand" technologies. The BRCF services are available to all university faculty based on a cost recovery model (i.e., university approved recharge rates). The core facilities comprising the BRCF include: DNA sequencing, flow cytometry, bioinformatics analysis, biosafety containment, proteomics and peptide synthesis, metabolomics, transgenic animal models, viral vector creation, microscopy and imaging analysis, the biomedical research store, and a sample preservation freezer facility.

The Office of Research launched a business review of the BRCF in order to identify ways to improve the ability of the core facilities to meet our researchers' needs. This review also resulted in the identification of areas of strengths, including reliable, high-quality services, national recognition associated with specific core facilities, and competitive recharge rates within the university and across the nation compared to peer institutions. The BRCF is a significant operation with annual expenditures in excess of $17 million, with most of the cost of operations recouped through recharges to investigators.

An important aspect of the business review was the identification of the challenges that threaten the timely acquisition of new, state-of-the-art technologies for the core facilities. For example, the review identified that both the general fund allocation and the level of administrative support for the BRCF had been stationary for decades. The static funding for the core facilities curtailed progress in the development of new methodologies and prevented the acquisition of new equipment. These issues were further compounded by a core facility financial system that was not keeping pace with the growth and increasing complexity of the BRCF, with its myriad recharge accounts and billing across a broad customer base of internal and external clients. The system did not readily generate automated reports with the type of information needed to track the granular performance of the BRCF business portfolio. Finally, the absence of key performance indicators for each core facility as well as the lack of a standard process for evaluating where cores are in their business lifecycle hindered the strategic and operational management of these costly assets.

Overall, the lack of predictable and strategic funding allocations that kept pace with inflation and researchers' demands for services along with a deficient prioritization process for procuring new equipment and technology were arguably the most serious threats to the viability of the BRCF's activities and the scientific competitiveness of our faculty. The review found that without a financial and operational strategy supported by executive leadership 1) investments became static and insufficient; 2) equipment was increasingly becoming obsolete or the number of instruments available was no longer meeting the demand of faculty, resulting in long wait times for investigators; 3) the budget neither accounted for state-of-the-art methods development

required by many core facilities nor provided financial aid to investigators recovering from large-scale instrument failures, leaving faculty with the entire liability; 4) governance and decision making regarding the fate of a core facility when business either waned or boomed was opaque; and 5) the absence of standard, key performance indicators that are routinely monitored clouded the oversight and management of the core facilities.

Business Strategy

Armed with the information generated during the business review, the Office of Research developed a multipronged business strategy that has served to facilitate informed decision-making around investing, sustaining, monitoring, and managing the lifecycle of these key core facility assets. The Office of Research's approach to the business assessment consisted of benchmarking peer institutions; surveying our faculty for their most pressing core facility needs; assessing short- and long-term solutions to meet those needs; establishing metrics to chart service utilization, faculty satisfaction and financial feasibility; and building a standard, transparent decision tree to guide consistent decisions making on our core facility portfolio. This latter tool aids the Office of Research in determining whether to invest in established or new core infrastructure, maintain existing core infrastructure, or sun down core infrastructure that has become commoditized or is less scientifically relevant. The goal of this process was to facilitate more, better, and faster scientific investigations by our research community and to increase awareness and oversight of current infrastructure. To execute this business strategy, specific tactics were used that included: 1) creating a process for core facility capital equipment planning; 2) implementing a process for reviewing and managing the lifecycle of existing core facilities (invest, maintain, or sun-down); 3) developing a process to evaluate whether department-based core facilities should transition into the central BRCF operations; 4) stabilizing the financial investment in core administration; and 5) providing funds for the development of the next generation of research enhancing, cutting-edge methods as well as a central pool of "insurance" funds for emergencies, such as large-scale instrumentation or technical failures.

Planning and Acquisition of Core Facility Capital Equipment

Robust state-of-the-art infrastructure, including leading-edge equipment offered by a centralized core facility, is vital to the success of research faculty. Previously, each core director was responsible for securing capital investments by seeking financial contributions from individual department chairs, which, if successful, significantly delayed the timely acquisition of the latest technologies or upgrades to existing instrumentation. Due to the lack of strategic, central investment, much of the BRCF instrumentation was obsolete, lagging by several generations in technology, and largely oversubscribed with demand well beyond capacity. As a result of the business review, the Office of Research secured a three-year investment from the Dean of the Medical School to replace obsolete equipment and to increase capacity in cores with long wait times. Moreover, in an effort to better plan for capital acquisitions in the future, a central inventory of BRCF equipment with a useful life depreciation schedule was developed to calculate the timing of ongoing equipment replacement needs, to identify impending obsolescence, and to formalize multi-year forecasting for capital funding.

A Capital Investment Committee was also established and is comprised of research faculty, who are customers of the BRCF. The committee is advisory to the Medical School Senior Associate Dean for Research. This committee is charged with reviewing and making recommendations on acquiring equipment for either replacement or bringing new technologies/methodologies on line. The Capital Investment Committee has overlapping membership with the BRCF Advisory Committee, which is a faculty committee responsible for providing counsel and guidance related to the scientific direction of the cores. The overlap in membership ensures continuity between technology acquisition and the scientific objectives of the core facilities. The Capital Investment Committee meets twice a year to review capital request applications submitted by the BRCF core unit directors. A Capital Equipment Request Form is used to outline the need, the purchase cost, the return on investment, and a proposed recharge rate to defray operating costs. In addition to submitting the Capital Equipment Request Form, the individual core directors deliver a short presentation to the committee justifying the importance and impact of specific equipment purchases to our research community. The committee weighs the information, strategically prioritizes requests taking into consideration the financial, operational and scientific benefits of the potential investment, and makes their recommendations for specific technology acquisition to the Senior Associate Dean for Research.

Since its inception in 2010, the Capital Investment Committee has recommended approval of $10.5 million in equipment purchases. These investments have allowed the BRCF cores to more effectively fulfill demand (e.g., the DNA Sequencing Core has increased the number of bases sequenced per month by a factor of five) and reduce turnaround time (e.g., the Flow Cytometry Core reduced its wait time from 4 weeks to 2-4 days). The Capital Investment Committee has declined $5.4 million in equipment requests due to a low impact (either in number of faculty served or the level of anticipated utilization of the equipment), a lower strategic research priority in comparison with other requests, or significant uncertainties associated with the emerging technology.

Managing the Lifecycle of the BRCF Portfolio

In order to maintain optimum services and provide the capacity to deliver the next generation of emerging technologies, the BRCF has developed a core lifecycle management process that is used to conduct an annual evaluation of the scientific and financial health of its core facilities (Figure 1).

A decision tree was developed and implemented to aid in making transparent, consistent decisions regarding the management of the BRCF's portfolio of core facilities. This process provides insight into investing in core facilities that are experiencing high demand for existing service offerings or new, emerging technologies; maintaining a core facility that has reached a steady state in its business, neither experiencing growth nor a decline in service utilization; or phase out a core facility that provides a service or technology that is available as a commodity, readily offered by vendors, or the underlying science has evolved beyond the technology/method offered. The decision tree is informed by four introductory questions:

1) Is the core facility financially self-sustaining?

2) Would additional investments make the core facility self-sustaining?

3) Does the core facility enable better science by being housed within the Medical School?

4) Is the core facility a regulatory requirement?

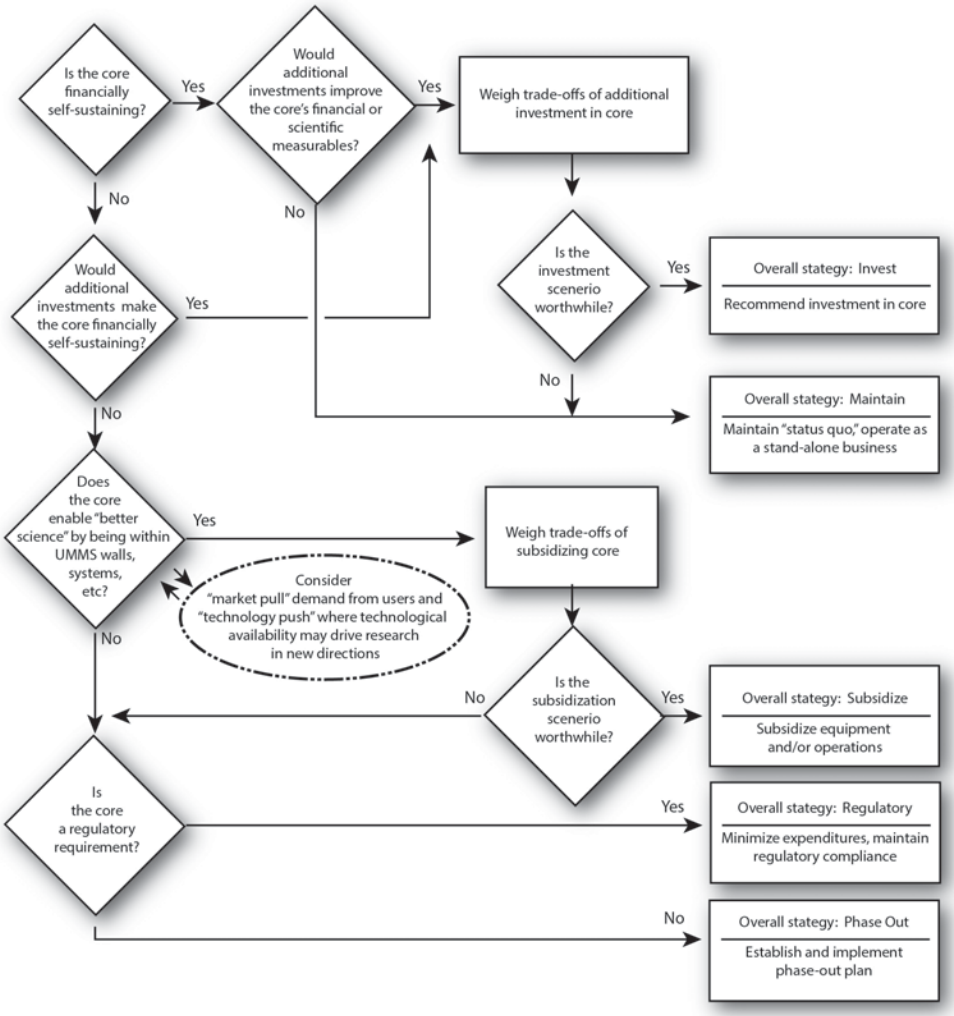

Figure 1. A "roadmap" to guide decisions on managing the core facility portfolio. This decision tree provides insight into whether to invest in an established BRCF core facility or transition a department-based core into the central BRCF envelope of operations; to maintain the status quo of the core facility under consideration as it currently is; or to sun down underutilized or scientifically less relevant core facilities.

Affirmative answers to either of the first two questions lead to the consideration as to whether the investment scenario is worthwhile when weighed against competing priorities. A further positive response signals that specific investment in the core facility is strategically important and support is recommended. However, if at this point on the decision tree it is deemed that other competing activities take precedence, the financial support is denied, and the core facility maintains current

operations "as is." Two main considerations become drivers for answering the third question on the decision tree: does the core facility enable better science by being within the Medical School? The first consideration is aimed at addressing whether the demand or "market pull" from our faculty and staff consumers is significant, thus fulfilling the economic paradigm of supply and demand. The second consideration is whether the core has the potential to provide a "technology push," thus driving research at the Medical School to a new level or in a new direction by offering the service or technology. An affirmative answer to either consideration directs the final investment decision into the trade off against competing priorities category. The decision tree further considers the issue of compliance, as research-intensive institutions are increasingly asked to deal with unfunded regulatory mandates. Therefore, if a core facility fulfills a regulatory requirement or enables compliance for our researchers, the decision tree takes that into consideration and supports maintaining compliance while minimizing expenditures as long as the characteristics of an enterprise-wide core facility described in the next section continue to be generally met. Lastly, the decision tree indicates when a core facility should be placed under a phased-out plan and shuttered in a timeframe that takes into account alternative options for investigators. This latter action is implemented when each of the four fundamental queries in the decision tree is answered in the negative. This model was originally established to evaluate entire BRCF core units but has more recently been leveraged to also assess the individual service offerings, or business segments, within each core unit.

The annual BRCF assessment provides information to categorize the individual core facilities into specific lifecycle management stages as shown in Figure 2.

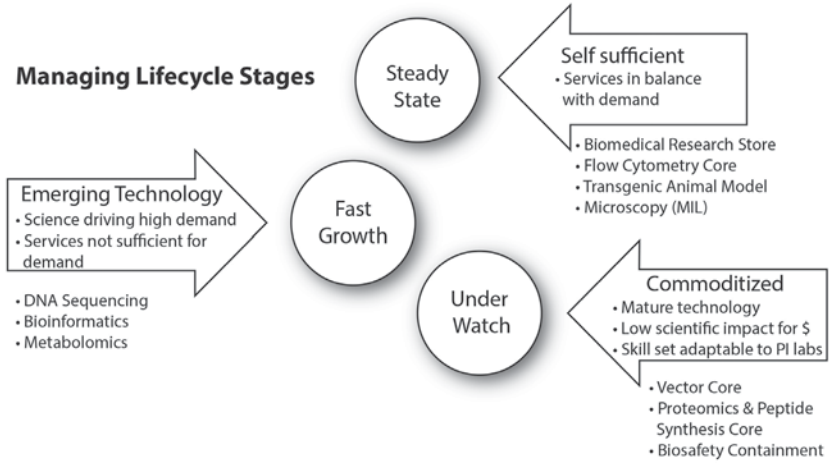

Figure 2. Core facility lifecycle management. In order to manage the return on investment of the core facilities, they are monitored and assigned to stages of their lifecycle. This includes a steady-state stage, where the core facility is nearly self sufficient with services in balance with demand; a fast growth stage, where emerging technology drives high demand that is not met by present services; and an under watch stage, where the mature technology is now a commodity and the core facility provides low scientific impact for the investment.

Those core facilities that provide science-driving services and emerging technologies that cannot keep pace with demand are designated as "Fast Growth" and are strategically considered for new investments. Core facilities categorized as "Steady State" indicate that the services are in balance with the demand. These units are, or are nearly, self-sufficient and need little to no subsidization. An "Under Watch" designation indicates that the core facility is providing mature technologies with low scientific impact for the financial investment required to maintain the service. In addition, the technology may have matured to a point where it either can be conducted routinely in an individual investigator's laboratory or is readily available as a commercialized service. As such, there likely are diminishing returns with further investments and an exit strategy is contemplated.

A specific example of a BRCF fast growth core facility is the DNA Sequencing Core Facility, which is characterized by the high scientific demand and rapidly changing technology of next generation sequencing (Shendure & Ji, 2008). The demand is driven by a number of factors, including that genomics research has penetrated many scientific disciplines, RNA and DNA sequencing technology is expected to continue to evolve for the foreseeable future (technology 'generations' only lasting 2-3 years), and investment in genomics technology and methodologies brings services at the frontier of science to our faculty. The demand for this technology is shown in Figure 3, where the number of bases sequenced rose dramatically with the acquisition of each additional high sequencing instrument. As a consequence, fast growth core facilities are typically poised for strategic investment.

"Steady State" or maintenance core facilities are characterized by providing critically needed services that are financially backed by near self-sustaining recharge rates. The BRCF Flow Cytometry Core Facility, which provides both analytic and cell sorting activities, is a good example of this type of core facility. Interestingly, the ability of this core facility to enter the

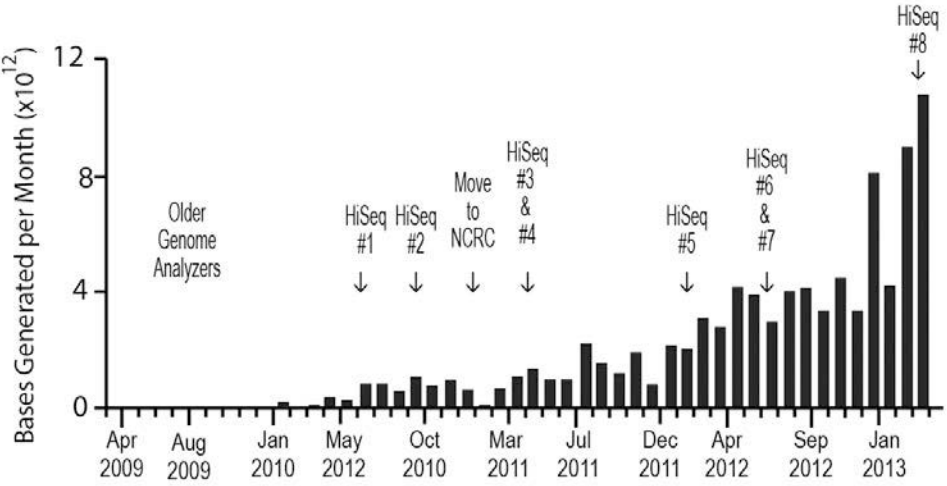

Figure 3. DNA sequencing is an example of a fast growth core where there is high demand for emerging technology. Each time a high capacity sequencer was added to the core facility the use of the service, as determined by bases of DNA sequenced, exponentially rose.

steady-state category was facilitated through the capital planning process, with new investments into an oversubscribed facility that had been operating with both dated equipment and too few instruments to meet the research community's demands. The Flow Cytometry Core Facility had been operating with lead times approaching 4 weeks. Replacement of old cytometers with multiple new higher-capacity cytometers reduced turnaround times to 2-4 days and has continued the path to self-sustainability.

"Under Watch" status has been assigned, for example, to the Proteomics and Peptide Synthesis Core. Historically, the book of business for this core facility was cannibalized by multiple, stand-alone proteomic facilities in various medical school departments. The low utilization and high carrying cost of this core led to the decision to pilot outsourcing the technical services to commercial vendors and other academic institutions, while maintaining an in-house consultation service using the core facility's existing scientific expertise. This paradigm has actually resulted in increased usage, while decreasing annual costs. An overall savings resulted from both capital equipment avoidance and a reduction in annual recurring operating expenses.

Transitioning Department-based Core Facilities into the Central BRCF Operations

Due to the decentralized structure at the University of Michigan, many core facilities initially emerge within departments or programmatic centers in direct response to the specific needs of a subset of investigators within a discipline or field of study. However, over time the scale and scope of department-based core facilities may change. Demand for a given technology/method may grow and utilization of a department-based core facility may far exceed the original targeted investigator base. Under such circumstances, the faculty member responsible for the nascent development of the core may no longer want to divert the required time and effort away from their individual research to manage a high-quality core facility. Transitions in key technical personnel, the complexity of the business operations, and significant ongoing costs of service contracts, replacing capital equipment, and space are additional reasons why, on occasion, department-based core facilities may request consideration to transition from a department-based operations to the centralized operations of the BRCF.

In order to determine whether an existing, department-based core facility outside the central authority of the BRCF should be acquired and integrated into the BRCF structure, a consistent and transparent evaluation process was established. The assessment is based on what the Office of Research has defined as the fundamental characteristics of an enterprise-wide core facility. These features include 1) the ability of the core facility to serve a broad range of faculty from multiple departments, 2) the identification of a faculty or staff leader with expertise in the technical domain to provide scientific vision and translate that vision into business operations, 3) the ability to enable science by operationally being in the university as opposed to outsourcing, 4) the capability of the core facility to meet a regulatory requirement for the university, and 5) the likelihood of the core facility becoming financially self-sustaining. Using these characteristics of a medical school core facility as a framework for decision-making, a Core Facility Consideration Request Form and business plan template were developed. The business plan template captures the history of the core facility, leadership capabilities, space requirements, impact of the service

on facilitating research, and historical and forward looking financials, including recharge rates, expenditures captured through cost recovery, and the level of department subsidization.

The BRCF Advisory Committee reviews the information and makes a recommendation to the Senior Associate Dean for Research to either incorporate the department-based core facility into the central BRCF or decline the request. The Senior Associate Dean for Research has the final decision making authority. To date, the BRCF Advisory Committee approved integrating the Microscopy and Image-Analysis Lab, Bioinformatics Core, Metabolomics Core, and the Vector Core, while declining four other requests. Those requests that have been declined were due to low demand and narrow range of investigators served (i.e., serve few faculty largely from a single, or very few, departments), limited application of the technology provided, or lack of alignment with strategic research priorities.

