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AUGUST 2010

**RESEARCH GRANTS (RESEARCH SEED
AND WORKING PAPERS) GRANTS**

**GLOBAL AND LOCAL (GloCaI)
KNOWLEDGE LOGISTICS FOR
INNOVATION AND COMPETITIVENESS**

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GLOBAL AND LOCAL (GloCal) KNOWLEDGE LOGISTICS FOR INNOVATION AND COMPETITIVENESS

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UNDER REVIEW – OCTOBER 2010

1. Introduction

The increasing engagement of firms within global knowledge and production networks and their ability to source knowledge globally as well as locally (GloCally), for the development of innovation capacities will shape the future of UK's knowledge resources and its role in the global economy. Practices such as off-shoring R&D activities are widely adopted, creating challenging, and not very well understood, issues related to cross-country and inter-firm knowledge and technology flows. We seek to address the internationalisation and networking of research and innovation activities, including the roles and strategies of enterprises, universities, research centres, governments in a cross-country and inter-sectoral way, to assess the impact and the implications for sustaining and enhancing the competitiveness of UK firms and other British knowledge producers and users.

This research is important for both theory and practice. We are witnessing fundamental changes in knowledge supply chains. Knowledge is now developed, diffused and used in networks-based alliances and relationships outside traditional firms' and countries' historical boundaries. Knowledge supply chains involve different actors at different sites. While the new supply chain knowledge gives firms sustenance of innovation capabilities and opportunities to upgrade and cross-pollinate their knowledge expertise, its international boundaryless inter-organizational nature creates fundamental challenges in terms of managing knowledge and innovation. For instance, many innovation partnerships are temporary networks of alliances that collaborate to explore and/or exploit innovative ideas by partners sharing skills, expertise and expenses, leading to critical problems when the networks are disbanded, leading to fragmentation of knowledge to different geographical locations and parts of the knowledge supply chain. Given the importance of innovation in a knowledge based economy, a failure to understand the process through which knowledge is created, transformed, mutated and used through the knowledge supply chain may erode firms' competitiveness. Surprisingly, our stock of knowledge on the factors and dynamics that shape knowledge supply chain is very limited. We will map out the approaches and processes through which UK firms and their national and international innovation partners develop, diffuse, transform and use knowledge through the knowledge supply chain. Such an understanding will enhance UK firms' ability to achieve a better and more efficient management of knowledge supply chain.

We seek to combine the expertise of Prof. Koh (Director of Logistics and Supply Chain Management (LSCM) Research Group at the University of Sheffield) in upskilling managerial workforces and internationalising supply chains, Prof. Kamel Mellahi expertise in global strategy and Prof Carayannis (co-director of the European Union Research Center and co-founder as well as co-director of the Global and Entrepreneurial Finance Research Institute at George Washington University) on technology innovation, transfer and commercialisation in order to achieve the research aims and enhance UK-US collaboration in this area.

2. Background

At a national level, it has been reported that in the knowledge economy the marketplace is not divided into towns and regions, but into affinity groups that descend from a high propensity to sociability also known as the invisible networks of peers¹ and which are also structured by knowledge creation, diffusion and use modalities (what we also call “knowledge-ducts” along which flow “knowledge nuggets”²) such as innovation networks and knowledge clusters³⁴. In a truly and openly global economy one country is no longer able to dominate the others and such an economy consists of knowledge-driven economies and knowledge-based societies that materialise only in an atmosphere of community. The transition to that state of social, political and economic affairs is full of challenges as well as opportunities and in that context, even advanced industrial economies struggle to capture the potential benefits of the modern-day knowledge society, economy and polity. The path towards a new age of prosperity through knowledge to business is full of pitfalls. The complexity of global as well as local ‘GloCal’ knowledge production and flows in global knowledge supply chains, which are prone to risks and uncertainties will exacerbate the impact of innovation and dampen real value creation²³. For instance, the European Research Area (ERA) system of innovation resembles more an archipelago of islands of excellence and less of a strategically integrated, multi-layered, multi-modal, and multi-nodal knowledge grid. This fragmentation results in substantial added value not being captured and value-adding potential not being realised in the context of the national science, innovation and technology enterprise³ and especially the quantity and quality (i.e. defensibility, sustainability, scalability) of new technology venture formation and growth⁴. This is further exacerbated by the nature of research being highly inter-connected and non-linear as well as increasingly cross-disciplinary.