Investment in Core Facility Administration for Operational Efficiencies

The business strategy not only addressed scientific and operational issues within individual core facilities but also focused on the central administration of the BRCF. Opportunities to increase operational efficiencies and strengthen the administrative arm were identified that will aid in ensuring the continued success and longevity of the BRCF. One of the first priorities of the Office of Research following the business review was to develop a financial plan that reflected the growth and increased complexity of the BRCF business that had occurred over the past decade. Previously, the BRCF had a merged financial structure, where all the core facilities finances were rolled together into a single financial view, requiring manual segregation of funds to develop a financial picture of individual core facility finances and obscuring individual core performance. The increase in the number and scale of core facilities within this financial structure created an opaque and unwieldy environment to effectively manage individual core operations. The granularity, adaptability, and responsiveness demanded by the core facility life cycle management outlined above required modernizing the approach to managing the BRCF finances. To align the finances to the oversight model, individual core facilities were separated into units with a consistent financial structure that allows for effective reporting and consistent evaluation at an individual core level or as a roll-up for a total BRCF financial picture.

The new financial structure has enabled greater transparency of large, complex cores within the BRCF. By aligning revenues and expenses by service lines within an individual core, the evaluation and lifecycle management concept developed for management at the core-level of the BRCF can be applied to managing an individual core facility's service portfolio. Within a given core facility, each service offering can be evaluated and characterized as a fast growth, steady state, or under watch. This approach has allowed the BRCF to begin discussions, for example, as to whether a low demand service line within the DNA Sequencing Core should be terminated to free up technical and financial resources to invest in higher demand next generation sequencing offerings.

In addition to altering the overall financial structure of the BRCF, the Office of Research worked in partnership with the Dean of the Medical School to establish a new annual budget that reflected the significant growth in the BRCF portfolio. Furthermore, two critical deficiencies in the prior budget model were addressed by including specific line item allocations within the new budget.

These allocations included providing dedicated funds for cutting-edge methods development as well as provisioning a small amount of funds that would operate like an insurance fund for operational/technical failures. The latter funds are used when a BRCF core facility experiences a failure or error that would be catastrophic to an investigator's research program. The funds are used to help mitigate, if possible, the impact to the investigator by providing resources to repeat an experiment. These dedicated line items as well as a funding line item for capital equipment that is informed by the multi-year forecast undergo rigorous evaluation, justification, and adjustment as part of the Dean's Office annual budget review.

Methods development is essential for shepherding new technologies into reliable scientific services (Chalmers, Bracken, Djulbegovic, Garattini, Grant, Howells, and Ioannidis, 2014) and is a cost not recoverable by standard recharge mechanisms. Dollars for this activity allow the core directors time and resources to develop new techniques or optimize methods for newly acquired instrumentation. Recognition of methods development as a deliberate investment supports the timely introduction of new technologies to the research community, fueling the pipeline of new core services, and can significantly influence a core facility's position within the lifecycle model. These resources also afford a core facility to take strategic and calculated scientific risks, which are essential to achieving innovative, game changing services. The Bioinformatics Core is an example of leveraging the methods development budget to systematically evaluate and validate continually evolving software that, ultimately, leads to the development of novel methods for analyses of data from new DNA Sequencing platforms.

Additional areas of focused attention included developing standardized operational metrics to provide insight into the number and diversity of investigators served, both internal and external to the university; demand for provided services; turnaround times; financial sustainability via recharge collections; and customer satisfaction. The above metrics are routinely tracked, which allow strength and weakness trends to be identified for each of the individual cores. Another focal point was succession planning for key personnel to ensure sustainable core facility leadership and continuity of scientific and operational expertise. Furthermore, to raise awareness of available services and to improve responsiveness to the research community, acquisition of a dedicated marketing specialist was defined as another key priority. The marketing specialist has improved communications and increased core facility recognition through initiatives such as redesigned websites, core facility newsletters, core facility showcases, and real-time customer satisfaction surveys.

Conclusion

Optimizing institutional approaches to enable research is a necessary strategy that should be embedded into all research-intensive universities. Developing and implementing a robust managerial and stewardship strategy is particularly necessary for core facility services, as the current institutional environment of competing priorities and constrained financial resources place many services at risk of being scaled back or dismantled. Core facility and infrastructure-intensive activities may especially be in jeopardy, as the costs associated with maintaining existing services, starting up new technologies, and hiring highly trained faculty/staff to serve as methodology consultants and instrumentation managers are substantial. However, investments in

both core facility-associated personnel and equipment are an absolute necessity if an institution's scientists are going to remain competitive and scientifically current. Clearly, the sophistication of biomedical research has created the demand for more complex and innovative technology and services, thus enabling faculty to dramatically advance research along the entire spectrum of basic and clinical investigations.

The BRCF at the University of Michigan Medical School has implemented processes, business practices, and governance models that have allowed more robust management of the core facilities while better meeting the needs of our research community and improving faculty satisfaction with the core facilities' performance (Table 1). With this systematic strategic approach, the BRCF has

Table 1. Realized Benefits of a Core Facility Business Strategy

1. Replaced obsolete equipment
2. Introduced new technologies
3. Increased scientific capability and capacity
4. Reduced turnaround times
5. Created standardized and sustainable oversight
6. Created core evaluation processes and metrics
7. Piloted a model to outsource services
8. Gained efficiencies with a web-based core facility management system
9. Improved faculty satisfaction

been able to demonstrate rigor in making challenging trade off decisions and making compelling, data-driven arguments for investments that have resulted in stronger core performance. Customer satisfaction surveys for individual BRCF core facilities indicate increasing satisfaction with the improved quality and timeliness of core facility services, along with new services created through methods development. Engaging faculty, who are end users of the services to actively participate in the acquisition of new technology and provide scientific guidance to the BRCF director, has empowered the research community to influence and shape the service offerings available to them. Interestingly, we have found the faculty committees to apply a high standard of rigor in their deliberations and recommendations.

Medical School leadership has embraced the transparent core facility evaluation framework, as it enhances communication, provides accountability for investments made, and creates a path forward to not only efficiently sustain core facilities but also allow them to thrive based on the scientific demands of the research community. The transparency and consistent application of the process has provided a solid rationale for making tough trade off decisions that can be effectively communicated to faculty and departmental leadership. Moreover, it demonstrates sound stewardship of limited resources. Some of the principles developed for managing the BRCF are now being applied to other areas of the Medical School. One such example is the implementation of the central capital equipment inventory with useful life depreciation schedules and a capital

line item budget allocation for the Unit for Laboratory Animal Medicine, which is also a capital-intensive, recharge unit in the Medical School.

A number of key lessons have been learned from this comprehensive approach to core management. (1) Business planning supported by ongoing financial analyses and key performance indicators should become part of a core facility's culture. (2) Capital equipment planning and methodology development must become fully integrated into the budget process. (3) Faculty who are consumers of the core facility's services should be involved in providing guidance and counsel on key aspects of the core facility's operations, such as introduction of new technologies and lifecycle management. (4) Succession planning for scientific and administrative core facility leadership is imperative for continuity and sustained performance. (5) A process integrated into routine business practice needs to be set in place to annually monitor services that need to be expanded, maintained, or dismantled. (6) Within a financially constrained environment of research-intensive institutions, trade-off investment decisions are better informed with well-established performance metrics, and when difficult decisions are required, having a transparent, consistent process assists with making those decisions and effectively communicating them to your constituency. In total, a core facility specific strategy with defined and actionable tactics is key to providing robust and pertinent services to support our research faculty and staff with the goal to facilitate more, better, faster, cutting-edge research.

Author Note

The material contained in this manuscript, including opinions, observations, and conclusion is solely the responsibility of the authors. The authors would like to acknowledge Tina Bowen, Christine LaJeunesse, Mike Yiu, and Jennifer Hill from the University of Michigan Medical School for active consultation. Part of the material in this manuscript was presented in abstract form at the 2014, AAMC's Group on Business Affairs Meeting, Coral Gables, FL. Correspondence should be addressed to Teri Grieb.

Teri Grieb, Ph.D.
Senior Director for Research
University of Michigan
Medical School Office of Research
Managing Director
Michigan Institute for Clinical & Health Research
Office of Research, University of Michigan Medical School
2800 Plymouth Road
Building 520, 3rd Floor
Ann Arbor, MI 48109-2800
Phone: (734) 763-4412
Email: tgrieb@med.umich.edu

Jeffrey R. Horon
Consultant, Elsevier Research Intelligence

Cassandra Wong
Director of the Biomedical Research Core
Office of Research, University of Michigan Medical School
Ann Arbor, MI 48109-0674
Email: ckwong@med.umich.edu

Jessica Durkin, M.S.
Associate Director of Administration for Research
Office of Research, University of Michigan Medical School
Ann Arbor, MI 48109-0674

Steven L. Kunkel, Ph.D.
Senior Associate Dean for Research
Office of Research, University of Michigan Medical School
Ann Arbor, MI 48109-0674

References

Angeletti, R . H., Bonewald, L. F., De Jongh, K., Niece, R., Rush, J., & Stults, J. (1999). Research technologies: Fulfilling the promise. *FASEB Journal, 13*, 595-601.

Chalmers, I., Bracken, M. B., Djulbegovic, B., Garattini, S., Grant, G., Howells, D. W., & Ioannidis, J. P. A. (2014). How to increase value and reduce waste when research priorities are set. *Lancet 383*, p.156-165.

Haley, R. (2009). A framework for managing core facilities within the research enterprise. *Journal of Biomolecular Techniques, 20*(4), 226-230.

Haley, R. (2011). Institutional management of core facilities during challenging financial times. *Journal of Biomolecular Techniques, 22*(4), 127-130.

Murray, R. (2009). Shared experimental infrastructure. *Analytical Chemistry, 81* 8655-8662.

Rey, C. M. Creating campus core research facilities: Trying to stay ahead of the technological curve. *UCSF Today*, Oct 26, 2007.

Shendure, J. & Ji, H. (2008). Next generation DNA sequencing. *Nature Biotechnology. 26*, p.1135-1145.

Slaughter, C. (2005). A bright for but demanding future for core facilities. *Journal of Biomolecular Techniques, 16*(2), 167-169.

Liaison and Logistics Work with Industrial Advisory Boards

Kathryn K. Michel, B.A.
University of Colorado MAST Center
Boulder, CO

Abstract: *One model for successful university research centers is based upon close collaboration with other organizations, including large and small companies as well as federal and state agencies. Collaborations of this nature often involve an Institutional Advisory Board (IAB), which can have significant responsibility for management and financial oversight. This paper addresses two critical areas for facilitating a strong working relationship between a university research center and an IAB: (1) streamlining information transfer, and (2) organizing a well-run center meeting. The paper addresses specific strategies for effective information transfer among center participants including sponsors, faculty and students. Also discussed are best practices for center meetings that ensure a suitable level of efficiency expected of an IAB. The methods described in the paper are established, well-accepted psychological and organizational principles. These methods have contributed to the paradigm for successful industry-university collaboration developed over the last 25+ years by the National Science Foundation's I/U CRC program.*

Keywords: *Capacity Building, Research Collaboration, Social Network Theories*

Background and Objectives

Industry-University research collaboration has become increasingly important in recent years, due to a shrinking pool of available funds from state and federal sources. In order to maintain the level of research productivity expected at many institutions, researchers have increasingly turned to alternative funding opportunities through collaborations with industry. Ideal industry partners include those with a vested research interest who lack either the facilities or manpower to accomplish research goals. The National Science Foundation's Industry & University Cooperative Research Program (I/UCRC) has achieved considerable long-term success based on this premise (National Science Foundation, 2014). The Membrane Science, Engineering and Technology (MAST) Center site at the University of Colorado, Boulder is a member of the NSF I/U CRC program and continues to receive the majority of its funding from industry. During the last fiscal year, the Center distributed $650,000 in industry support to faculty from the three universities that comprise the Center, the University of Colorado Boulder, the New Jersey Institute of Technology, and the University of Arkansas at Fayetteville (Greenberg, Sirkar, Noble, Wickramasinghe, Meyer and Michel, 2014). All centers in the NSF I/U CRC program are required to have an IAB that oversee the distribution of such industrial funding.

According to the NSF model the IAB is comprised of representatives from private industry and government laboratories/agencies that interface with a research center to guide research direction and sponsor the training of undergraduate, graduate, and post-doctoral fellows through careful

selection of sponsored research and subsequent mentoring on the selected research projects. The IAB takes an active role in discussions on the specifics of technology advancement through:

(1) review of research progress reports

(2) selection of future projects submitted in a request for proposal (RFP) process

(3) in-depth mentoring of Principal Investigators and researchers

(4) participation in semi-annual meetings of research presentations

(5) providing feedback (NSF, 2014).

The typical IAB, comprised of technical subject matter experts, is organizationally led by a chairperson or executive committee tasked to lead communications and information transfer with the academic research center. The Chair also presides over Center meetings where operational decisions are made.

With the increase in collaborative efforts between industry and academia, there is a need to provide a logistical and communication framework that will allow industrial advisory board members to access needed information in a timely manner. Such a framework would allow more interaction and comprehensive feedback to assist academic research efforts.

Major challenges to effective IAB functions are maintaining active engagement and transmitting information in a timely manner. In particular, research centers are often hampered by the following deficits in technology and communications:

- Lack of a suitable communication platform for timely information access and transfer among the IAB, researchers and center personnel.
- Lack of training for currently available resources such as web-based platforms
- Lack of attendance at semi-annual meetings.

Within the last two years, the NSF I/U CRC program (NSF 13-594) instituted an operations track at their annual Director's meeting to address many of these issues. Within the 2013 and 2014 annual meetings there were sessions focused on ways to improve IAB relations and run more effective meetings (Michel and Greenberg, 2013, Michel, Palmeri, Schabenberger and Brown, 2014). Additionally, there were break-out sessions for collaboration with I/U CRC coordinators from across the United States during these meetings to share information and find novel solutions to these long-standing challenges.

Regrettably, the lack of existing literature on the subject is an additional challenge. The closest related articles in present literature that might serve to provide direction in logistics and liaison work for IAB's only describe the stressors for business travelers (DeFrank, Konopaske, & Ivancevich, 2000; Beaverstock, Derudder, Faulconbridge, & Witlox, 2009; Wickham & Vecchi, 2009). These stressors and needs will be addressed later in this discussion. However, despite a 30-year track record of the program through the National Science Foundation, the literature search did not locate any reports specifically tailored to the needs of an IAB working in collaboration with university research centers.

Through the example set by the Membrane Science, Engineering and Technology Center it has been shown that many of these challenges listed above could be addressed if research centers would engage in a concerted effort to embrace emerging technology and develop an appropriate hierarchy of needs to streamline information transfer, event preparation, and event coordination. When process run smoothly, it is more likely the IAB will be fully engaged. Full engagement is more likely to result in IAB members providing assistance in recruiting other organizations to join the center and perhaps increasing the likelihood of spin-off funding. The ability of the center to transform new IAB members into long-term center collaborators ultimately provides significant benefits for the center sponsors, faculty and students.

Methods

Part I. Effective Liaison Work with Industrial Advisory Boards

In order to determine what is most critical in liaising it is necessary to determine the primary goal(s) of the IAB, which may differ from Board to Board but generally include:

- Increased intellectual property and technology transfer for commercialization
- Development of access to current research
- Leveraged funding on a limited research budget, i.e., pay for one project, and have access to multiple projects (NSF, 2014)
- Gaining access to a hiring pool of highly educated students
- Establishing meaningful professional and networking relationships with other experts in the field/other companies, and to increase the general visibility of the organization (DeFrank et al., 2000)
- Attain social recognition of the commitment to collaborative research with academia

In order to accomplish the specific goals, IAB members need timely access to information, frequent and regular contact with the center, and assurance that intellectual property rights are protected. The MAST Center addresses these needs by:

- Scheduling frequent contact initiated by center coordinators and directors, considered to be advantageous for healthy collaboration
- Providing a secure server enabling direct download of regularly updated information
- Providing use of the center website (www.mastcenter.org) to post pertinent information for the semi-annual meetings, benefitting the IAB, researchers, students, and potential sponsor visitors.
- Ensuring real-time customer service by the center coordinators

The MAST Center found that inundating the IAB with a barrage of emails within a short timeframe desensitizes the audience, (i.e., the "importance threshold" was lowered significantly), resulting in unread email. To address the reported gaps in information retention and, given that the average person can remember three to four items of information from one associative trigger

(Cowan, 2010), MAST had the most success in transmitting information with emails limited to three or four items related to a single theme. Experience indicates that monthly contact between meetings is effective for general communication while more frequent, targeted contacts are utilized effectively for specific issues.

The mechanics of the MAST Center information transfer have evolved over the last 15 years to keep pace with technological advances, replacing the multiple hard-copy environment with the following resources:

- Secure Server: The secure server has downloadable information resources for the IAB to access via username and password including information rosters, project report history, meeting history, sample agreements, and a section to conduct Request for Proposal cycles.
- www.mastcenter.org: The MAST Center website provides links to pertinent center information. , The website been organized with the assistance of specialists in marketing and psychology. It is reviewed and updated on a bi-weekly basis. Portals to online registration and proposal and project report submission are linked for easy access (see below).
  - www.regonline.com: This service allows for secure online registration for meetings payable by credit card. After account initiation, meeting organizers can establish a registration portal that is linked to a meeting website. Opening an account is free; however, there is a fee for each transaction.
  - www.formsite.com: This service provides secure online submission of proposals and confidential progress reports. The website allows administrators to access the secure online repository to download the files via the secure server with successful transmission confirmation. The service charges a minimal fee in relation to the number of portals and forms that are in effect at one time.
  - www.surveymonkey.com: This service allows project feedback to be accomplished in less time than required by traditional manual survey methods using paper copies, collating and manual data entry. The surveys can be collated quickly and individual reports can be created and distributed for review and incorporation into planned research direction.

In addition, the IAB needs to have a secure infrastructure which allows proactive operation within required timelines. Advances in secure technology including secure web and server access have made significant strides in fulfilling this need. Future directions for secure technology are being determined in upcoming meetings with the IAB.

Part II. Best Practices for IAB Meeting Logistics

Face to face meetings allow for greater depth of communication and understanding as well as adding the advantage of real-time decision making that is often impeded by technological delays (Arvey, 2009, Richman, 2013). Among the areas that have been determined to benefit from face-to-face meetings are the following: 1) to understand the reactions to the information presented by interpreting facial expression, body language and tone of voice, 2) to capture attention in order to initiate a new idea/process, 2) to inspire a positive group climate, 3) to build relationships, and 4) to make decisions based on complex information (Richman, 2013; McEuen and Duffy, 2010).

All of these conditions are present within the average IAB meeting. While some might believe that technological advances enable the substitution of an "in-person" meeting with webinars, videoconferencing and teleconferences, the MAST Center has found that the benefits of real-time and face-to-face contact are critical for success: not only is there the opportunity to work with researchers in real-time, but there is also a chance to build meaningful relationships among industry, faculty, and student researchers (Beaverstock et al., 2009).

However, travel is stressful on many people and the IAB representatives are often required to travel more than their peers. Goals of an IAB meeting include review of research results, mentoring of researchers and students, and networking with other sponsor companies, requiring two-to three days for meetings, plus travel time. Therefore, ensuring that the needs of the IAB members are met has become a pivotal factor in successful meeting preparation and optimization of IAB performance.

In order to adequately determine needs of attendees it is beneficial to study the demographic of the IAB. IAB members often have the following traits in common:

- Between 35-65 years of age
- Possess advanced degrees and are technical experts in their field
- Experienced travelers with high standards of logistics and performance
- Frequent travelers with a higher-than-average stress level (DeFrank et al., 2000)
- Some have administrative staff that assists them with tasks and arrangements
- Access to decision-makers in their companies, but are often restricted by company/ governmental policy and budget considerations.
- Several destinations are often grouped in one trip

Daily business tasks are not suspended while on travel, and they need to maintain contact with their home companies. These traits cumulatively represent a demographic with a higher expectation of service in the travel industry partners used (i.e., chain of hotel, reward programs, etc.) as well as a need for higher level of organization of travel plans.

According to popularly known theory of the hierarchy of human needs (Maslow, 1943), a person's physiological needs must be addressed before emotional and self-actualization needs.

Maslow's hierarchy of needs shown above (Gupta, 2014), might be reasonably reframed in the analogy below to apply to the needs of the IAB.

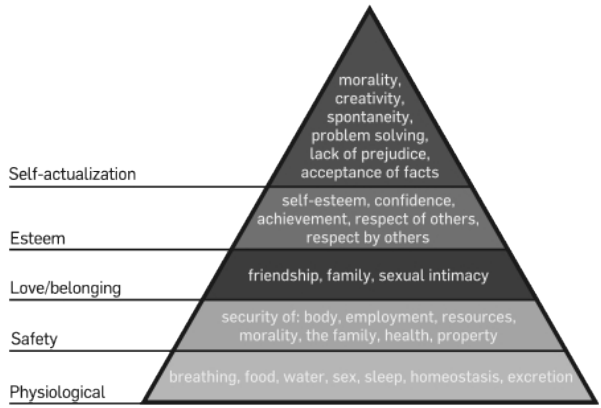

Figure 1. Abraham Maslow's Hierarchy of needs (as shown in Gupta, 2014)

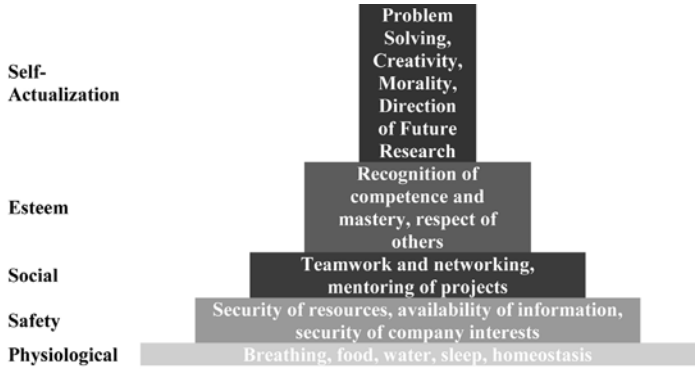

Figure 2. Hierarchy of IAB Meeting Needs.

For the purposes of business travel and meeting function, the focus of the five major stages has herein been shifted. The first two stages are identical to Maslow's, whereas the third stage is primarily concerned with teamwork and networking. The fourth stage addresses recognition of competence, mastery, and the respect of others, and the fifth stage focuses on problem-solving, morality, creativity, and fulfilling the overall organizational mission. The meeting planner is responsible for the first two stages, while the other three stages are accomplished though meeting activities.

The first question addressing the modified hierarchy is "how will the meeting attendees be as physically comfortable as possible?" It has been determined through past IAB meetings if physiological needs of attendees are addressed consistent physical and intellectual engagement remains high.

Schedule details should be addressed at the onset, including meeting dates as well as daily activities. When the MAST Center convenes a meeting, the following elements are considered to combat meeting fatigue:

- academic calendars of the institutions,
- related professional meetings
- religious holidays
- location of the nearest airport, reducing travel time
- break schedules at (maximum) intervals of 2.5 hours
- Having ample space to present.

Logistics are arranged for activities, including meetings, evening functions and poster sessions, with a goal of providing a reasonable vantage point with room to comfortably stand and walk. For seated functions, provide at least 36 inches between tables to allow for movement of chairs, and screen projection angles are not more than a 45-degrees. For poster sessions, allow for 48 inches between projects and leave at least a 60-inch walkway. These configurations prevent crowding the presenter and eliminate "choke points."

Travel assistance and local amenities are initial planning details. Executives, even technically-oriented ones, expect certain amenities at lodging accommodations (DeFrank et al., 2000) - many require executive rooms with shuttle service, a fitness center, a suitable restaurant, and reliable wireless access. It is wise to negotiate a discounted room rate, but this may not always be possible unless a room block can be guaranteed. It is a good practice to give attendees a range of lodging choices, to accommodate budget and frequent-traveler preferences, if possible. Organizers of meetings should investigate options for shuttle services, but some travelers may also choose to utilize public transportation or rent their own means of transportation. For those who are walking to the meeting site, the organizer should make sure that comprehensive maps and directions are available. A best practice is to walk the route personally, verifying that the directions are accurate. Provide a list of local restaurants, for attendees who choose to dine out. It is beneficial, if possible to have a local contact host excursions. Hosted dinners (our Recruitment Coordinator, who has at times labeled himself the "surly native guide") are particularly effective for both recruiting and networking purposes.

With a significant portion of IAB meeting functions centering on mealtimes, it is important to pay attention to food choices. Many executives have reported increased consumption, leading to stress and in some cases making an attendee physically ill (DeFrank et al., 2000). Given the range of the typical IAB meeting attendee, the dietary needs can be complicated. Common dietary needs include:

- High-protein, low-fat and lower-carbohydrate meal choices
- Higher vegetable/meat quotient, and more salad options
- Fewer fried hors-d'oeuvres and more fresh vegetables, fruit and cheeses
- Smaller-portion desserts
- Ample supply of quality coffee
- Cold water on hand at all times in all meeting/function rooms
- Quality beer and wine choices
- High quality box lunches may be served on the last day to accommodate travel schedules considerations.

Ensure that meeting technology is available and working properly, in order to decrease attendees' travel stressors (DeFrank et al., 2000). Since most attendees are also working with their home companies while at a meeting, inadequate connectivity can be a serious point of contention (Wickham & Vecchi, 2009). A requirement for any site is reliable internet access with a high transfer speed. Additionally, sound systems must accommodate speakers with low volume voice output, and use of an in-house projector and screen with high resolution is a must. Within the last year, the MAST Center has also instituted the concept of the "Meeting Office," allowing use of the secure server at the meeting site, printer availability, and access to other services.

The next issue in the Hierarchy of IAB Meeting Needs model relates to the 'organizational safety' of the meeting. Experience has shown that timely and proactive transmission of information seems to assure attendees that they have immediate access to necessary information, thus increasing their

sense of safety and security. To accomplish this, a schedule of information transfer is established using the following timeline:

- **3 months prior to meeting:** Announcement of dates and initial travel resources are communicated via email, and posted on the meetings page of www.mastcenter.org.
- **2 months prior to meeting:** Notification that the online registration portal is open and a preview of the overall meeting agenda (also available on both the website and the secure server).
- **One month prior to the meeting:** Reminders are sent regarding meeting registration, travel information, transmission of schedules for presentations and mentor meetings.
- **Two weeks prior to the meeting:** Notification that written progress reports are available for download and review in the secure server as well as the business meeting agenda.
- **One week prior to the meeting:** Notification that presentations are available for download and review in the secure server, as well as any last-minute items required for the meeting.

While it could be argued that one-to-two weeks' notice for read-ahead material is too short, experience has shown that longer time frames do not produce better preparedness: when sent too early, it is often "put on the back-burner" and not viewed at all, or there is poor recollection of the material read early.

Nonetheless, it is important to note that careful preparation will not anticipate every circumstance. Thus, it is critical to have contingency plans and standard practices that will accommodate the fluctuating needs of the IAB meeting. Below are some best practices that have been found to reduce stress, and increase the feeling of "on-site sense of safety" for attendees:

- The meeting coordinator is first on and last off site. The coordinator checks all equipment and meeting details to ensure equipment functions properly and the space setup is correct. The coordinator is responsible to obtain assistance, if an issue arises.
- The coordinator is tasked along with the center directors for ensuring the meeting is on schedule. Over-runs and delays due to lack of preparation are unprofessional.
- The coordinator will have all pertinent information for the meeting available for immediate access. This information should also be readily accessible either by print or electronically for attendees.
- The coordinator will have contingency plans that anticipate the needs of the attendees (e.g., extra parking passes, number for the airport shuttle, a printer for boarding passes, etc.).
- The coordinator will have a backup plan, including phone numbers of vendors and all relevant event points of contact.
- The coordinator follows customer service basics: listen, comprehend, and assist the attendee in finding an acceptable solution. Additionally, the event staff needs to remain calm in the presence of attendees, to reduce the stress and prevent unforeseen circumstances from impeding the meeting.

When the physiological, organizational safety and informational needs of IAB members are satisfied, according to the Maslow Hierarchy model, they are equipped and prepared to

progress to the successive stages of needs fulfillment - social contact, esteem fulfillment, and self-actualization. It is in these latter stages where the IAB is then enabled to 1) perform at the most optimal levels in teamwork, networking, and mentoring activities; as well as 2) conduct essential problem solving through creative, moral, forward-thinking discussions.

Results

The MAST Center has had a successful history for the last 24 years as an I/U CRC as both a single site center and a multi-site center, currently comprised of three sites: the New Jersey Institute of Technology, the University of Colorado Boulder, and the University of Arkansas Fayetteville. The Center has had a total of 59 sponsors over the last 24 years that have made possible 88 completed three-year projects and 14 more currently in progress. There are 14 faculty members working on these 14 projects, supporting 14 graduate students and 6 post-doctoral fellows at 3 universities. Over the life of the center, 253 peer-reviewed publications, 580 presentations, and 7 complete patents have been realized. Spin-off funding for related research has been generated in excess of $32M. The MAST Center administrative operations ratings and meeting organization procedures are considered to be particular areas of excellence as evidenced in the results of survey feedback from all attendees and as stated in our Evaluators' Report to NSF (Greenberg et al., 2014, Meyer, 2013, 2014).

Conclusions

Research centers that engage in a concerted effort to work with emerging technology and the hierarchy of needs to aid in streamlining information transfer, event preparation, and event coordination, have been shown to produce highly efficient meetings with engaged IAB members. Such engagement can lead to the high productivity levels demonstrated by the MAST Center over the last 24 years.

Author Note

This paper has developed out of a movement within the National Science Foundation's Industry/University Cooperative Research Centers (I/U CRC) program to provide training for its operations personnel, including sessions on operating more effective and streamlined Industrial Advisory Board (IAB) meetings that are required as part of the program. Some of the topics in this paper were presented at the 2013 NSF I/U CRC Annual Meeting entitled, "Best Practices for IAB Meeting Logistics" (Michel & Greenberg, 2013). This paper and the previous presentation are supported by NSF Grant 1074320, titled, "I/U CRC Collaborative Research: Membrane Science, Engineering and Technology Center." Correspondence should be addressed to Kathryn Michel.

Kathryn Michel, B.A.
University of Colorado MAST Center
Department of Mechanical Engineering
432 UCB, Room ECME 267A
Boulder, CO 80309
Phone: 303-492-4614
Email: Kathryn.Michel@colorado.edu

References

Arvey, R.; "Why Face-to-Face Business Meetings Matter", White Paper for the Hilton Group, 2009, http://www.iacconline.org/content/files/WhyFace-to-FaceBusinessMeetingsMatter.pdf.

Beaverstock, J.V., Derudder, B., Faulconbridge, J.R., and Witlox, F., (2009) "International Business Travel: Some Explorations", *Geografiska Ajnaler, Series B, Human Geography 91* (3) 193-202.

Conley, C., (2007) *PEAK: How Great Companies Get Their Mojo from Maslow*, Jossey-Bass Publishing, 2007.

Conley, C., (2010). "Getting more Mojo from Maslow: In order to survive the struggles of the economic recession, we need to reframe difficult business experiences as opportunities to find meaning in our work", November 24, 2010 blog post, PEAK Organization website, http://peakorganizations.com/category/blog/maslows-hierarchy-of-needs

Cowan, N., (2010). "The Magical Mystery Four: How is working memory capacity limited, and why?" *Curr Dir Psychol Sci. 19*(1): 51–57. doi: 10.1177/0963721409359277

DeFrank, R.S., Konopaske, R., and Ivancevich, J.M., (2000) "Executive Travel Stress: Perils of the Road Warrior", *Academy of Management Executive, 2000*, vol. 14 no. 2, pp 58-71.

Maslow, A.H., (1943). "A Theory of Human Motivation," *Psychological Review, 50*, 370-396.

Greenberg, A., Sirkar, K., Noble, R., Wickramasinghe, S.R., Meyer, D., and Michel, K., (2014). "IAB Business Meeting Presentation", Spring 2014 MAST Center IAB Meeting, Newark, NJ, April 6, 2014.

Gupta, A., (2014). "Maslow's hierarchy of travel needs", January 17, 2014 blog post, planmy.travel blog, http://blog.planmy.travel/post/7305171361/maslows-hierarchy-of-travel-needs

McEuen, M.B., and Duffy, C., "The Future of Meetings: The Case for Face-to-Face", The Maritz Institute White Paper, September 2010, http://www.themaritzinstitute.com/perspectives/~/media/files/maritzinstitute/white-papers/the-case-for-face-to-face-meetings-the-maritz-institute.pdf

Meyer, D; (2013). "2012 Evaluator's Report, Membrane Science, Engineering and Technology (MAST) Center", required report for NSF I/U CRC program, March 18, 2013

Meyer, D; (2014). "2013 Evaluator's Report, Membrane Science, Engineering and Technology (MAST) Center", required report for NSF I/U CRC program, March 31, 2014

Michel, K., and Greenberg, A.R., (2013). *"Best Practices for IAB Meeting Logistics"*, Invited presentation at the 2013 NSF Annual Industry/University Collaborative Research Center Annual Meeting, Arlington, VA.

Michel, K., Palmeri, A., Schabenberger, L., and Brown, D., (2014). *"Fantastic Meetings"*, Invited presentation and Operations Fair booth, NSF 2014 Annual I/U CRC Meeting, Arlington, VA. Retrieved November 24, 2014, from http://www.cvent.com/events/2014-nsf-industry-university-cooperative-research-centers-annual-meeting/agenda-f0adabdb849c4013aaed592900e1a6c4.aspx

National Science Foundation, "I/U CRC Model Partnerships" (2014), National Science Foundation I/U CRC Website, http://www.nsf.gov/eng/iip/iucrc/program.jsp

National Science Foundation Program Announcement for Industry/University Collaborative Research Centers, NSF number 13-594; http://www.nsf.gov/pubs/2013/nsf13594/nsf13594.htm

Wickham, J., and Vecchi, A., (2009) "The Importance of Business Travel for Industrial Clusters – Making Sense of Nomadic Workers". Geografiska Ajnaler, Series B, *Human Geography 91* (3) 245-255.

Ori, J., (2009). *"The Hierarchy of Needs for Employees"*, August 2009 Blog post, Houston Chronicle Online, http://smallbusiness.chron.com/hierarchy-needs-employees-20121.html

Perone, J.S., Winters, P.L., Read, M., Sankah, I., (2005) *"Assessing Hierarchy of Needs in Levels of Service,"* Research Report delivered to the Florida Department of Transportation on FDOT Project BD 549-1, NCTR Project 527-08.

Richman, B., *"Face to face communication can help you accomplish business objectives"*, The Business Journals, 8/29/13, http://www.bizjournals.com/bizjournals/how-to/human-resources/2012/08/face-to-face-communication-can-help.html?page=all

Seth, A., (2013). *"Maslow's Hierarchy of Corporate Needs"*, August 15 2013 Blog post, Huff Post Business website, http://www.huffingtonpost.com/abhishek-seth-maslows-hierarchy-of-corp_b_3756841.html

www.mastcenter.org, website for the Membrane Science, Engineering and Technology Center (MAST), currently administered by the site at the University of Colorado Boulder

www.regonline.com, online registration portal that allows for credit card payments.

www.formsite.com, online submission engine for secure submission of project progress reports.

www.surveymonkey.com, online survey engine used for project feedback.

Evaluating the Impact of Research Produced by a Mission-Directed Emergent University

Paul W. Ivey
School of Graduate Studies, Research & Entrepreneurship (SGSRE), University of Technology, Jamaica (UTech)

Gossett Oliver
School of Graduate Studies, Research & Entrepreneurship (SGSRE), University of Technology, Jamaica (UTech)

Martin Henry
School of Graduate Studies, Research & Entrepreneurship (SGSRE), University of Technology, Jamaica (UTech)

Abstract: *The University of Technology, Jamaica (UTech) is quite young, having been granted university status in 1995, a mere 19 years ago. Nevertheless, UTech is acutely aware that it is research that sets a university apart from other post-secondary institutions. Driven by this awareness, it has developed, articulated, and implemented a coherent research agenda and established a supporting research management ecosystem. In this paper we argue that the two main traditional metrics – peer-reviewed publications and citations - which are used in evaluating research productivity and impact, respectively, of a university, while useful, are not sufficient. UTech's mission, like that of many other similar institutions, includes "service to our communities" and its research focus is on "interdisciplinary and applied research relevant to (national) economic and societal problems." By adopting a reflective inquiry method, we cite two examples of how research by UTech staff members has, in one case, had positive impacts on the university's proximate stakeholders, and in another case has the potential to generate significant impact on a particular sub-sector of the economy. We use the sense-making gleaned from these examples to propose an expanded schema of metrics for evaluating research impact. The schema we are proposing is one that includes "Fidelity-to-Mission (FTM)." The inclusion of FTM is based on the premise that an emergent university's first obligation, especially in resource-deficient contexts, must be to address through its research the needs of those it purports to serve, as expressed in its mission statement. Therefore, the extent to which it does so in objectively verifiable ways is a legitimate metric worthy of recognition.*

Keywords: *Fidelity-to-Mission, mission statement, reflective inquiry, research management, research performance metrics, University of Technology, Jamaica*

Introduction and Contextualization

Brief History of UTech

The University of Technology, Jamaica (UTech), succeeded the Jamaica Institute of Technology (JTI), which was established in 1958 and re-branded as the College of Arts, Science, and Technology (CAST) in 1959. On September 1, 1995, the Jamaican Parliament accorded CAST university status under its current name, the University of Technology, Jamaica (Sangster, 2010). The mission of the University of Technology, Jamaica is: *"To stimulate positive change in Caribbean society through the provision of high quality learning and research opportunities and service to our communities"* (University of Technology, Jamaica, Student Handbook, 2012-2013, p.1). UTech is viewed as Jamaica's National University, with a student population of more than 12,000 pursuing more than 50 programmes at certificate, diploma and undergraduate and graduate degree levels through three Colleges and five Faculties. The history of UTech and the contributions of its staff and students are intimately connected with the social and economic development of Jamaica.

UTech's Research and Innovation Management Ecosystem

It is generally agreed that research output is one of the key indicators that sets a university apart from other post-secondary institutions (Organization for Economic Cooperation and Development, 2004). Also, research is central to the very appealing idea of the university as an autonomous entity with the freedom to make its own rules (Lemann, 2014). On being accorded university status, it was important for the newly-created University of Technology, Jamaica to establish and implement a coherent research agenda and a supporting ecosystem of research management. Accordingly, the Office of Research and Graduate Studies (ORGS) was initially established (Onyefulu & Ogunrinade, 2005).

However, in 2007 with the appointment of a new president who set about establishing research and graduate studies as major thrusts at the institution, the ORGS was replaced by the School of Graduate Studies, Research, and Entrepreneurship (SGSRE) as the unit responsible for Research and Innovation Management (RIM) at UTech.

Two imperatives motivated the change from the ORGS to the SGSRE. One, an understanding that "research management" comprises a distinct suite of activities separate from the conduct of research itself (Association of Commonwealth Universities [ACU], 2004). And two, the fact that university-based research has come to be seen not merely as the catalyst of economic growth, but a vital part of the research-innovation ecosystem. Indeed, the concept of the "knowledge economy" based on the application of scientific knowledge as the key source of economic and political power, and social and individual prosperity is now one of the main paradigms across the world. This correlation is strongly promoted by the OECD, the World Bank, UNESCO, and the European Union, among others, and by many national governments (Hazelkorn, 2012).

Key Institutional Research-Related Initiatives

Directed by its mission, "To stimulate positive change in Caribbean Society through the provision of high quality learning and research opportunities and service to our communities," key institutional research-related initiatives are included in UTech's Strategic Plan (Table 1).

Table 1. Strategic research-related initiatives of the University of Technology, Jamaica.

a. Partner with other universities and tertiary institutions to develop new research opportunities;
b. Collaborate with research 'strong' units and organizations;
c. Promote benefits of publication to staff;
d. Track citations, copyright, and patents;

Source: University of Technology, Jamaica Strategic Plan.

In addition, through a consultative process led by the SGSRE, "research focus areas" have been identified reflecting the perceived strengths of the university that may be applied to address significant social and economic problems nationally (Table 2).

Table 2. Research focus areas of the University of Technology, Jamaica.

a. Alternative use of natural resources;
b. Built environment;
c. Energy;
d. Forensics;
e. Health;
f. Hospitality & foods;
g. ICT applications & information systems;
h. Land management;
i. Organizational behaviour and productivity;
j. Technical and vocational education;
k. Sport;
l. Urban space management;
m. Waste management.

Source: Ivey, et al. (2013).