We will prototype and pilot a bottom-up response (that is, a grassroots response - where the drivers are small and medium sized (SME) firms implementing practical approaches as solutions – as opposed to top-down policy mandates) to address this opportunity. Over the long-run pilots such as the one we propose will improve the UK systems of innovation and will become more urgent as nations and clusters thereof in the rest of the world are promoting similar initiatives. Regional and other economic development strategies have increasingly focused on issues under the classification of innovation networks and knowledge clusters and the building of stronger resources, linkages and networks frequently themed as public-private partnerships. Such innovation modalities consist of a critical mass of local knowledge, expertise, personnel, and resources grouped together by related technologies and may include researchers, collaborators, competitors, partners, and other supply chain members within related technologies^{5,6}. The typical regional innovation strategy is usually derived based on studies consisting of infrastructure-dependent data collection and statistical analysis—all in an effort to define the existing state of regional innovation drivers, triggers and impediments, which are purported to be strongly correlated to the development and advancement of technology infrastructure. Typically, data is collected on R&D funding, technology transfer, role of cluster enabling organisations, size and characteristics of high-tech workforce, availability of venture capital, number of patents issued, scientific publication outputs, and so forth⁷. However, present studies merely define current or historical input conditions, but tell us little about how future technological, demand, competitive and public policy conditions might affect innovation outcomes^{8,9}. This is not to suggest that an unambiguous and clear forecast of innovation environments is realistic, but it is possible and even likely that glocal strategies do not adequately address *vital risk factors and contingency planning*^{10,17}. The technology innovation community concerned with implementing GloCal innovation strategies and partnerships needs to conduct a critical investigation and ascertain answers to the following research questions (a) how can regional technology strategies better leverage GloCal innovation networks and

knowledge clusters? (b) How to best retain and attract knowledge experts? (c) What is the underlying innovation model and associated metrics used by innovation network- and knowledge cluster-based partnership initiatives? (d) What macro (glocal, market), meso (regional, industry) and micro-level (local, firm) socio-technical factors actually determine GloCal innovation outputs, outcomes and impacts (short, medium and long term results)?

Knowledge creation, diffusion and use, known as “MODE 3”, is a multi-lateral, multi-nodal, multi-modal, and multi-level systems approach to the conceptualisation, design, and management of real and virtual, “knowledge-stock” and “knowledge-flow” modalities. These modalities catalyze, accelerate, and support the creation, diffusion, sharing, absorption, and use of co-specialised knowledge assets. “Mode 3” is based on a system-theoretic perspective of socio-economic, political, technological, and cultural trends and conditions that shape the co-evolution of knowledge with the “knowledge-based and knowledge-driven, GloCal economy and society” ^{[vii][i]}. Innovation Networks are real and virtual infrastructures and infra-technologies that serve to nurture creativity, trigger invention and catalyse innovation in a public and/or private domain context (for instance, Government-University-Industry, Public-Private Research and Technology Development Co-operative Partnerships) ^{[viii][ii]} ^{[viii][iii]}Carayannis and Alexander, 2004). Knowledge Clusters are agglomerations of co-specialised, mutually complementary and reinforcing knowledge assets in the form of “knowledge stocks” and “knowledge flows” that exhibit self-organising, learning-driven, dynamically adaptive competencies and trends. The concept of “MODE 3” and Innovation Networks will be applied in this research to enhance the understanding of the inter-relatedness of these critical elements in a ‘GloCal’ knowledge logistics context.

3. Aims and Objectives of the Research

The novelty of our proposed research lies in advancing the understanding of the role of knowledge logistics in a GloCal supply chain context. It is multi-level and multi-disciplinary in the sense that concepts, methodologies and tools from management as well as other disciplines such as engineering and physics may be deployed for modelling, simulation and optimization purposes. The Forrester effect ^{11,12} systems dynamic (founded by Forrester in the 1950s) ¹³, systems thinking ^{14,15} and chaos theory ¹⁶ will be used to explain and model the “GloCal” knowledge logistics phenomena. “GloCal” knowledge logistics can be inferred as a complex system and it is one that is characterised with many risks and uncertainties, and hence the Forrester effect, systems dynamics, systems thinking and chaos theory are suitable theoretical frameworks to be used for understanding the dynamic behaviour of this complex system. The Forrester effect has been widely applied to explain the bull-whip effect in supply chains ¹⁷. Systems dynamic theory has also been extensively applied for examples in the development ¹⁸ and implementation ¹⁹ of new technology, in analysing the maintenance functions towards system performance ²⁰ and in combination of the above ²¹. Similarly, systems thinking has also been widely adopted for example in supply chain design ²², whilst chaos theory has been adapted ²³. Taken altogether these theoretical frameworks have not been applied in the context of the proposed research. The aim of this research is to: identify and profile the role of knowledge as one of the key assets in GloCal logistics designs, systems and architectures as a basis for sustainable competitiveness with the following objectives:

1. To better understand the internationalisation and GloCalisation of research and innovation activities and systems and assess the impact and implications for UK’s research and innovation systems as well as its contribution to growth and competitiveness.
2. To explore the opportunities and challenges of “off-shoring” research and development internationally.

3. To study the cross-country and inter-firm knowledge and technology flows.
4. To explore how different factors shape the future of UK's knowledge resources and its role in the global economy.
5. To explore the roles, strategies and attitudes of enterprises, universities, research centres, governments or formal and informal institutions towards the phenomenon of GloCalization.

This project will develop some deliverables in the form of pilot prototypes and specifically:

- To form a “GloCal Knowledge Grid” (GKG) to enable the “GloCal Knowledge Logistics” that would serve as an empirical validation laboratory (for example, using social networking modalities to map, monitor and analyze knowledge experts mobility patterns we could provide data and information that the GKG would then transform into critical knowledge for supporting decision by industry leaders and policy makers on the matter of knowledge expert retention and attraction).
- In this context, we aim to draw solid conclusions about the implications of the internationalisation on UK's research and innovation systems and thus develop explicit recommendations to facilitate the formation of more sustainable UK policies on its research and innovation systems and their contribution to growth and national competitiveness.

4. Programme and Methodology

4.1 Assessment of the nature, drivers, dynamics and risks that undermine qualitatively superior designs, systems and architectures in Glocal Knowledge Logistics operational frameworks within the UK and abroad: A critical review of the literature will be carried out by Research Associate (RA) #1 (based in the UK) and RA#2 (based in the USA) in order to develop a conceptual model listing the critical success and failure factors, and their relationships and dynamics for “GloCal” knowledge production and flows. Critical mapping of the theoretical frameworks will also be conducted to prepare for analytical grounding in explaining the behaviours and relationships conceptualised in the model. The conceptual model will then feed into the next work programme in designing the interview questions.

4.2 Study of selected areas in terms of technology and geography within the UK (at the macro (glocal, market), meso (regional, industry) and micro-level (local, firm) levels) to provide empirical data for modelling, simulation and prototyping purposes: A triangulation approach will be used where broadly targeted surveys will be complemented by semi-structured interviews and in-depth case studies. The surveys will be thematically, geographically and sectorially focussed to provide insights as to how and where to focus the semi-structured interviews and in-depth case studies. The in-depth case studies method will be employed to validate the conceptual model, involving multiple semi-structured interviews by RA#1 with knowledge stakeholders (for example, universities, research centres, public organisations, private organisations and government bodies) along the knowledge supply chain. This qualitative method will give rich insights of the actual phenomena and it is deemed suitable for data collection in such complex system. The interview data will be coded and analysed with NVIVO software by RA#2; content analysis and grounded theory approach will be used to identify emerging patterns and theoretic themes.

4.3 Simulation and analytical modelling of frameworks and solutions for supporting robust competitiveness and innovation in the UK industry: A new “GloCal” knowledge logistics grid (GKLG) will be analytically modelled and simulated in order to integrate the frameworks, standards, validated conceptual model and route map as a unified entity. Analytical Hierarchy Process (AHP)^{24,25,26} will be

used for analytical modelling and the data will be collected from questionnaire survey of random sample of knowledge stakeholders from diverse parts of the logistics knowledge chain. RA#2 will develop the analytical model and AHP software will be used to analyse the data, which will be used to develop a simulation model of "GloCal" knowledge logistics. By embedding uncertainty and risk factors into the simulation model, the Forrester effect, systems dynamics, systems thinking and chaos theory will be used to explain to what extent the "GloCal" knowledge logistics will perform and otherwise^{27,28,29,30}. RA#2 will also develop the simulation model and analyse the antecedents required for its sustainability as well as its *competence in terms of macro, meso and micro co-opetition, co-specialisation, and co-evolution processes* and its predictive power. These processes will be captured and profiled via higher order learning models and concepts^{31, 32} and will be used by RA#2 for embedding self-organizing and dynamically adapting mechanisms (neural nets and other dynamic associative reasoning and learning Artificial Intelligence tools, such as Social Networking Analytics will also be deployed. Case Based Reasoning (CBR) will be adopted in establishing references to best practices case matching³³ and identifying the range of potential solutions for supporting firm competitiveness and innovation through the GKLG. The RA will then integrate the analytical and simulation models to form the decision support tool. The GKLG will thus be the core for a decision support tool to be created in this work programme and provide multi-dimensional visualisation interactive environments for strategic planning and decision making purposes.