The SGSRE has been designated "owner and driver" of UTech's strategic research-related initiatives and is required to provide performance status reports on them at monthly meetings of the university's executive management committee. Supporting the work of the SGSRE are College/Faculty Graduate Studies, Research and Entrepreneurship Coordinators (C/FGSRECs) serving as the critical link between the SGSRE and the various academic units within the university (University of Technology, Jamaica, Research Policy, 2009, p.3; School of Graduate Studies, Research and Entrepreneurship, 2014).

Research Management Support for Staff

Pre- and Post-Award Support Services

Recognizing the importance of research to its legitimacy as a university and the benefits that will accrue to its "proximate stakeholders" (i.e. primarily the people of Jamaica) from its research findings if it remains faithful to its mission, UTech through the SGSRE has implemented several initiatives and provides a suite of pre- and post-award support services aimed at promoting and encouraging staff involvement in research (Table 3).

Table 3. Pre- and post-award research support services provided by the SGSRE to staff at the University of Technology, Jamaica.

a. Advice and assistance with sponsored research, grants, and contracts for research and scholarly activities;
b. Identification and negotiation with potential partners and collaborators;
c. Help with interpreting and complying with university policy and procedures;
d. Capacity building workshops on grant proposal writing;
e. Provision of information regarding the interpretation and application of the university's Intellectual Property Policy, including assistance with the filing of patents and registering copyrights;

Source: Ivey, et al. (2013).

Internal Research Grant, Research Award, and Research Journal

The SGSRE also manages a competitive, internal research grant fund - the Research Development Fund (RDF). The RDF is an institutional fund, which was originally established in 1998 to stimulate a research culture and build the University's research capacity. The fund has been revised a number of times since its inception to respond to the growing needs of staff, and in keeping with the University's research agenda. The RDF provides funding for the following activities:

1. Research projects.
2. Publication fees for books, book chapters, and peer-reviewed journal papers.
3. Research capacity-building activities.
4. Protection of intellectual property.

In addition, the SGSRE is the secretariat with responsibility for selecting annually the awardee for a major cash incentive, the President's Research Initiative Award (PRIA), which is the university's most prestigious award. The purpose of the award is to stimulate research and scholarly activities by encouraging and supporting individuals who demonstrate exceptional ability through their scholarly activities, research publications, research income generation and grants secured, creative research activity and other research outputs. Since its establishment, 11 members of staff have received the PRIA.

Action is also taken by the SGSRE on an on-going basis to improve the support provided to staff, to encourage research activity among them. So, for example in 2011, the scope of activities eligible for RDF funding was expanded to include covering the costs of staff members' papers accepted for publication by peer-reviewed journals. Also, in the same year the SGSRE re-launched the University's *Journal of Arts Science and Technology (JAST)*, which publishes peer-reviewed papers in the areas covered by the three colleges, five faculties and 18 schools of the university. JAST is thus a medium through which staff members may publish the results of their research, alongside other researchers in other institutions and countries.

Research and Technology Day

The SGSRE is also the chief organizer of UTech's annual Research and Technology Day, which provides an opportunity for the university to display its research work and capabilities to stakeholders. The event facilitates interaction between the university and its various publics. In so doing, the university not only showcases the research work of its researchers, which is of value to the society, but also seeks to develop strong linkages with industry, academia, and with government. And the most recent initiative under consideration is a proposed re-organization of the SGSRE for greater effectiveness (Ivey, Streete, Henry & Oliver, 2012; Ivey, Potopsingh, Henry & Oliver, 2013; School of Graduate Studies, Research and Entrepreneurship, 2014).

Engagement with the Global Research Management Network

Beyond the provision of support services to staff researchers, the University of Technology, Jamaica, through the SGSRE, has also engaged with the Global Research Management Network (GRMN), which is managed by the Association of Commonwealth Universities (ACU) and is "dedicated to the development of international collaboration amongst the research management community" (Research Global, 2010, p.3).

In 2009, the University of Technology, Jamaica became the Caribbean partner on the EU/ACP-funded Science and Technology project, "The Improvement of Research & Innovation Management Capacity in Africa and the Caribbean for the Successful Stimulation and Dissemination of Research Results (RIMI4AC)." The RIMI4AC project, which ended in November 2013, was funded at €2.6 million under the Science and Technology Programme of the ACP with support from the European Union. The specific objective of this project was to strengthen the capacity of research institutions in the regions for sustainability, to effectively manage research and innovation activities, and to improve dialogue between researchers and

policy makers, to inform evidence based national and regional policies feeding into the regional sustainable development agendas of the five regions from which project partners were drawn.

In addition, two of UTech's Research Managers participated in the fifth biennial congress of the International Network of Research Management Societies (inorms), held in Washington DC, USA, from April 10-14, 2014. Research Managers from UTech have self-reported gaining meaningful exposure, experience, and overall building of their research management capacity from this engagement with the GRMN.

The Imperative to Evaluate Research Performance

Higher education institutions (HEIs) along with independent research organizations and industry have a significant part to play in the creation of new knowledge and in this context universities have assumed huge significance in creating value. Since higher education can be regarded as a "key enabler of the knowledge economy," the severity of the global economic crisis has re-fuelled the debate about HEIs being accountable and ensuring value-for-money and return on (taxpayer) investment (Hazelkorn, 2012). Similarly, because research output is one of the key indicators that sets it apart from other post-secondary institutions, it is of paramount importance that a university evaluates its research performance. Indeed, the measurement of research output and the ranking of universities has become somewhat of an industry in itself (Leydesdorff, 2008).

The Two Most Pervasive Traditional Research Performance Metrics

Various metrics for evaluating the research performance of universities have been used over the years. But, in terms of pervasiveness of use, the two most common, traditional metrics are: (i) counts of the number of publications ("research productivity") and (ii) counts of the number of times a particular published paper has been cited by other authors ("impact factor"). These are referred to as bibliometric measures. Measuring research performance provides a university with information that may be useful in: (i) informing decisions concerning allocation of funding to particular areas of research (ii) benchmarking itself against local and international standards of research output, that revolve around the following questions: how much research is conducted? What is its impact? How many papers are published in quality journals? What is the overall trend in the number of such of publications? (Thomson Reuters, 2008).

Beyond the Traditional Metrics, How Else Might a University Evaluate the Impact of its Research Output?

While taking note of these questions, and being aware that the main global university ranking schemes accord significant weight to the traditional metrics used to measure research output and impact, the main question being posed in this paper is: beyond the traditional metrics, how else might an emergent university evaluate the impact of its research output? This issue began to exercise our minds when we participated in the Association of Commonwealth Universities' (ACU) Conference of Executive Heads held in Kingston, Jamaica, in November 2012. The theme of the conference was "University rankings and benchmarking: do they really matter? In a presentation made at the conference, we argued that, for emergent universities, "contextually

impactful outcomes are important versus prescriptive ranking criteria." We also adopted the position that "emergent universities should perhaps not seek to hop onto the 'rankings treadmill' just for the sake of following mainstream trends or values, but seek to be faithful to their missions" (Ivey & Oliver, 2012). We made a further presentation on the topic "Measuring excellence in research (Within the context of a mission-directed emergent university)" at the 5th biennial congress of the International Network of Research Management Societies (inorms), held in Washington DC, USA, in April 2014 (Ivey & Oliver, 2014). In this paper, we are proposing a schema reflecting our views.

Mission Statements as Institutional Guides

Ideally, an institution's mission reflects self-imposed expectations and those of its proximate stakeholders (taxpayers, in the case of publicly-funded institutions), rather than prescriptive global rankings criteria. Of course, this is not to say the pursuit of knowledge and understanding without immediate practical applicability or the various global universities ranking schemes (such as the Times Higher Education/Thomson Reuters World University Rankings) are without merit, or that a university should be entirely parochial in its activities, outlook, and influence.

However, we note that, in recognizing the limitations of the leading global universities ranking schemes, UNESCO promulgated the "Berlin principles on ranking of HEIs" to ensure that those producing rankings and league tables hold themselves accountable for quality in their own data collection, methodology and dissemination. The Berlin Principles comprise five categories and 16 good ranking practice statements, one of which is that rankings should recognize the diversity of institutions and take account of their different missions and goals. In addition, UNESCO does not advocate the pursuit by universities of 'world-class' status or high rankings as goals in themselves (UNESCO, 1996; 2013). We think the main thrust of this paper is consistent with UNESCO's position on rankings.

The Merits of Fidelity-to-Mission as a Metric for Evaluating Research Impact

We define "proximate stakeholders" of UTech broadly as the people of Jamaica, given that the university is publicly funded as a national university. It is necessary to restate here that the research focus areas of UTech represent the strengths of the university that are aligned with the needs of the Jamaican society in particular.

Moreover, UTech is commonly referred to as the 'Peoples' University' and seen as one of the vehicles that must contribute to the realization of Vision 2030 Jamaica. Vision 2030 Jamaica is Jamaica's first long-term National Development Plan, which is aimed at the achievement of developed country status by the year 2030. The plan is based on a comprehensive vision: "Jamaica, the place of choice to live, work, raise families, and do business" (Planning Institute of Jamaica, 2009, p.XXI).

Our attraction to the mission statement of an organization as a meaningful reference point is that such a statement embodies the organization's purpose and in some situations its identity (Ellis & Miller, 2014). More fulsomely, Pearce (1982) states that a mission statement is a "broadly defined

but enduring statement of purpose that distinguishes the organization from others of its type and identifies the scope of its operations..." (p. 15).

Therefore, seeking to relate a university's research performance with its mission is both objectively and intuitively logical. Indeed, according to Dickeson (2010), "the mission statement of an education institution is the academic grid against which it will be measured" (p.37). So then, when the focus is placed on university's mission, the essential question to be answered now becomes: to what extent is an university, through its research, exhibiting fidelity to its mission and, by extension, doing right by its proximate stakeholders? The schema we are proposing that includes *"Fidelity-to-Mission (FTM)"* as a metric for evaluating research impact is shown in Figure 1.

Fidelity-to-Mission may be susceptible to being regarded as a nebulous, amorphous idea. However, when supported by objectively verifiable evidence, its utility and merits as a metric for evaluating the impact of a university's research are appropriate for several reasons, more so for emergent universities operating in resource-deficient contexts in which selective excellence may be a prudent strategy.

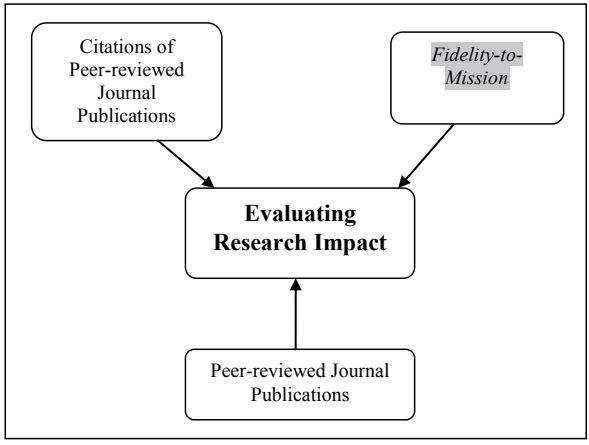

Figure 1. Schema showing *Fidelity-to-Mission* as an additional metric for evaluating research impact.

First, according to Hazelkorn (2012), academic research output, as measured by peer-reviewed-publications, and its impact, as judged by citations, reflects peer accountability rather than social accountability. Second, Weidman and Delgado (2009), while noting that the number of scientific publications and patents from Latin American and Caribbean countries was low, asserted that these countries should commit to social, economic and cultural development, not only the measurement of publication or research studies divorced from their realities.

In a similar vein, Mohamedbhai (2012), with specific reference to African Universities, argued that, given resource constraints, only a few are likely to appear under any of the various global rankings or league tables, as these rankings are based on research, publications in international journals, and citations. He argued that these universities should focus instead on their countries' development and problems because in the rankings race, the playing field is decidedly not level. This is why although not ignoring the role and importance of rankings, UTech has chosen instead to make as its priority research that may be applied to address significant local social and economic problems.

Gnolek, Falciano & Kuncl (2014), noted that it would take hundreds of millions of dollars to be among *U.S. News & World Report*'s top 20 national universities; many universities in developing

countries may not readily have this kind of money. Besides, even if they did, in our view, chasing global rankings is hardly the most prudent way to spend such financial resources. In addition, Lemann (2014) asserted that integrating the research life of universities more fully into the way society understands and experiences these institutions is the best way of maximizing their benefit, and of securing their future. Additionally, Price (2010) asserted that an inappropriate fixation on global ranking schemes may encourage institutions to change strategy just to score better rankings rather than doing what is right for their local settings. We wholeheartedly agree.

Examples of the Impact of UTech's Research on Proximate Stakeholders

Research Councils UK (2007) defines research impact as "the demonstrable contribution that excellent research makes to society and the economy; research impact embraces all the diverse ways that research-related skills benefit individuals, organizations and nations" (p.14). In addition, Research Councils UK cites the following areas where evidence of the translation of research into impacts is usually manifested: human capital, business and commercial, policy, and quality of life.

With specific reference to *quality of life and business and commercial*, we now cite in this section two examples of how the research work of the University of Technology, Jamaica, resulted in tremendous local impact:

1. *Carron Hall Solar-Powered Water Pump, Storage & Treatment Facility*
2. *Celebrating the Culinary Wonders of Cassava*

Carron Hall Solar-Powered Water Pump, Storage & Treatment Facility

Carron Hall is a rural, agricultural community located in the northern region of Jamaica. For many years, the only source of water for residents' domestic use was a natural spring sited more than 300 feet below the level of the nearby roadway. Daily, adults and children alike scrambled up and down the precarious slope with assorted containers, to collect water.

The University of Technology, Jamaica, was approached by local political representatives and community leaders to improve the residents' access to potable water. Approaching UTech for help was not a random act. Rather, it was driven by the political representatives' reasonable and strongly-held expectation that bettering the lives of Jamaicans was among the main reasons for the existence of the university, which is supported by public funds.

In response to the request, Engineers from the Renewable Energy Research Group of UTech's Faculty of Engineering and Computing (FENC) researched the problem and designed and implemented a solar-powered pump and water storage and treatment facility for this community. The project has had the positive impact of improving the *quality of life* of the approximately 2,000 residents of Carron Hall by providing clean piped water. Like many developing countries, Jamaica has challenges meeting the basic needs of many citizens for potable water.

According to the 2011 Population and Housing Census conducted by the Statistical Institute of Jamaica (STATIN), Jamaica had a population of 2,704,133. However, only 16% of Jamaican households or 141,835 persons have access to treated piped water for drinking. Another 68,839

households reported having access to treated drinking water, but it is not piped. STATIN found that 503,411 households or a significant 57.1% have access to piped water used for drinking, but said it is not treated. Another 85,392 households or 9.7% have access to water for drinking from other sources not specifically identified, but it is also not treated (Statistical Institute of Jamaica, 2012).

Access to safe drinking-water is important as a health, basic human right, and development issue at a national, regional and local level (World Health Organization [WHO], 2006). The WHO estimates that 1.4 billion people globally lack access to safe drinking water. The WHO also estimates that 80% of human illness results from insufficient water supplies and poor water quality caused by lack of sanitation. Additionally, the WHO notes that interventions in improving access to safe water favour the poor in particular, whether in rural or urban areas, and can be an effective part of poverty alleviation strategies (World Health Organization, 2006). For those of us who work as research managers, this data underscores the significant impact of the Carron Hall project on the quality of life of the immediate beneficiaries.

Reflecting further on this project, we have learnt that it has had other positive impactful outcomes. For example, another less obvious but no less important positive impact of the Carron Hall intervention is the heightened technological awareness that such a project, which has received good publicity in the local print and electronic media, brings to Jamaica; it demonstrates that the application of science can solve local problems. This is a very important "by-product" of this project in a country where the routine use of science-based solutions to local problems is not the norm. However, this project demonstrates concretely how this is possible.

It is not unreasonable to assume, we believe, that still another positive impact from the Carron Hall solar-powered water storage and treatment research project is that UTech's image was burnished in the minds of the beneficiaries – a set of our university's proximate stakeholders. University research managers should therefore be vigilant in identifying and documenting the non-obvious, but no less important, positive impacts that flow from the research work done by staff.

What is more, the Government of Jamaica (GOJ), through its Rural Water Supply Company, has requested the replication of the Carron Hall project in another area towards a country-wide deployment in similar community settings experiencing similar problems accessing potable water. In this regard, after the project was reported on widely in the local print and electronic media, the Managing Director of the Rural Water Supply Company made direct contact with the Manager of Projects and Operations in the SGSRE, to arrange a meeting. Here we see one of the further benefits to a university of having a dedicated Research Management Office with which interested persons may engage in order to obtain information about the research work of the institution. We attribute the GOJ's strong interest in the Carron Hall project to its clear potential to positively impact the quality of life of a large number of Jamaican citizens. At the time of writing, discussions are continuing with the GOJ to agree a framework for country-wide deployment of projects similar to the Carron Hall one in other communities.

Celebrating the Culinary Wonders of Cassava

We now turn to the second example. Jamaica has an annual food import bill of US$1 billion and authorities believe this can be reduced by up to US$300 million. Among the initiatives being

pursued to contribute to this reduction is a campaign dubbed "Eat what we grow, grow what we eat," which is aimed at encouraging increased consumption of locally-produced agricultural commodities. One of the crops specifically identified as having high potential is Cassava *(Manihot esculenta)*.

Following the launch of the "Eat what we grow, grow what we eat" campaign, a team of researchers from UTech published the book, *Celebrating the Culinary Wonders of Cassava* (McNish, Eyre & Rowe-Campbell, 2013). Although it could be mistaken as a recipe book, it is definitely more. It is a fine research publication, compiled by a three-member cross-disciplinary, cross-faculty research group. Two members are lecturers from UTech's School of Hospitality and Tourism Management (SHTM) and the other is a registered nutritionist and lecturer in the School of Allied Health and Wellness.

The nutritionist contributed *"critical nutritional analyses"* to the formulations of the two culinary innovators. The authors note that the book was published *"to promote the consumption of cassava and cassava value-added products..."*. The authors and the book are focused on nutrition for wellness based on local foods, and the publication contains innovative lab-tested cassava products which now need to be marketed.

In reflecting on the publication of *Celebrating the Culinary Wonders of Cassava*, we see that, through the research of its staff, UTech is placed at the centre of another important local issue; in fact, no less a person than the Minister of Agriculture was guest speaker at the launch of the book. By offering nutritious and creatively presented cassava products, the publication has the potential to exert significant impact on the "Eat what we grow, grow what we eat" initiative by triggering a consumer-led (demand-driven) increase in the production and utilization of cassava.

In his foreword to the book, the president of University of Technology, Jamaica noted that, *"UTech is committed to fostering development through the contribution of our research output in a number of relevant areas that can drive national and regional advancement. Our indigenous foods clearly represent an important area of comparative advantage ... that has significant potential for not only boosting brand Jamaica, but for earning foreign exchange and reducing our food import bill"* (p. i).

Of course, the launch of the book was a public event. But what of the "invisible" research management interventions that made it a reality? To begin with, one of the authors emphasized to the audience at the launch that the team was initially encouraged by one of the institution's research managers to "go for it." One sees here that research managers can motivate researchers and build their confidence to work on their nascent ideas. As in the example cited here, meaningful outcomes can result from such interventions. The team of researchers was also supported by another research manager in protecting their intellectual property rights (IPR) in the work. Researchers need to be supported by skilled, high-quality professional colleagues (Research Africa, 2013).

In addition, the university's research management office contacted the leading commercial producer of cassava to initiate a collaborative arrangement aimed at jointly promoting the consumption of cassava. Basically, the partnership will be based on the premise that promoting use by consumers of the recipes in the UTech publication will result in increased demand for the company's cassava, thereby setting up a virtuous cycle.

Conclusion

Traditional metrics - peer publications and citations - are not ignored in measuring UTech's research productivity and influence. However, the university's mission includes "service to our communities" and its research focus is on "interdisciplinary and applied research relevant to economic and societal problems." Therefore, *fidelity-to-its-mission* is also given significant weight and is measured by the extent to which the university's research output benefits proximate stakeholders, which can be broadly viewed as the people of Jamaica, given that UTech is a publicly funded as a national university.

In the first case study, *Carron Hall Solar-Powered Water Pump, Storage & Treatment Facility,* we cited the impact of UTech's research on proximate stakeholders. The quality of life for approximately 2,000 local residents was significantly enhanced through securing easy access to potable water as a consequence of the intervention of researchers from UTech's Renewable Energy Research Group, Faculty of Engineering and Computing. It was also noted that the project has attracted strong Government of Jamaica interest towards country-wide deployment of projects similar to the Carron Hall one in other communities.

With respect to the second case study, *Celebrating the Culinary Wonders of Cassava,* we have demonstrated that the publication in popular form of applied research with high social and economic utility placed the university at the centre of another important local issue - encouraging the increased consumption of locally-produced agricultural commodities as public policy.

More generally, we posit that emergent universities in Jamaica, the wider Caribbean, and elsewhere should regard themselves as critical tools, not only for traditional "scholarship," but also for social & economic empowerment of the communities they serve. This posture is consistent with that of Weidman and Delgado (2009) and Mohamedbhai (2012), who asserted, with respect to universities in Latin American and African countries, that the emphasis should be placed on research aimed at their countries' development and solving proximate (or local) problems. Implicitly, the extent to which these objectives are achieved is the extent to which the research performance of these institutions has been impactful.

Interestingly, in their analysis of the mission statements of seven HEIs in Jamaica, Ellis & Miller (2014) found that only UTech and the University of the West Indies (UWI) mentioned "research" in their mission statements. This being the case, we believe it further underscores our view that research conducted by these institutions must benefit their proximate stakeholders. Moreover, "service to our communities" is also explicitly stated in UTech's mission statement.

Finally, we believe that the main thrust of this paper is consistent with one of the "good ranking practice" statements promulgated by UNECSO in its "Berlin principles on ranking of HEIs," which is that rankings should recognize the diversity of institutions and take account of their different missions and goals (UNESCO, 2006).

Author Note

This article was developed from presentations made at the Association of Commonwealth Universities' Conference of Executive Heads, held in Kingston, Jamaica, in November 2012 and at the 5th biennial congress of the International Network of Research Management Societies (inorms), held in Washington DC, USA, from April 10-14, 2014. Correspondence concerning this article should be addressed to Paul W. Ivey, Associate Vice President, Graduate Studies, Research and Entrepreneurship, School of Graduate Studies, Research and Entrepreneurship, University of Technology, Jamaica, 237 Old Hope Road, Kingston, Jamaica, Phone: (876) 927-1680-9 ext: 2823, Email: paul.ivey@utech.edu.jm

Paul W. Ivey
Associate Vice President, Graduate Studies, Research and Entrepreneurship
School of Graduate Studies, Research and Entrepreneurship
University of Technology, Jamaica,
237 Old Hope Road, Kingston, Jamaica
Phone: (876) 927-1680-9 ext: 2823
Email: paul.ivey@utech.edu.jm

Gossett Oliver
Vice President, Graduate Studies, Research and Entrepreneurship
School of Graduate Studies, Research and Entrepreneurship
University of Technology, Jamaica,
237 Old Hope Road, Kingston, Jamaica
Email:goliver@utech.edu.jm

Martin Henry
Manager of Projects and Operations
School of Graduate Studies, Research and Entrepreneurship
University of Technology, Jamaica,
237 Old Hope Road, Kingston, Jamaica
Email:mhenry@utech.edu.jm

References

Association of Commonwealth Universities. (2006). International research management: benchmarking programme report to the Higher Education Funding Council (HEFC), UK, by the Association of Commonwealth Universities (ACU), May 2006.

Ellis, J., & Miller, P. (2014). Providing higher education in post-modern times: what do university mission statements tell us about what they do and believe? *Research in Comparative and International Education. 9* (1): 83-91.

Gnolek, S.L., Falciano, V.T., & Kuncl, R.W. (2014). Modeling change and variation in U.S. News & World Report College Rankings: What would it really take to be in the Top 20? *Research in Higher Education*. DOI: 10.1007/s11162-014-9336-9.

Hazelkorn, E. (2012). Measuring Value: University-Based Research and National Needs. *Chronicle of Higher Education*. August 7, 2012.

Ivey, P., & Oliver, G. (2012). Measuring research impact within the context of an emergent University. Presentation at the Association of Commonwealth Universities'(ACU) Conference of Executive Heads, Kingston, Jamaica, November 9-11, 2012.

Ivey, P., Streete, T., Henry, M., & Oliver, G. (2012). Evaluating the research performance of an emergent technological university. *Global Journal of Engineering Education. 14* (1), 132-136.

Ivey, P., Potopsingh, R., Henry, M., & Oliver, G. (2013). Structured research management in action: A review of recent experiences at the University of Technology, Jamaica. *Journal of Arts Science and Technology. 6*:74-82.

Ivey, P., & Oliver, G. (2014). Measuring Excellence in Research (Within the Context of a Mission-Directed Emergent University). Presentation at the 5th biennial congress of the International Network of Research Management Societies (inorms), Washington DC, USA, April 10-13, 2014.

Lemann, N. (2014). The soul of the research university. *The Chronicle of Higher Education*, April, 2014. Washington, D.C., USA.

McNish, J., Eyre, S. A., & Rowe-Campbell, C. (2013). *Celebrating the culinary wonders of Cassava*. JSC Publishing. Kingston, Jamaica.

Mohamedbhai, G. (2012). Should African universities be globally ranked? *Inside Higher Ed*. Accessed at: www.insidehighered.com, November 15, 2012.

Onyefulu, F., & Ogunrinade, A. (2005). Kick-starting research in newly emergent universities: why faculty do not apply for research development "seed" funding at the University of Technology, Jamaica. *The Journal of Research Administration, XXXVI* (2), 14-22.

Organization of Economic Cooperation and Development. (2004). The growing significance of the research mission to higher education institutions. University Research Management: Meeting the institutional challenge.

Pearce, J. (1982). The company mission as a strategic tool. *Sloan Management Review. 23* (3):15-24.

Planning Institute of Jamaica. (2009). Vision 2030 Jamaica: national development plan. Kingston, Jamaica

Price, M. (2010). Do university rankings matter? Mail & Guardian Online, South Africa. Retrieved from http://www.mg.co.za/article/2010-09-24-do-university-rankings-matter Research Africa. (2013). A research manager's notebook (Part1), Being a research manager: Understanding your role and maximising your impact. Research Africa, South Africa.

Research Global. (2010). *Association of Commonwealth Universities*. October 2010, Issue 6.

Sangster, A. (2010). The making of a university: From CAST to UTech. Ian Randle Publishers. Kingston, Jamaica.

School of Graduate Studies, Research and Entrepreneurship, University of Technology, Jamaica. (2014). Structured research management supporting impactful research. University of Technology, Jamaica, Kingston, Jamaica.

Statistical Institute of Jamaica. (2012). Population and Housing Census 2011 Jamaica. STATIN, Kingston, Jamaica

Thomson Reuters. (2008). Using bibliometrics: A guide to evaluate research performance with citation data.

United Nations Educational, Scientific, and Cultural Organization (UNESCO). (1996). Berlin Principles on Ranking of Higher Education Institutions. UNESCO, Paris, France.

United Nations Educational, Scientific, and Cultural Organization (UNESCO). (2013). Rankings and Accountability in Higher Education Uses and Misuses. UNESCO, Paris, France.

University of Technology, Jamaica. (2009). Research Policy, 2009.

University of Technology, Jamaica (2012). Student Handbook, 2012-2013.

Weidman, J., & Delgado, J. (2009). Research indicators in Latin American and Caribbean higher education – Inequalities linked to access and quality of knowledge (Working Paper). Proceedings of the Latin American Studies Association Conference. June 11-14, Rio de Janeiro, Brazil.

World Health Organization. (2006). Guidelines for drinking-water quality - First addendum to third edition. Vol. 1, Recommendations. – 3rd ed. WHO Press, World Health Organization, Geneva, Switzerland.

Building Research Collaboration Networks - An Interpersonal Perspective for Research Capacity Building

Jun Song Huang, PhD
National Institute of Education, Singapore

Abstract: *While collaboration is increasingly recognized to be important for research, researchers' collaboration networks are still not adequately recognized as a form of research capacity in the literature. Research is a knowledge creation activity and interpersonal research collaboration networks are important for knowledge cross-fertilization and research productivity. By referring to social network theories, this paper argues that research collaboration networks are a form of research capacity at interpersonal level. It complements capacity building at individual, organizational and inter-organizational levels. However, building research collaborations can be challenging. Three key issues are raised for discussion. First, collaboration networks have nonlinear effect on research productivity. Second, fostering heterophilous communications and maintaining degrees of heterophily can be contradicting and thus challenging. Third, building research collaboration networks proactively requires shift of research management philosophy as well as invention of analytical tools for research management. Debates and solutions with regard to these issues may contribute to the advancement of theory and practice of research management.*

Keywords: *Capacity Building, Research Collaboration, Social Network Theories*

Introduction

The development of social network theories has revealed that social structure of relationships around a person, group, or organization affects beliefs and behaviors (Burt, Kilduff, & Tasselli, 2013). For example, in research on innovation diffusion, Ryan and Gross (1943) find that Iowa farmers' adoption of hybrid-seed corn was mostly influenced by their neighbors, even though the farmers first heard the innovation from commercial salesmen. Godley , Sharkey and Weiss (2013) demonstrate that office location is one of the strongest predictors of grant collaborations amongst neuroscientists within an institute. Rogers (2003) further points out that interpersonal linkages among individuals in a social system can influence the communication flow and promote the adoption and diffusion of innovations in the system.

Increasingly, researchers are working in collaborations to address complex research issues. Higher Education Institutes (HEIs) are giving incentives for their researchers to take part in international collaborative projects. Funding agencies also favors collaborative research because it can draw diverse expertise, promote creativity and innovation and therefore lead to scientific breakthroughs. Social networks have been the subject of both empirical and theoretical studies in the social sciences for at least 50 years but has only been recently applied to research collaborations (Godley, et al., 2013; Woo, Kang, & Martin, 2013).

Implicit in social network theory is the assumption that there are outcomes associated with the connections. It is the thesis of this paper that research collaboration networks derive benefits to higher education institutions (HEIs). This author argues that of two hypothetical institutes (Figure 1), Institute B's intentional connections provide greater opportunity for research collaboration than does Institute A wherein the researchers work in isolation. The author further claims that Institute B has higher research capacity as compared to Institute A.

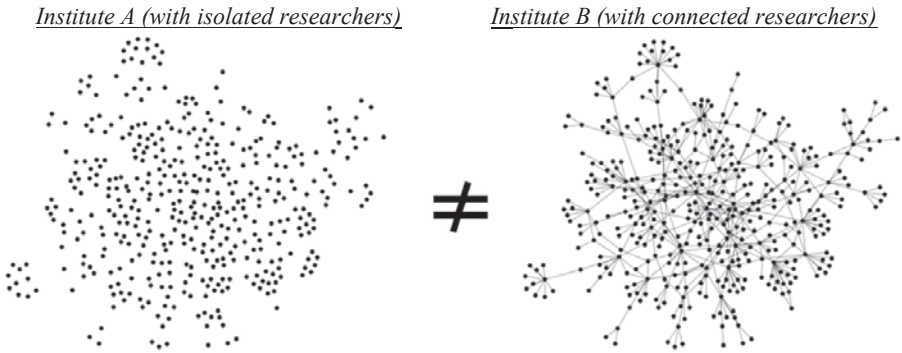

Figure 1. Comparison of Institute A and Institute B

This paper will focus on three important topics. Are social network theories relevant to research management? Can research institutes be informed by social network theories to promote research collaborations? What limitations do social network theories have when applying to research collaborations? In addition, this paper seeks to provide a theoretical framework for the role of research administration and capacity building through social networks. By linking social network theories with research management, the paper hopes to make contribution to the theory and practice of research capacity building.

To anchor this paper theoretically, social network theories are briefly introduced in the next section. The section does not cover technical details of the social network theories and models. More in-depth review of the theories can be found in the literature of Social Network Analysis (SNA) (Woo, et al., 2013).

Social Network Theories

Social network theories form a major paradigm in contemporary sociology. The theories focus on how people, organizations or groups interact with others in social networks (Burt, et al., 2013). In this sociology paradigm, the social relationships are studied in terms of diagrams of social networks which constitute nodes (e.g., people) and ties (e.g., the relationships among people). The diagrams can be used to understand social capitals (Williams & Durrance, 2008), the advantage that an individual, cluster or a network may gain from social interactions as a result of their location in social networks (e.g., who they are connected with). Theories are developed to explain why people interact, how they interact, at what level of closeness and with what kind of outcome.

The study on social network diagrams has led to multiple theories on social networks. For example, when examining the process of job seeking, Granovetter (1973) identifies the strength of weak ties. He finds that job seekers tend to hear of job opportunities from people connected by weak ties (e.g., acquaintance that does not share many common friends, just like people in a social network that has loose connections among members), rather than by strong ties (e.g., close friends who are closely connected among each other, just like people in a social network that has dense and coherent connections among members). The example of weak/strong ties is illuminated in a social network diagram presented in Figure 2. Node E shares a weak tie with Node H and strong ties with Node F and G. Granovetter explains that weak ties can transmit information (such as job opportunity) from distant part of the social system. Thus people that have few weak ties are confined mostly to the local information of their close friends. Empirical studies (Ahuja, 2000; Mehra, Kilduff, & Brass, 2001) have also demonstrated that individuals with weak ties can bridge different clusters in a social network and gain significant advantage.

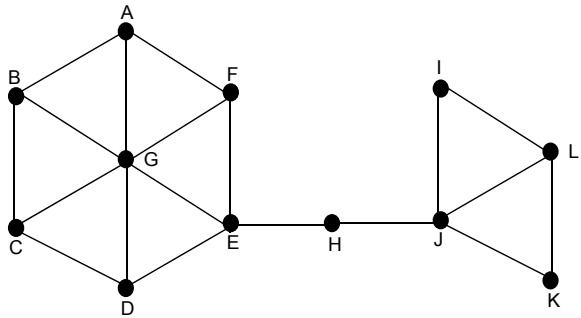

Figure 2. Network 1

Social network theories have their limitations. These theories take a relational approach and emphasize primarily the properties of relations among individuals (Kadushin, 2011). One major critique is their lack of recognition of the properties of these individuals (Martin & Wellman, 2010), for example, individuals' agency and determination in seeking information in social networks. Without denying this limitation, this paper argues that social network theories have potential to inform research management in HEIs.

The rest of the paper is developed into five sections (i.e., Section Two to Section Six). Section Two highlights the importance of collaboration in research. The next section reviews the literature of research capacity building. It argues that research collaboration networks are not adequately recognized as a form of research capacity. The fourth section uses two network diagrams to illustrate that structures of research collaboration networks can have impact on research creativity and productivity at both individual and collective levels. It is then argued that research collaboration networks can make unique contributions to research capacity building. The fifth section refers to social network theories and presents three mechanisms for building research collaboration networks. By making reference to the mechanisms and empirical findings, the last section discusses three challenging issues in building research collaboration networks.

Collaboration is Important for Research

Research collaboration has gain attention in the past few decades (Bammer, 2008; Wray, 2006). The observed growth in co-authorship provides partial evidence for increased collaborations in research (Katz & Martin, 1997; Sooho & Bozeman, 2005).

Bukvova (2010) notes that there is no clear definition on research collaboration in the literature. Many forms of collaboration work, such as casual discussion on a research idea, are hard to be measured as evidence of collaboration. For the purpose of this paper, research collaboration is regarded as joint work between researchers in achieving research objectives. More specifically, the two main forms of research collaboration discussed in this paper are jointly conducting research projects (i.e., joint grantsmanship) and co-authoring publications.

There are at least four reasons for researcher to collaborate: the need to address complex research issues; the need for learning and productivity in research; the need to reduce research cost and the need for intellectual companionship.

First, collaboration is necessary for researchers to address complex research issues that otherwise cannot be addressed by individual researchers. Due to the increased specialization in science, there is a need for individual researchers to keep their own activities focused and specialized (Bukvova, 2010; Katz & Martin, 1997). Such focus and specialization would allow researchers to make significant knowledge advancement in their respective fields (Bukvova, 2010). While it is possible for individual researchers to learn all the knowledge and skills needed to solve a complex research problem, this learning process can be very time-consuming and may prohibit one from being specialized. Thus, researchers, when addressing complex problems, need to pool expertise together and obtain cross-fertilization through interdisciplinary collaborations (Johari, Zaini, & Zain, 2012).

Second, collaboration is important for researchers' sustainable development in knowledge creation. The United Nations Office for Sustainable Development (2012) points out that in a knowledge economy, knowledge and capacity may be replaced or refreshed at a very fast pace. Thus, continuous learning and knowledge transfer are critical for researchers to remain relevant in their respective fields in an ongoing knowledge creation process. Such learning and transfer may bring together researchers with culturally different ideas which create conditions for new knowledge creation. Thus, learning and transfer through collaborations not only lead to research productivity (as indicated by grantsmanship and publications, as a result of knowledge creation), but also help researchers to maintain their ability for sustainable development in a knowledge economy.

Third, collaboration may reduce research costs. Bukvova's (2010) review on research collaboration finds that experimentalists tend to collaborate more than theoreticians. In experimental research, the instrumentations required are getting increasingly complex. Scientific instrumentation costs have jumped considerably with the successive generations of technology. By working together in collaboration, research costs can be shared and research facilities can be better optimized and utilized.

Fourth, collaboration may enable intellectual companionship as well. The goal of research is to expand the boundaries of knowledge. As researchers are specialized and focused, their advancement at the frontier of each research field can be lonely (Bukvova, 2010; Katz & Martin, 1997). An individual may partially overcome this intellectual isolation by collaborating with others and forming working relationships with them.

Since collaboration is important to research, social network theories may have potential in application to research management to promote collaborative relations among researchers. However, the literature review of research management and research capacity building suggests that the literature does not adequately emphasize building research collaboration networks, especially collaboration networks within an institute (but see Godley et. al., 2013).

Research Capacity Building and Research Collaboration Networks

Capacity building is a process in which individuals, groups, and institutions enhance their abilities to mobilize and use resources in order to achieve their objectives on a sustainable basis (Asian Development Bank, 2004). In the context of research capacity, it refers to the ability to conduct research sustainably.

Building research capacity is a key to both the survival of HEIs and their attainment of institutional missions (Hazelkorn, 2005). This is because the funding of HEIs is increasingly tied to the performance (Altbach, 2014; Altbach & Salmi, 2011) measured by research productivity (e.g., scholarly research publications) and impact. The current paper focuses on discussing dimensions of research capacity, rather than their measurements. Commonly accepted indicators (Cooke, 2005), such as publications and grantsmanship are used when discussing research capacity with different dimensions.

The following segments review the literature related to research capacity building. The author suggests that the literature emphasizes research capacity building at individual, organizational and inter-organizational levels. However, the interpersonal collaboration networks within institution are inadequately recognized as a form of research capacity.

Capacity Building at Individual Level

There are widespread concerns among HEIs on research capacity at the individual level. HEIs worry that they have too few researchers who have the knowledge and skill to lead the design, delivery, and dissemination of high quality research (Fowler et al., 2009). HEIs share concern that lacking such would affect their research mission attainment.

To develop the knowledge and skill of researchers, capacity building is usually carried out through professional development (Department for International Development, 2008). For example, the Teaching and Learning Research Programme (TLRP) was funded by the Economic and Social Research Council (ESRC) at the United Kingdom (UK). The programme supported and developed educational researchers across the UK through conference, training, online resources and mentorship. Wilkes, Cummings and McKay (2013) also share that a mentoring approach was

implemented in 2012 in New South Wales (Australia) to assist a group of generalist pediatricians practicing to comply with the demands in research.

Crisp, Swerissen, and Duckett (2000) characterize professional development as a bottom-up organizational approach for capacity building. The underpinning premise is that developing a core of well-trained individuals decreases reliance on external consultants and increases local capacity (Schuetzenmeister, 2010). Such development sustains institute's research efforts.

Capacity Building at Organizational Level

Research capacity can also be defined as organizational enablers, such as pro-research environments. Such enablers make an HEI better able to promote professional development of its researchers, enable research work and enhance research productivity (Cooke, 2005; Fowler, et al., 2009). In the recent research assessment exercises in the UK and Australia, organizational enablers are included as an assessment component (Olson & Merrill, 2011).

Organizational development is a top-down organizational approach for capacity building (Crisp, et al., 2000). The underpining assumption is to remove organizational factors that restrict research and to establish enabling factors that are absent. This involves improving organizational factors, such as research policy, cluture and structure. For example, the North American Primary Care Research Group Committee (2002) focuses on building a research culture to value research and to regard research as an expected and enjoyable activity. The United Nations Development Programme (2008) highlights policy, leadership, strategy and institutional reform as the enablers for research and capacity building. The North American Primary Care Research Group Committee (2002) establishes research centres as the enabling infrastructure for research.

Capacity Building at Inter-Organizational Level

From an HEI's perspective, building inter-organizational linkages deals with the external factors that promote research capacity. Contrasting with the internal factors, such as building individual staff's knowledge and organization's research environment, building inter-organizational linkages concerns with inter-organization collaborations and engagements of stakeholders and society.

The demand for building inter-organizational linkages can be traced to the argument of Network Organization (Borgatti & Foster, 2003) that organizations are embedded in the network of economic and social relations. Thus, organizations must transform themselves into networks. They need to rely on trust and embedded social relationships in order to effectively respond in the ever-changing economic environment. This idea is consistent with social network theories and was operationalized by some institutions for research capacity building. For example, the Welsh Education Research Network (WERN) develops research capacity by building collaborative partnership among all HEIs in Wales (the UK).

Crisp, Swerissen, and Duckett (2000) characterize this approach as the partnership approach and community engagement approach for capacity building. The partnerships approach involves strengthening inter-organizational relations (for example, research partnerships among universities). The community engagement approach aims to transform users of higher education

research innovations (such as industries) from passive recipients to active participants (Finn and Checkoway, 1998). Underpinning this approach is the notion of empowering beneficiaries (Mansuri & Rao, 2004). The empowerment allows an HEI's beneficiaries to be more engaged and aligned for the HEI's institutional mission attainment.

Lack of Capacity Building at Interpersonal Level

Researchers are connected into informal research teams and groups through their research collaboration relations. Rogers, Bozeman and Chompalov (2001) argue that in knowledge economy, such relationships are more important than individuals' attributes. Dulworth (2008) even purports that social networks (e.g., networks of collaboration relations) define who a person is.

Recent work suggests that some factors in collaboration can increase the likelihood of knowledge creation and thus research productivity. Research collaboration networks can play an important role to bridge knowledge flow among researchers in an institute (Easley & Kleinberg, 2010). The number of collaborators is noted as a strong predictor of publication productivity in research (Sooho & Bozeman, 2005). Krebs (2008) finds that one's ability to reach a diverse set of others in the network through very few links is a key to success for both individuals and teams. Dawson, Tan and McWilliam (2011) note that a researcher's ability to access collaboration networks is closely associated with his/her creativity potential. As research is a knowledge creation activity, creativity potential is critical for knowledge creation and research productivity.

However, the literature for research capacity building lacks adequate focus on building interpersonal collaboration networks, especially networks of collaborators within an institute. In many institutes, research participation is often advocated as an approach to increase researcher's knowledge and skill in research (Talajic, 2013). Such participation is different from doing research in collaboration, in which researchers contribute equally as peers and co-learners. Building external linkages is advocated in the literature, but the focus is usually on linkages among organizations. Interpersonal collaboration networks, especially collaborations among researchers within institutions are not adequately recognized in the literature.

To duly recognize how collaboration networks contribute to research capacity, Section Four refers to social network theories and argues that interpersonal research collaboration networks within institutions are also a critical form of research capacity. It can complement capacity building at individual, organizational and inter-organizational levels.

Collaboration Networks are Also a Form of Research Capacity

This section argues that researchers in HEIs may gain advantage in research as a result of their location in collaboration networks. Social network theories have identified that individuals and social groups may gain advantage in information flow due to their locations in social networks. Similarly, it has been theorized that generating new knowledge in research requires knowledge cross-fertilization and conflicting ideas that can be fully utilized in collaborative networks (Haylor, 2012). Thus, interpersonal research collaboration networks may facilitate knowledge flow and

create conditions for research creativity and innovation. However, the literature on the subject of research management lacks empirical studies deciphering how research collaboration networks exert such influence, the discussion in this section is thus primarily focused at a theoretical level based on the understandings established by social network theories.

The section comprises of three segments. The first two segments illustrate how research collaboration networks may facilitate knowledge flow at the individual and collective level. The third segment presents how research collaboration networks may enhance capacity building at individual, organizational and inter-organizational levels.

Collaboration Network May Lead to Individual's Advantage in Knowledge Flow

At an individual level, a researcher may gain advantage in knowledge access and flow over other researchers in the same network. This advantage could arise from his/her position in the network and transcend to the researcher's capacity in research. A social diagram illustrated in Figure 2 may be regarded as a hypothetical research collaboration network (i.e., Network 1). The diagram may be used to illustrate individuals' advantage.

In Network 1, the nodes represent researchers in an institute; the lines represent research collaboration relations among researchers (for example, researchers' involvements in research grants). Researcher C (i.e., node C) is linked with Researcher D, representing that Researcher C and Researcher D work together on a research project, for example Researcher C is the principal investigator (PI) of a project and Researcher D is a co-PI; or vice versa.

In Network 1, Researcher G has more advantage in knowledge access as compared to Researcher K. Researcher G has the largest number of linkages. This suggests that to satisfy the needs for knowledge cross-fertilization (Hanneman & Riddle, 2005), Researcher G has six alternative ways (i.e., through Researchers A-F) to gain access to new knowledge and ideas. In comparison, Researcher K only has two alternative ways (i.e., through Researchers J and L).

Compared to Researcher J, Researcher E is better able to send his/her knowledge-access request to other researchers in the network. Although Researchers E and J both have four connections to other researchers, Researcher E is closely connected to a large cluster (which is comprised of Researchers A-E on the left side of the network in Figure 2). Researcher J is only closely connected to a small cluster (which is comprised of Researchers I-L on the right side of the network). It is much easier for Researcher E to send his/her collaboration request to all other researchers in the network.

Compared to Researcher I, Researcher H has more control over knowledge flow. Researchers H and I both have two connections to other researchers, but Researcher H serves as a bridge that connects two research clusters (on the left and right sides of the Network 1) together. Dawson, Tan and McWilliam (2011) and Katz and Martin (1997) find that researchers holding bridging roles can connect different network clusters. These researchers have access to a greater diversity of knowledge, bring about perspectives from different disciplines or fields, and facilitate knowledge cross-fertilization. They can generate new insights that, when working individually on their own, would not have grasped or grasped so quickly. Thus, Researcher H has easy access to new knowledge and ideas (from both clusters) and he/she has the power to control the knowledge

flow and idea cross-fertilization between the two clusters. This power puts Researcher H in an advantaged position in research collaboration.

One may argue that Researcher E may request to collaborate with Researcher J (or Researcher I) directly without going through Researcher H, the bridge. But this may not be the case for at least two reasons. First, it may be meaningless for Researcher E and Researcher J to collaborate. For example, Researchers E and J may be doing research on science education and social science education respectively. They both join Researcher H's research project that studies the phenomena of conceptual change (in science and social science education). However, it does not make much sense for Researchers E and J to work together directly. Second, there may not be trust between Researchers E and J to collaborate. Researchers have great autonomy and freedom in engaging in research (Zalewska-Kurek, Geurts, & Roosendaal, 2010). They often do not have perfect information in choosing the right collaborator (Coleman, 1988; Govier, 1997). Even if they do, they tend to collaborate with those who they trust, rather than the one who has the right complementary knowledge and skill (Burt, 2003).

Collaboration Network May Lead to Collective Advantage in Knowledge Flow

The overall structure (for example, pattern of the research connections) of a research collaboration network in an institute may also affect the institute's ability and advantage in knowledge flow. This collective advantage can be illustrated in two ways.

First, if a network has few connections, not much power can be exerted by individuals (Kadushin, 2011). Thus the collective advantage in research collaboration is also limited. Highly connected research collaboration network potentially has more power to better facilitate knowledge flow and cross-fertilization. Such a network can better promote creativity and therefore may lead to higher productivity.

Second, even when two networks have the same number of collaboration connections, one network may gain more advantage over the other due to how the connections are structured in each network. The networks illustrated in Figure 2 and Figure 3 (below) are compared to illuminate this argument.

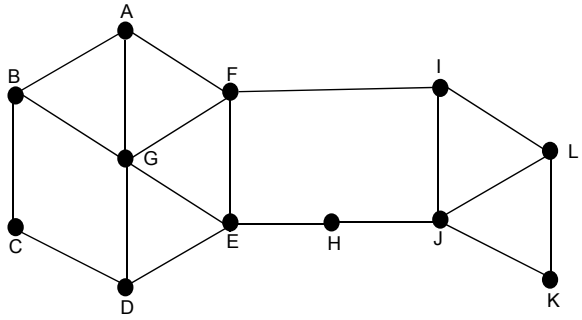

Figure 3. Network 2

Network 1 (illustrated in Figure 2) and Network 2 (illustrated in Figure 3) have the same number of nodes and connections. Network 1 is highly dependent on Researcher H to facilitate knowledge flow between the two clusters (on the left and on the right of the network). This dependency creates a high risk of network disruption for Network 1. In the event that Researcher H (or Researcher E or J) resigns and leaves the institute, knowledge flow between the two clusters will not be possible.

Network 2, on the other hand is less reliant on any particular researcher to bridge the two research clusters. The network has more bridges between the two clusters (for example, from Researcher F to Researcher I, and from Researcher E to Researcher J via Researcher H). In fact, the left and right clusters are less obvious in Network 2. The network may be better regarded as one cluster, instead of two. Network 2 may have more potential to cross-fertilize knowledge and research ideas which may lead to higher research productivity, as compared to Network 1.

The above comparison between Networks 1 and 2 only intuitively demonstrates the existence of collective advantage. In SNA, the collective advantage of a social network can be measured and analyzed mathematically for comparison. Readers may refer to the literature of SNA for such analysis.

Increasing Capacity at Individual, Organizational and Inter-Organizational Levels

If properly engaged, the interpersonal research collaboration networks may also promote capacity building at individual, organizational and inter-organizational levels. First, research collaboration networks allow researchers to utilize relationships to increase their capacity and productivity (Hatala, 2009; Ramanadhan, Kebede, Mantopoulos, & Bradley, 2010). Sooho and Bozeman (2005) study the correlation between collaboration and publication. They find that researchers who spend a higher percentage of time working alone are less likely to be productive in publication.

Hatla (2009) recognizes that an individual researcher's ability to access social network resources could lead to his/her professional success. Hasan and Pousti (2006) argue that even in large highly-structured organizations, collective knowledge-building at small-team level is the predominant source of learning, creativity and innovation. Tacit knowledge, especially new advancements in each discipline may not be necessarily documented in publications. Collaboration networks can foster transferring new knowledge, especially tacit knowledge among researchers (Sluijs-Doyle, 2009). Such knowledge transfer through research collaboration networks could enhance individuals' professional development.

Second, research collaboration networks may also enable organizational development, but Marjanovic, et al. (2013) in a critical evaluation of the existing literature on research capacity building argue that the current focus is on policy-relevant issues at a relatively high-level. There is a need to emphasize how research collaborations influence organizational development. Borgatti and Foster's (2003) summary from the literature of classic social psychology highlights that the amount of interactions, similarity of beliefs and attitude, and affirmative ties are interrelated. As researchers collaborate, they develop common meanings, beliefs, and mutual understandings. This process is called *homophily* (Kadushin, 2011) in the literature on social network theories. *Homophily* is further discussed in the next section as a mechanism for building collaboration

networks. Through the process of *homophily*, collaboration networks among researchers may bring about stronger and more aligned voice from researchers to push the change of institutional rules for research (for example, pushing to reduce bureaucracy in research-related procurement).

Research collaboration networks may also support the development of inter-organizational collaboration and engagement. A further research finding on weak/strong ties is that people who are connected by strong ties are likely to share common friends as well (Granovetter, 1973). This means that researchers in a collaboration network (within an institute) that has dense and coherent connections are likely to share other connections (for example, external collaboration connections) in common. More dense and coherent connections among researchers within an institute also put the institute at a stronger position when negotiating collaboration arrangements with external partners and stakeholders.

With the inclusion of interpersonal research capacity argued in this paper, a more holistic perspective (as illustrated in Figure 4) is that research capacity building constitutes building capacities at individual, interpersonal, organizational and inter-organizational levels. Research capacity at interpersonal level is primarily contributed by research collaboration networks (within an institute).

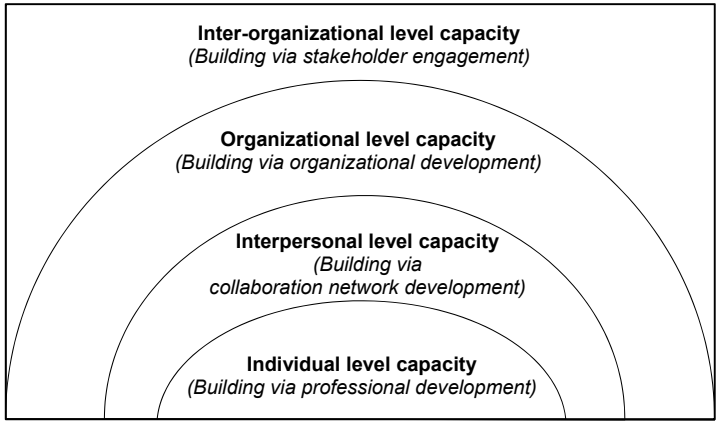

Figure 4. A holistic perspective on research capacity building

However, building research collaboration networks to increase an institute's research capacity is not an easy task. Section Five makes reference to social network theories to present three underpinning mechanisms for building research collaboration networks. The challenges in building research collaboration networks are highlighted in Section Six.

The Mechanisms of Building Collaboration Networks

The formation and development of collaboration networks are organic in nature. Cross, Parker and Sasson (2003) point out that members of a collaboration team must have trust among each

other. Members know that honesty expressed during the team's activity will not be used against them. This explains why most research collaborations are conducted by informal groups. In these groups, researchers are binding together mainly by trust, rather than by institutional arrangements.

To understand how collaboration networks are formed and developed as well as how they contribute to research productivity, *propinquity* and *homophily* are synthesized from social network theories as two key organic mechanisms for building social networks. Research productivity requires knowledge flow and crashing ideas. This makes research collaboration networks unique from normal social networks. This section also discusses why *heterophily* is critical to research capacity and productivity.

Propinquity

The first mechanism is *propinquity* (Kadushin, 2011), which suggests that spatial proximity can lead to social proximity. Individuals are more likely to be friends if they are located geographically close to each other (Kadushin, 2011). Perhaps this is because of the low social transaction cost between individuals who are spatially close.

Propinquity exists in research collaborations. Sooho and Bozeman (2005) study the patterns between collaboration and publication. They find that for researchers who collaborate, more than half of their collaborations are with colleagues in their same institute. Cantner, et al. (2010), Borgatti and Foster (2003) and Katz and Martin (1997) also find that close physical proximity seems to encourage collaborations, perhaps because it tends to generate more informal communications.

Thus, turning physical proximity into social proximity and then to research productivity is important in building research collaboration networks.

Homophily

Homophily (Kadushin, 2011) is the second mechanism. It implies that similarity breeds connection (McPherson, Smith-Lovin, & Cook, 2001): birds of a feather flock together. *Homophily* also suggests that people in the same social group tend to become homophilous over time (Kadushin, 2011).

The exchange of ideas occurs most frequently between individuals who are alike, or homophilous (McPherson, et al., 2001). Individuals enjoy the comfort of interacting with others who are similar. Communication is also more effective when source and receiver are homophilous, for example, when they share common meanings, beliefs, and mutual understandings. Stvilia et al. (2011) observe that collaborations between researchers of different rank are less common. Even such collaborations do happen; they have less impact on research productivity than collaborations between researchers of the same rank.

Homophily also produce homophilous group members over time. Borgatti and Foster (2003) note that amount of interactions, similarity of beliefs and attitude as well as affirmative ties are interrelated. The network organization theory (Sluijs-Doyle, 2009) affirms that networks create group tastes and preferences, and inspire conformity in thought and action among members in the network (Burt, 2003; Coleman, 1988).

Thus *homophily* creates a self-reinforcing positive feedback loop: similarity breeds connection and connection produce more similarities. The self-amplifying feedback loop leads to the establishment and stabilization of a social network in an organic manner from bottom-up.

Homophily exists in research collaborations. Interconnectedness of scientists promotes the diffusion of scientific knowledge and capacity (Wagner & Leydesdorff, 2005). The discussion in Section Four suggests that people do not have perfect information in choosing the right collaborator in research. Even if they do, they tend to collaborate with who they know and trust. Thus, research collaborations also reinforce *homophily* within a collaboration network.

Compared to establishing a new collaboration network, it is more effective to build research collaborations by leveraging on *homophily* in existing networks. Kezar (2014) reviews change in education setups noting that existing social networks are more influential than networks created as part of the change process (Coburn & Russell, 2008; Cole & Weinbaum, 2010). Change is more likely to be successful if it is built upon existing social networks, because trust and *homophily* already exist in these networks (Moolenaar & Sleegers, 2010).

Heterophily

Social network theories suggest that a certain degree of *heterophily* (Kadushin, 2011) is also critical for the success of an organization. This is particularly important for research collaborations because research creativity requires integration of ideas and perspectives from different fields or disciplines, or in another word, *heterophily*.

Heterophily refers to "love of the different". Rogers, Medina, Rivera and Wiley (2005) suggest that diversity of ideas promotes innovations. Granovetter (1973) uses weak ties to illustrate the importance of *heterophily* in communication. Weak ties are those ties 'outside' the core connections that any members of an existing coherent social network has. Granovetter demonstrates that weak ties can serve as bridges, allowing the flow of knowledge and information between two otherwise unconnected networks (e.g., two unconnected groups of friends). While information spreads efficiently among members connected by strong ties, it is usually weak ties that bring in new information (such as clashing ideas) that is crucial for knowledge creation in collaboration. Therefore, a certain degree of *heterophily*, such as weak tie, is necessary for creativity and productivity in research collaborations.

Some Challenges in Building Research Collaboration Networks

While the organic mechanisms appear to be simple, this section highlights some challenging issues in building research collaboration networks. These issues are not meant to be exhaustive. The purpose is to illuminate the complexity in building research collaboration networks and to invite more discussions and dialogs in order to advance the theory and practice of building interpersonal research capacity.

Three issues are selected for discussion in this section. The first issue arises from empirical findings which suggest that collaboration networks have nonlinear effect on research productivity. Therefore designing and maintaining a collaboration network at a sweet spot, where vision is

clear, goals are compelling, people see ways to contribute, progress is tangible, and everyone believes that they can succeed, can be challenging. The second issue is derived from a theoretical argument that *homophily* may have double-edged effect on collaborations. Thus maintaining a good balance between *homophily* and *heteophily* is a challenge. The third issue is on management's role in building collaboration networks. If management is to take a proactive role in building collaboration networks, there is a need to explore analytical tools to inform and support their decision-makings.

Challenge 1: The Nonlinear Effect of Collaboration Networks

The literature on research management suggests that more research collaborations do not always lead to higher research productivity. This is because some factors, such as size of membership and member's social position in a collaboration network have nonlinear effects on research productivity. Thus, there is a need to identify and maintain research collaboration network (in an institute) at certain sweet spot.

Empirical evidence reveals that the size of a collaboration group only has a linear effect on research productivity within certain upper and lower thresholds. Kenna and Berche (2011) examine the data from British and French higher-education research-evaluation exercises. They find that research quality increases with group size, but only up to a limiting threshold referred to as an upper critical mass. Similarly, von Tunzelmann, Ranga, Ben and Geuna (2003) also reveal that growth in productivity declines above a certain group size threshold. O'Leary, Mortensen and Woolley (2011) study multiple team membership and productivity. They note that the variety of teams that an individual works as members reduces productivity, even though such collaborations increase the diversity of information and knowledge that the individual and teams encounter. Martín-Sempere, et al.'s (2002) research on the consolidation of research teams suggests that consolidation could result in a substantial improvement of researchers' capability to establish contacts and collaborations with colleagues. Such consolidation could therefore favor researchers' potential to publish in quality publications. Heinze, Shapira, Rogers and Senker (2009) also identify that for groups in natural science, a size of five to six members seems to be optimal. These findings imply that an optimal group size is desired to enhance productivity in research collaboration.

Member's position in a collaboration network also affects his/her productivity in collaboration. Hansen (2009) finds that there is a difference between those teams that have many direct connections to other project teams and those that use both direct and indirect ties to reach the resources they need. Vardaman et al. (2012) demonstrate that an individual's degree of centrality in a collaboration group is positively and significantly related to his/her productivity. Bukvova's (2010) review show that the collaboration's effect on productivity depends on the type of links collaborative members have. While collaboration with high-productivity scientists tends to increase personal productivity, collaboration with low-productivity scientists generally decreases it. These findings suggest that optimizing an individual's social connections to enhance productivity is a challenge to overcome too.

In summary, the empirical findings suggest that there is a need to maintain research collaboration network at an optimal size and to build critical bridges for knowledge flow among different collaboration clusters. These are to be done carefully with an aim to optimize knowledge flow and productivity in research collaboration. However, what the optimal size is and how to identify a critical bridge to build are challenges to overcome.

Challenge 2: The Double-Edged Effect of Homophily

Homophily (Kadushin, 2011) is a key underpinning mechanism for building social networks. As discussed in Section Five, *homophily* creates a self-reinforcing positive feedback loop that leads to the establishment and stabilization of a social network from bottom-up. However, *homophily* may also produce negative effect on research productivity.

First, *homophily* may generate negative effect on knowledge cross-fertilization. *Heterophily* leads to idea diversity and cross-fertilization and generates new insights (Katz & Martin, 1997; McPherson, et al., 2001). Thus, research creativity requires degrees of *heterophily*. However, *homophily* makes heterophilous communications difficult to take place. Heterophilous communications is less frequent as compared to homophilous communication. Patterns of ties among individuals in a homogenous network constrain the knowledge flow between homophilous individuals in the network and their heterophilous counterparts from a far distance of the network. How to foster more frequent communication between heterophilous individuals is a challenge.

Even when frequent homophilous communication is fostered, *homophily* may also dilute *heterophily* when there is too much heterophilous communication. Rogers, Medina, Rivera and Wiley (2005) suggest that certain degree of *heterophily* is needed to promote innovation and diffusion of innovation. However, *homophily* suggests that heterophilous individuals, when their frequency of communication increases, can be homogenized over time. Identifying an optimal balance between *homophily* and *heterophily* is a challenge.

Even an optimal balance can be identified, maintaining the balance is also a challenge. Bradeley, Hausmann and Nolan (1993) characterize social networks as being less stable and more organic than functional hierarchies. New networks are regularly and instantaneously formed, not from top-down, but from bottom-up influenced by collaborations and day-to-day interactions. The organic nature of collaboration networks makes the control of the network-building process difficult or even not feasible.

Second, group taste and preference produced by *homophily* may sometimes prevent groups from adapting in fast changing research environments. Social interactions among people give members a sense of identity and common purpose through the process of *homophily*. At the same time, the identity and common purpose also constrain the evolution of identity and purpose into the future (Woolcock & Narayan, 2000). This creates 'path dependency' (Holland, 1995) in a complex evolution process: future evolution is both supported and constrained by the current status. Thus, the patterns of ties and network norms created by *homophily* can be both strength and constraint; both promise and obligation.

In summary, the social network theories suggest that maintaining an optimal balance between degrees of homophily and heterophily is a critical challenge to successful innovation and capacity building.

Challenge 3: Management's Role in Building Collaboration Networks

The first two challenges discussed above suggest that building collaboration networks is challenging. A follow-up issue is whether management should play a proactive role in building research collaboration networks. If it does, how can it perform this role?

This paper argues that management should take such a proactive role. Coburn, Choi and Matta (2010) importantly critique the tendency to overly focus on the organic nature of social networks and not look at ways that organization could influence or support the development of networks. Ron Burt (2000) asserts that managing an organization's social capital is becoming one of the core competencies in knowledge-based organizations. Scholars such as Reagans and McEvily (2003), Tilly (2005) and Mansuri and Rao (2004) have also made similar arguments.

More specifically, Castells (2011) argues that management has a role to create goal alignment when building social networks. He argues that once a goal is programmed to a network, the network would have greater capacity to perform efficiently and to reconfigure itself in terms of ties and nodes to achieve its goals (for example, for an institute's mission attainment). Moolenaar and Sleegers (2010) suggest that management can perform this role more successfully if it leverages existing social networks, because trust already exists. Thus, this paper argues that management should take a proactive role to stimulate and influence interactions and development with a commensurate degree of governance in directing research.

It is not possible to prescribe ways in which management foster goal alignment and build collaboration networks. Castells (2011) points out that how different networks are programmed for goal alignment is a process specific to each network. Power relationships at a particular network have to be identified and understood in terms specific to the network. Thus, a useful exploration is to identify tools that can support management in addressing the two issues discussed above.

One possibility is to identify analytical tools to analyze research collaboration networks to inform and guide the building process. IBM (2013) advocates that in knowledge economy, management should use analytics, not instinct. Social Network Analysis (SNA) (Burt, et al., 2013) can be such an analytical tool. SNA is the study of the patterns of social relations by examining how the structure of social relations allocates resources, constrains behavior, and channels social change. It is based on the assumption that the success or failure of societies and organizations often depends on the patterns of their internal social structures (Martin & Wellman, 2010). The tool has been increasingly used to study the structures of social networks. With the theoretical framing established in this paper, another paper is being prepared by the author to highlight how SNA can be used to support the development of research collaboration networks and the building of research capacity.

It is also important to note that while the above three issues have highlighted some common issues across disciplines, there are also discipline-specific variations to be considered in building

research network capacity. For example, Sooho and Bozeman (2005) study the collaboration patterns across disciplines. They find that researchers in computer sciences and electrical engineering tend to have more collaborators whereas researchers in biological and life sciences as well as civil engineering much less. If HEIs adopt the strategies proposed in this paper to build research network capacity, the desired level of collaborations should be calibrated according to the sweet spots in each discipline.

Conclusion and Discussions

In summary, this paper argues that collaboration is important for research and research collaboration networks can contribute to HEI's research capacity and productivity. In the existing literature, research capacity focuses on three dimensions: individual's professional development, organization's policy, culture and structural enablers, and inter-organizational linkages. This paper broadened the perspectives of research capacity by advocating for an additional dimension of research capacity: the interpersonal capacity arising from research collaboration. The argument is significant to the theory and practice of research capacity building.

Research collaboration networks are best developed organically from the bottom-up, rather than superimposed from top-down. However, the literature does not provide an adequate understanding of how to build research collaboration networks to improve research productivity. This paper drew references from social network theories and highlighted *propinquity, homophily* and *heterophily* as three key mechanisms for building research collaboration networks. These mechanisms suggest that similarity and physical proximity breed social connection and at the same time, social connections lead to more similarities. Maintaining degrees of *heterophily* is thus critical for research creativity and productivity. By connecting social network theories with the literatures on research management and research capacity building, this paper suggested a new avenue to advance the theory and practice of research capacity building in specific and research management in general.

However, the practice of building research collaboration networks to improve research productivity can be challenging. Three issues were presented to illuminate the complexity. First, empirical studies suggest that collaboration networks have nonlinear effect on research productivity. More collaboration connections do not always lead to higher research productivity. Being able to develop and maintain collaboration networks at certain sweet spot, or sustainable network of interactions with clearly defined goals, is critical and challenging. Second, heterophilous communication is hard to foster, and too much heterophilous communication may lead to *homophily*. This may negatively affect knowledge cross-fertilization in collaboration. These two issues led to the third issue for discussion: how management can take a proactive role in building and optimizing research collaboration networks. Invention of analytical tools to inform and support research management is necessary.

One way for management to deal with the issues is to engage SNA as a tool to inform and guide the building of research collaboration networks. While SNA can be one possible solution, explorations of possible solutions in breadth and depth are needed. The three issues and the possible solutions are debatable in order to further advance the theory and practice of building collaboration networks.

Readers should also note the limitations of this paper. First, while this paper primarily argues for the importance of relational properties, the properties of individuals should not be neglected. Second, the disciplinary differences is noted in this paper but is not examined further. Nevertheless, by expanding the dimensions of research capacity and by introducing social network theories into research capacity building, this paper contributes to the expansion of the literature of research management and perhaps even the literature of social network theories. It also informs the practice of research management, in particular the practice of building research capacity at interpersonal level.

Author Note

Correspondence concerning this article should be addressed to Jun Song HUANG, PhD, Tel: +65-62196177, Email: junsong.huang@nie.edu.sg. The author was the Head of Education Research Administration and Communication at the National Institute of Education Singapore before he obtained a PhD degree in 2014 and pursued his research interests as a research scientist. This paper is the crystallization of his research-management experience in the past ten years. The article is based on presentations at the first international meeting of the National Council of University Research Administrators (NCURA) and the annual congress of the International Networks of Research Management Societies (INORMS) in 2014. The presentations showed how Social Network Analysis (SNA) was used to build research collaboration networks and research capacity in a HEI. The author thanks Associate Professor Victor Chen at the National Institute of Education (Singapore) and the editors of the Journal of Research Administration for their helpful suggestions and constructive critiques.

Jun Song Huang, PhD
Research Scientist
National Institute of Education
1 Nanyang Walk
Singapore 637616
Tel: +65-62196177
Email: junsong.huang@nie.edu.sg

References

Ahuja, G. (2000). Collaboration networks, structural holes, and innovation: A logitudinal study. *Administrative Science Quarterly, 45*(3), 425-455.

Altbach, P. G. (2014). The abdication of thinking capacity in international higher education. *International Higher Education, 74*, 6-8.

Altbach, P. G., & Salmi, J. (2011). *The road to academic excellence: The making of world-class research universities*. Washington DC: The World Bank.

Asian Development Bank. (2004). *Capacity development*. Manila, Philippine: Asian Development Bank.

Bammer, G. (2008). Enhancing research collaborations: Three key management challenges. *Research Policy, 37*(5), 875-887.

Borgatti, S. P., & Foster, P. C. (2003). The network paradigm in organizational research: A review and typology. *Journal of Management, 29*(6), 991-1013.

Bradeley, S., Hausmann, J. A., & Nolan, R. (1993). *Globalization, technology and competition.* Boston, MA: Harvard Business School Press.

Bukvova, H. (2010). Studying research collaboration: A literature review. *Sprouts: Working Papers on Information Systems, 10*(3). Retrieved from http://sprouts.aisnet.org/10-3

Burt, R. S. (2000). The network structure of social capital. In R. I. Sutton & B. M. Staw (Eds.), *Research in Organizational Behavior*. Greenwich, CT: JAI Press.

Burt, R. S. (2003). The social origin of good ideas. University of Chicago.

Burt, R. S., Kilduff, M., & Tasselli, S. (2013). Social network analysis: Foundations and frontiers on advantage. *Annual Review of Psychology, 64*(527-547).

Cantner, U., Conti, E., & Meder, A. (2010). Networks and innovation: The role of social assets in explaining firms' innovative capacity. *European Planning Studies, 18*(12), 1937-1956.

Castells, M. (2011). A network theory of power. *International Journal of Communication, 5*, 773-787.

Coburn, C. E., Choi, L., & Matta, W. (2010). "I would go to her because her mind is math": Network formation in the context of a district based mathematics reform. In A. Daly (Ed.), *Social network theory* (pp. 33-51). Cambridge, MA: Harvard Education Press.

Coburn, C. E., & Russell, J. (2008). District policy and teachers' social networks. *Educational Evaluation and Policy Analysis, 30*(3), 203-235.

Cole, R., & Weinbaum, E. (2010). Peer influence in high school reform. In A. Daly (Ed.), *Social network theory* (pp. 77-96). Cambridge, MA: Harvard Education Press.

Coleman, J. S. (1988). Social capital in the creation of human capital. *The American Journal of Sociology, 94*(Supplement), S95-S120.

Cooke, J. (2005). A framework to evaluate research capacity building in health care. *BMC Family Practice, 6*(44). Retrieved from http://link.springer.com/article/10.1186/1471-2296-6-44/fulltext.html

Crisp, B. R., Swerissen, H., & Duckett, S. J. (2000). Four approaches to capacity building in health: Consequences for measurement and accountability. *Health Promotion International, 15*(2), 99-107.

Cross, R., Parker, A., & Sasson, L. (2003). *Networks in the knowledge economy*. Oxford, UK: Oxford University Press.

Dawson, S., Tan, J. P. L., & McWilliam, E. (2011). Measuring creative potential: Using social network analysis to monitor a learners' creativity capacity. *Australasian Journal of Educational Technology, 27*(6), 924-942.

Department for International Development. (2008). Working paper series: Capacity building. *DFID research strategy 2008-2013*. Retrieved from http://r4d.dfid.gov.uk/PDF/Outputs/Consultation/ResearchStrategyWorkingPaperfinal_capacity_P1.pdf

Dulworth, M. (2008). *The connect effect: Building strong personal, professional, and virtual networks*. San Francisco, CA: Berrett-Koehler Publishers.

Easley, D., & Kleinberg, J. (2010). *Networks, crowds, and markets: Reasoning about a highly connected world*. Cambridge, UK: Cambridge University Press.

Fowler, Z., Baird, A., Baron, S., Davies, S. M. B., Procter, R., & Salisbury, J. (2009). Building research capacity in education: evidence from recent initiatives in England, Scotland and Wales. *International Journal for Researcher Development, 1*(2), 173-189.

Godley, J., Sharkey, K. A., & Weiss, S. (2013). Networks of neuroscientists: Professional interactions within an interdisciplinary brain research institute. *Journal of Research Administration, 44*(2), 94-123.

Govier, T. (1997). *Social Trust and Human Communities:* McGill-Queen's Press-MQUP.

Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology, 78*(6), 1360-1380.

Hanneman, R. A., & Riddle, M. (2005). Introduction to social network methods Available from http://faculty.ucr.edu/~hanneman/

Hansen, M. T. (2009). *Collaboration - How leaders aviod the traps, create unity, and reap big results*. Cambridge, MA: Harvard Business Press.

Hasan, H., & Pousti, H. (2006). *SNA as an attractor in emergent networks of research groups*. Paper presented at the 17th Australian Conference of Information System.

Hatala, J.-P. (2009). Assessing individual social capital capacity: The development and validation of a network accessibility scale. *Performance Improvement Quarterly, 22*(1), 53-68.

Haylor, G. (2012). Breaking fences may make for good neighbours in collaborative research: Why the International Foundation for Science will introduce a collaborative research approach. Retrieved from http://ifs.se/IFS/Documents/Publications/Breaking%20fences%20may%20make%20for%20good%20neighbours%20in%20collaborative%20research.pdf

Hazelkorn, E. (2005). *University research management - Developing research in new institutions*. Paris, France: OECD Publishing.

Heinze, T., Shapira, P., Rogers, J. D., & Senker, J. M. (2009). Organizational and institutional influences on creativity in scientific research. *Research Policy, 38*(4), 610-623.

Holland, J. H. (1995). *Hidden order: How adaption builds complexity*. New York, NY: Perseus Books.

IBM. (2013). How to compete in the era of "smart". Retrieved from http://www.ibm.com/smarterplanet/global/files/us__en_us__overview__win_in_the_era_of_smart_op_ad_03_2013.pdf

Johari, M. H., Zaini, R. M., & Zain, M. F. M. (2012). Factors for cross-disciplinary research collaboration: Experiences of researchers at the faculty of engineering and built environment, UKM. *Asian Social Science, 8*(16), 122-127.

Kadushin, C. (2011). *Understanding social networks: Theories, concepts, and findings*. Oxford, UK: Oxford University Press.

Katz, J. S., & Martin, B. R. (1997). What is research collaboration? *Research Policy, 26*, 1-18.

Kenna, R., & Berche, B. (2011). Critical masses for academic research groups and consequences for higher education policy and management. *Higher Education Management and Policy, 23*(3), 9-29.

Kezar, A. (2014). Higher Education change and social networks: A review of research. *The Journal of Higher Education, 85*(1), 91-124.

Krebs, V. E. (2008). *Managing the connected organization*. Retrieved from http://www.orgnet.com/MCO.html

Mansuri, G., & Rao, V. (2004). Community-based and -driven development: A critical review. *The World Bank Research Observer, 19*(1), 1-39.

Marjanovic, S., Hanlin, R., Diepeveen, S., & Chataway, J. (2013). Researh capacity building in Africa: Networks, institutions and local ownership. *Journal of International Development, 25*(7), 936-946.

Martín-Sempere, M. J., Rey-Rocha, J., & Garzón-García, B. (2002). The effect of team consolidation on research collaboration and performance of scientists: Case study of Spanish University researchers in Geology. *Scientometrics, 55*(3), 377-394.

Martin, A., & Wellman, B. (2010). Social network analysis: An introduction. In P. Carrington & J. Scott (Eds.), *Handbook of social network analysis*. London: Sage.

McPherson, M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology, 27*, 415-444.

Mehra, A., Kilduff, M., & Brass, D. J. (2001). The social networks of high and low self-monitors: Implications for workplace performance. *Administrative Science Quarterly, 46*(1), 121-146.

Moolenaar, N., & Sleegers, P. (2010). Social networks, trust, and innovation: The role of relationships in supporting an innovative climate in Dutch schools. In A. Daly (Ed.), *Social network theory* (pp. 97-114). Cambridge, MA: Harvard Education Press.

North American Primary Care Research Group Committee. (2002). What does it mean to build research capacity? *Family Medicine, 34*(9), 678-684.

O'Leary, M. B., Mortensen, M., & Woolley, A. W. (2011). Multiple team membership: A theoretical model of its effects on productivity and learning for individuals and teams. *Academy of Management Review, 36*(3), 461-478.

Olson, S., & Merrill, S. (2011). International perspectives on measuring research impacts. In S. Olson & S. Merrill (Eds.), *Measuring the impacts of federal investments in research: A workshop summary* (pp. 61-68). Washington DC: The National Academies.

Ramanadhan, S., Kebede, S., Mantopoulos, J., & Bradley, E. H. (2010). Network-based social capital and capacity-building programs: An example from Ethiopia. *Human Resources for Health, 8*(17), 11. Retrieved from http://www.human-resources-health.com/content/8/1/17

Reagans, R., & McEvily, B. (2003). Network structure and knowledge transfer: The effects of cohesion and range. *Administrative Science Quarterly, 48*(2), 240-267.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York, NY: Simon and Schuster.

Rogers, E. M., Medina, U. E., Rivera, M. A., & Wiley, C. J. (2005). Complex adaptive systems and the diffusion of innovations. *Innovation Journal: The Public Sector Innovation Journal, 10*(3), 1-26.

Rogers, J. D., Bozeman, B., & Chompalov, I. (2001). Obstacles and opportunities in the application of network analysis to the evaluation of R&D. *Research Evaluation, 10*(3), 161-172.

Ryan, B., & Gross, N. C. (1943). The diffusion of hybrid seed corn in two Iowa communities. *Rural Sociology, 8*(1), 15-24.

Schuetzenmeister, F. (2010). University research management: An exploratory literature review. Retrieved from http://escholarship.org/uc/item/77p3j2hr

Sluijs-Doyle, J. (2009). *Capacity building in network organisations - Experience from and practical guidelines for HIV and other networks*. Utrecht, Nederlands: Voluntary Service Overseas.

Sooho, L., & Bozeman, B. (2005). The impact of research collaboration on scientific productivity. *Social Studies of Science, 35*(5), 673-702.

Stvilia, B., Hinnant, C. C., Schindler, K., Worrall, A., Burnett, G., Burnett, K., et al. (2011). Composition of scientific teams and publication productivity at a national science lab. *Journal of the American Society for Information Science and Technology, 62*(2), 270-283.

Talajic, M. (2013). Vascular 2013: Building capacity through collaboration. *Canadian Journal of Cardiology, 29*, 133-135.

Tilly, c. (2005). *Identities, boundaries, and social ties*. Boulder, CO: Paradigm Press.

United Nations Development Programme. (2008). Supporting capacity development: The UNDP approach Available from http://www.undp.org/content/dam/aplaws/publication/en/publications/capacity-development/support-capacity-development-the-undp-approach/CDG_Brochure_2009.pdf

United Nations Office for Sustainable Development. (2012). *Knowledge, capacity building, and networks for sustainable development: A review*. Incheon, Korea: United Nations Office for Sustainable Development.

Vardaman, J. M., Amis, J. M., Dyson, B. P., Wright, P. M., Van de, R., & Randolph, G. (2012). Interpreting change as controllable: The role of network centrality and self-efficacy. *Human Relations, 65*(7), 835- 859.

von Tunzelmann, N., Ranga, M., Ben, M., & Geuna, A. (2003). The effect of size on research performance - A SPRU review. Retrieved from http//www.sussex.ac.uk/Users/prff0/Publications/Size%20HE%20research.pdf

Wagner, C. S., & Leydesdorff, L. (2005). Mapping the network of global science: comparing international co-authorships from 1990 to 2000. *International Journal of Technology and Globalisation, 1*(2), 185-208.

Wilkes, L., Cummings, J., & McKay, N. (2013). Developing a culture to facilitate research capacity building for clinical nurse consultants in generalist paediatric practice. *Nursing Research and Practice*. Retrieved from http://www.hindawi.com/journals/nrp/2013/709025/

Williams, K., & Durrance, J. C. (2008). Social networks and social capital: Rethinking theory in community informatics. *Journal of Community Informatics, 4*(3). Retrieved from http://ci-journal.net/index.php/ciej/article/view/465/430

Woo, S.-H., Kang, D.-J., & Martin, S. (2013). Seaport research: An analysis of research collaboration using Social Network Analysis. *Transport Reviews: A Transnational Transdisciplinary Journal, 33*(4), 460-475.

Woolcock, M., & Narayan, D. (2000). Social capital: Implications for development theory, research, and policy. *The World Bank Research Observer, 15*(2), 225-249.

Wray, K. B. (2006). Scientic authorship in the age of collaborative research. *Studies In History and Philosophy of Science, 37*(3), 505-514.

Zalewska-Kurek, K., Geurts, P., & Roosendaal, H., E. (2010). The impact of the autonomy and interdependence of individual researchers on their production of knowledge and its impact: An empirical study of a nanotechnology institute. *Research Evaluation, 9*(13), 217-225.

Development of a System of Strategic Research Administration at Kyoto University

Tadashi Sugihara
Kyoto University, Kyoto, JAPAN

Taro Sonobe
Kyoto University, Kyoto, JAPAN

Seitaro Mutoh
Kyoto University, Kyoto, JAPAN

Abstract: *In 2004, all national universities in Japan, which had previously been legally subordinate to the Ministry of Education, Culture, Sports, Science and Technology (MEXT), became separate National University Corporations. With this change, the importance of securing competitive funding increased significantly, and university researchers have had to devote more time to non-research burdens related to obtaining competitive funds including project management and public engagement. In order to reduce the burden for researchers in Japan, MEXT launched a support program in 2011 called the "System to Develop and Secure University Research Administrators (URA)." Supported by the program, Kyoto University established The Kyoto University Research Administration Office (KURA) in April 2012 as a support organization to help with planning of research projects, obtaining research funding, project execution, and public engagement. In this article, the strategic planning to implement the URA program at Kyoto University shall be described within the historical context of how the Japanese government decided to launch this support initiative.*

Keywords: *URAs in Japan, strategic management of URAs, research university, pre-award, post-award, public engagement*

Introduction

The past three years has seen a rapid growth in the number of university research administrators (URAs) in Japan. Nationwide there are now more than 300 officially hired in this category. The Japanese government's decision to launch the URA project dates back to November 2009, when the Democratic Party of Japan, in power at the time, executed an unprecedented budget screening process for fiscal 2010. This screening was open to the public and televised live, resulting in major cuts in science and technology budgets, especially for the basic science. The criticism was leveled that investment in basic science was not able to show concrete results for the money spent to date. Basic science was an easy target for a government strongly insistent on a demonstration of the necessity for such research.

To address these concerns, on November 24, 2009, nine research intensive universities (Hokkaido, Tohoku, Tokyo, Nagoya, Kyoto, Osaka, Kyushu, Waseda, and Keio) announced a joint statement "Concerns about the future of education and research in universities" in which they argued that a dramatic decrease in the education and research budget would be extremely harmful for the future of Japan (RU11, 2009). Successively, on March 19, 2010, another joint statement "strengthening research infrastructure and development of human resources in universities as part of the nation's growth strategy" was published (RU11, 2010). Notably, this statement clearly indicated the necessity for designated "research administrators" able to support research and facilitate collaboration among researchers. Later, the University of Tsukuba and Tokyo Institute of Technology joined this consortium and a group of eleven universities formed the influential academic consortium "RU11" (http://www.ru11.jp/eng/).

Following this joint statement proposing a novel system of university research administration, the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) launched such a program in FY2011. Kyoto University applied to the program and five universities including Kyoto were appointed as model universities. In FY2012, ten universities were additionally appointed and fifteen universities in total started implementing the URA system.

Initiation of the KURA office

In January 2012, a task force at Kyoto University prepared a master plan to introduce the URA system and scheduled recruitment interviews. In April, eight total (three as senior administrators) were hired by the new central administration office of Kyoto University Research Administration, called KURA (http://www.kura.kyoto-u.ac.jp/en/).

Prior to the introduction of KURA, interaction between researchers and administrative staff mostly occurred at a single point at the end—to complete paperwork. This is because, in general, administrative staff did not have strong research experience, so from the researcher's view point, administrative staff did not have the expertise that researchers would want to consult with about research-related issues. At KURA office there was an explicit goal of hiring administrators with a research background. Thus, two senior URAs had worked for Kyoto University as professors in civil engineering and area studies, respectively; one senior URA with Ph.D. in pharmacy had worked as a director of research laboratories at a pharmaceutical company; and the remainder held Ph.D. such that, their specialties covered a wide range of research disciplines such as system neuroscience, developmental biology, agricultural studies, psychology, informatics, energy science, research ethics, science communication. The existing administrative system worked mostly complimentarily with KURA to support the research faculty. KURA staff performed both research development and general administrative tasks depending on the workload assigned to each member, whereas research development lay outside the existing administrative staffs' charge. The fact that all the KURA members had in depth experience in research was an important feature which distinguished the KURA from the administrative offices who had been organized at Kyoto University, in the sense that the KURA staffs work "closer" to researchers. It also facilitated communication between researchers and staff at the KURA office (Figure 1)

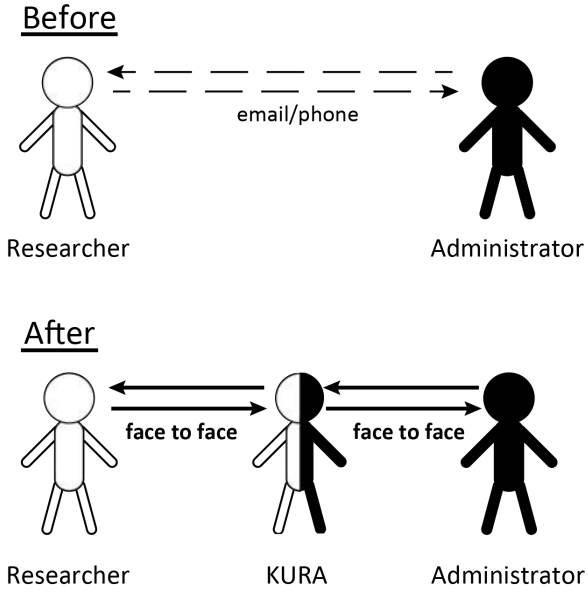

Figure 1. Before and after introduction of KURA.

Before the introduction of KURA, the primary communication tool was either email or phone call and the communication occurred mainly when some paperwork has to be done. After the introduction of KURA, in which many staffs have Ph.D. degree with research experiences, KURA staffs intended to increase opportunities to meet researchers directly so that KURA can correctly understand the demands on the researchers' side. This relationship happens because KURA staffs can understand research itself based on their academic specialties. Similarly, face-to-face communication is considered essential to establish good relationships with other administrators who had already been hired.

Job expectations for Japanese URAs depend greatly on the needs of their hiring universities, which are in turn strongly influenced by the strategic direction of the university as set by the executive board, including the president. Typical job functions roughly fall into three categories: support for pre-award, post-award, and academia-industry collaboration. KURA has been tasked with enriching the research environment, with an emphasis on pre-award and public engagement. As pre-award activities, KURA collects the information on the available research grants and distributes this information to the faculty at Kyoto University. KURA also provides grant-writing support for researchers at Kyoto University who apply for the research funding predominantly to Japanese government agencies. To increase public engagements, KURA provides the researchers with a variety of opportunities to disseminate their research output to the public through seminars, short reports in booklets and web homepages managed by KURA. Each staff member is expected to take part in the different kinds of work in order to learn various skills as URAs. The office's vision is "To contribute to the generation of world-class knowledge by collaborating with researchers in accordance with Kyoto University's mission, and to be a pioneering model

for university research administration in Japan." KURA's logotype was created by visiting professor Akio Okumura of the University's Academic Center for Computing and Media Studies (http://www.kura.kyoto-u.ac.jp/en/about/logo.php; Figure 2).

Figure 2. KURA's logotype.

Representative Activities

KURA's major activities can be categorized into three areas: pre-award, post-award, and public engagement. Compared to URAs in the United States, it is rather unique for KURA to include public engagement activities in its annual planning. Representative examples of such activities are described below.

Grants-in-Aid for Scientific Research (KAKENHI)

"Grants-in-Aid for Scientific Research", called KAKENHI in Japanese, are the most well-known category of research funding (Grants-in-Aid for Scientific Research). The program is managed by the Japan Society for the Promotion of Science (JSPS), and in FY2012 JSPS's research funding budget totaled 256.6 billion yen, more than half of the total budget for all available competitive funds in Japan. KAKENHI is described by JSPS as "curiosity-driven research," meaning that research proposals are researcher-oriented. In FY2013 the number of applications was 92,604, of which 25,825 were funded (27.9%, cf. JSPS Brochure 2013–2014).

Under these circumstances, it is very important for Kyoto University researchers to obtain KAKENHI funding. To increase the acceptance rate, the KURA office provides application review support with respect to readability and conforming with the strict requirements of the screening process. Considering the large number of researchers at Kyoto University, this support is augmented with volunteers including professors emeritus, and is limited to researchers who submit application drafts three months in advance of the official JSPS deadline.

To increase awareness among faculty of the need for high quality proposals, KURA has also published a booklet that explains key points for the preparation of the application form (Proposal for Grant-in-Aid) for KAKENHI. This booklet has been extremely well received by University faculty.

Enhancing Research and Education Collaboration with Foreign Universities

Kyoto University has a long history of Southeast Asian studies, including the Center for Southeast Asian Studies (CSEAS) that has conducted interdisciplinary research in the region for 50 years. To continue to increase the University's strong connections with many countries

in the region, Kyoto University has been pursuing cooperation in the field of engineering with major technological universities in Myanmar and the Myanmar Engineering Society (MES) in collaboration with the Japan International Cooperation Agency (JICA). To that end, one new project was prepared in Myanmar which met the needs of establishing a firm foundation for civil engineering, with the KURA office playing an important role in bringing together stakeholders in both Myanmar and Japan.

Due to such efforts, the Japan International Cooperation Agency (JICA) has requested Kyoto University provide educational support for civil engineering in Myanmar. In August 2013, as an example of such support, around 25 staff were sent from the University and from companies in Japan to give lectures at Yangon Technological University (YTU) and Mandalay Technological University (MTU).

Clearly, maintaining friendly relations at national and also university levels is essential to facilitate successful international collaboration. On these grounds, Kyoto University promotes international joint symposia with universities in many foreign countries. Since the establishment of KURA, joint symposia have been held together with the University of Bristol (UK), ETH Zurich, University of Zurich, EPFL (Switzerland), and the National Taiwan University (Taiwan), with KURA providing assistance for both the overall program and with the coordination of scientific sessions.

Public Engagement: Kyoto University Academic Day

In recent years, funding agencies such as The Ministry of Education, Culture, Sports, Science and Technology (MEXT) have begun requesting that their recipients widely disseminate the achievements of their projects. A specific goal of MEXT reinforces that expectation that dissemination and publicizing the research performance and achievements are important for promoting the use of the research outcomes to society and for deepening public understanding of the Grants-in-Aid for Scientific Research program. Researchers tend to feel that presenting their latest findings in scientific meetings is sufficient for such a purpose, but there is in fact value in going beyond the comfort zone of similarly-minded researchers, to speak to the lay audience which likely does not initially have sufficient knowledge to understand such research subjects.

To enhance these efforts, KURA provides researchers with a variety of opportunities to disseminate their research output to the public. One large-scale annual event, Kyoto University Academic Day, promotes face-to-face communication between researchers and the general public, with approximately two hundred researchers presenting their findings and around one thousand participating from surrounding communities.

Another example of KURA public engagement is Research Activities, a quarterly publication in English introducing both the history of Kyoto University and current topics in leading-edge research. Recent issues have featured articles on topics such as women researchers at the University, and the University's international relations endeavors (Kyoto University Research Activities).

Strategic Steps to Implement the URA Program at Kyoto University

Task-Sharing within the University

Prior to KURA's formation, URA-like functions were being performed in part by specialized administrators hired by the University but not called URAs. For such employees, the abrupt introduction of the URA system led to some confusion about how to divide tasks with the newly-hired URAs, even though the introduction of the URA system had been officially approved by the University.

To increase clarity, KURA has actively reached out to URA-like administrators, such as the organization of a Kyoto University Research Administration Seminar for which all employees involved in URA-related work are invited. Participants at the meetings discuss a variety of topics presented by invited speakers, sharing ideas about how to improve the University's research environment. This seminar plays an important role in facilitating mutual understanding between URAs and their administrative colleagues, related to expected roles, understanding differences, and finding commonalities. The opportunity to establish good relations through such discussions leads to interacting with each other directly to discuss and solve common problems.

The organizational structure of the university has KURA situated between the researchers and the existing administrative departments such as Research and International Affairs Department (Figure 3). KURA functions as the first contact point for researchers. Thus, it allows for discussion with faculty for research directions with future funding opportunities, whereas the existing administrative sections are more directly involved with the paperwork which has to be authorized by the university.

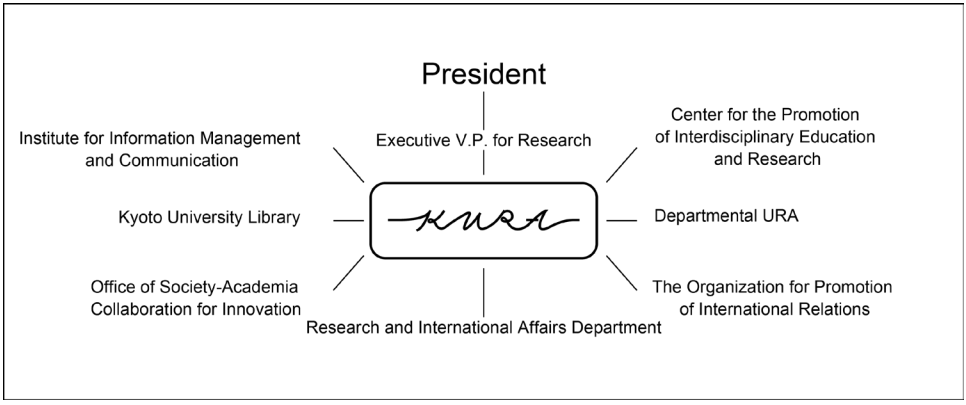

Figure 3. Organization chart at Kyoto University.

Relationships between major organizations and KURA are described. Among the administrative departments, close collaboration with Research and International Affairs Department has been performed. Kyoto University has also introduced departmental URA system to form a URA network.

For the organizations and administrative departments, KURA also functions as a friendly co-worker who provides an innovative idea and professional support functions. For example, with a request from the Kyoto University Library to increase the number of visitors who use a new learning commons, KURA developed an ongoing collaboration to organize a casual workshop to specifically facilitate interaction with young researchers and graduate students. As another example, a few KURA members who have strong professional skills in Information and Communication Technology have been collaborating with Institute for Information Management & Communication to create a university-wide database of research activities. Though the specific roles of KURA varies depending on the kinds of request from the organizations and tasks that need to be solved, KURA office is the office who listens to existing departments and organizational units to survey the demands inside the university for making the research environment more productive.

Increasing Capacity

With nearly 3,000 academic staff engaged in research across three campuses at Yoshida, Katsura, and Uji, KURA's aim to support researchers across the University was limited by what could be offered by its original eight members. In addition, KURA was tasked with additional responsibilities to work closely with various offices in the administrative headquarters of the University, resulting in an immediate need to augment the number of URAs to provide thorough support for researchers. Thus, in July 2012, Kyoto University launched the Kyoto University URA Network Project, in which new URAs were employed by individual departments and assigned to eight regions on the three campuses. As of July 1, 2014, 21 departmental URAs are working in these regions (Figure 3).

Making Kura Visible to Researchers

The formation of KURA was so rapid that efforts have been made to actively introduce the office not only to University administrators, but to faculty and researchers across the University. KURA staff has taken an active role by visiting faculty meetings at individual departments in order to briefly explain the roles of the office. Such opportunities have been the first step toward improving recognition of the office among faculty members.

KURA has also taken the initiative to join many key activities within university, including meetings to review research proposal presentations for obtaining external funding. At these reviews, representatives of proposed projects present their plans to faculty volunteers and KURA staff, who then give feedback related to clarity of the presentation materials and conformity to the requirements of the funding agencies. Providing detailed advice serves the purpose of giving faculty members a positive impression of KURA's role in the funding process.

Concluding Remark—Looking Forward

Kyoto University introduced its URA system as an attempt to improve the environment for research. KURA, the URA office that was established in April 2012 with originally only eight staff, took responsibility for implementing this system within the University. It created a firm

basis for itself within the university by demonstrating its activities to faculty and staff, and also making blueprints for mechanisms by which faculty could receive URA support regardless of their location on any of the three University campuses.

To augment this solid foundation, the effectiveness of this support system has to be further developed to maximize the advantages of the network of KURA and departmental URAs. Cooperation among all URAs is essential to overcome barriers between departments that tend to hinder progress at many large educational institutions worldwide. In addition, collaboration with existing URA-like administrators must be accelerated to increase mutual understanding and provide better service to end users.

In fiscal 2013, MEXT launched a new program to enhance the research activities in research-intensive universities. The proposal from Kyoto University was accepted, and new funding enabled Kyoto University to employ an additional 20 URAs in KURA, beginning in April 2014. This dramatic increase has necessitated reorganization within KURA, creating four new functional sections. FY2014 has thus become a special year for KURA and for the URA network, boldly moving forward to even further enhance the research environment of Kyoto University.

Author Note

The opinions and conclusions in this paper neither necessarily reflect the common views of Kyoto University nor of the Kyoto University Research Administration Network, but only the views of the authors. This paper is based on the presentation at inorms2014, "Development of Strategic Research Administration System in Kyoto University" (Mutoh, Sugihara and Sonobe, 2014). The authors are grateful to David H. Kornhauser for editing the English text. Correspondence concerning this article should be addressed to Tadashi Sugihara, Ph.D., Office of Research Administration, Kyoto University, Yoshida-Honmachi, Sakyo-ku, Kyoto-shi, Kyoto 606-8501, Email: sugihara@kura.kyoto-u.ac.jp

Tadashi Sugihara, Ph.D.
Deputy Director
Kyoto University Research Administration Office
Email: sugihara@kura.kyoto-u.ac.jp

Taro Sonobe, Ph.D.
Manager, International Strategy Section
Kyoto University Research Administration Office

Seitaro Mutoh, Ph.D.
Deputy Director
Kyoto University Research Administration Office

References

Grants-in-Aid for Scientific Research. http://www.jsps.go.jp/english/e-grants/index.html

JSPS Brochure 2013–2014 (2013, December). Retrieved July 23, 2014, from http://www.jsps.go.jp/english/aboutus/data/brochure13-14.pdf

Kyoto University Research Activities http://www.kyoto-u.ac.jp/en/issue/research_activities/index.htm

Mutoh, S., Sugihara, T., & Sonobe, T. (2014). Development of Strategic Research Administration System in Kyoto University. Retrieved July 23, 2014, from http://inorms2014.org/wp/wp-content/uploads/2013/04/24-Development-of-Strategic-Research-Administration-System-in-Kyoto-University-Mutoh.pdf

RU11 (2009, November). Retrieved July 23, 2014, from http://www.ru11.jp/eng/wp-content/uploads/2011/09/proposal_20091124.pdf (in Japanese)

RU11 (2010, March). Retrieved July 23, 2014, from http://www.ru11.jp/eng/wp-content/uploads/2011/09/proposal_20100319.pdf (in Japanese)

SRA

SRA International
Society of Research Administrators International
Serving the Profession Since 1967
500 N. Washington Street, Suite 300
Falls Church, VA 22046
www.srainternational.org

Published by the Society of Research Administrators International