4.4 Conceptualising ways and means to introduce a more entrepreneurial culture in large firms' decision making styles for strategic allocation of critical / scarce resources (human, intellectual, financial and even social capital): We will leverage the simulation and visualisation modalities mentioned above to endow the leadership of large firms with risk mitigation and management devices to enable them to become more entrepreneurial while remaining properly strategic in dealing with "Valley of Death" challenges and opportunities regarding the early stage evaluation of high risk / high pay-off projects. The results and findings from the case studies and interviews, supported by the relevant literature will be used as the input into the conceptualisation of ways and means to leverage the "Valley of Death" challenges and opportunities. A route map for this will be developed through focus group and workshop methods (which will involve knowledge producers, users and brokers from diverse stakeholders of the industrial ecosystem in this study). The focus groups (within stakeholder type) and workshops (between stakeholder type) will serve as roundtable discussions on challenges, opportunities and act as a platform to enable re-engineering of processes, mindsets and behaviours of knowledge stakeholders in the "GloCal" knowledge context. We will organize 10 focus groups with stakeholders from macro, meso and micro levels which will represent government, university as well as industry sectors^{34,35}. The focus groups will then be followed by a workshop aiming to consolidate the stakeholders' views. RA#1 will organise the focus groups and workshop, under the coordination of the project leaders.

4.5 Developing conceptual frameworks and standards for better understanding on how internationalisation and networking of research and innovation activities and systems influences the UK's ability to achieve the Lisbon goals and affects its socio-economic stability: A critical review of policy documents and interviews with policy makers will be carried out by RA#1 in order to develop a conceptual framework and standard for internationalisation of "GloCal" knowledge production and flows for innovation and entrepreneurship. The route map developed from the focus groups and workshops and the validated conceptual model will be used as benchmark for best practices in "GloCal" knowledge logistics, subject to country specific customisation. It is envisaged that issues related to implementation of this framework and standard will be discussed and ten Senior European policy makers (i.e. ministers, ambassadors, etc.) will be interviewed.

5. Outcomes

Improved understanding as to how internationalisation and networking of research and innovation activities and systems influence UK's ability to build and sustain a leading position in the global economy

Improved understanding of the roles of enterprises, universities, research centres, governments or formal and informal institutions in the changing environment of industrial competitiveness

Provision of strategic decision making methodologies (such as DEA and simulated annealing) as well as dynamic visualisation and road-mapping tools such as modelling, simulation and optimization that allow for envisioning what the optimal choices are in a dynamic knowledge logistics context)

Facilitation of the formation of policies, networks and initiatives that would support businesses and enhance the chances of UK industries to overcome the "Valley of Death challenge (ie, the gap between financing needs and available risk capital in early stage venture development resulting into firm failure) in their strategic resource allocation to their research and innovation systems and their contribution to growth and competitiveness

6. Project management

Prof. Koh and Prof. Mellahi will be responsible for supervision of RA#1 while Prof. Carayannis will be responsible for supervision of RA#2. Project partners will discuss the project monthly by utilising video conferencing facilities and aim to be jointly present at suitable UK and International conferences to conduct face to face meetings. Furthermore, two project meetings, one in the USA and one in the UK, will be scheduled at the beginning and close to the end of the project. In addition, RA#1 be provided training through the Sheffield Research Leaders' Programme – an initiative providing a coherent framework of leadership training, career development analysis and professional development.

7. Dissemination and Exploitation

In addition to presenting the finding in peer review journals and international conferences, we seek to disseminate and exploit the results through a variety of means:

- *A Glocal Knowledge Logistics Simulation, Visualisation and Planning Decision Support Tool (GKL-Tool)* that would enable industrialists with deeply threaded networking infra-structures to further facilitate and promote the formation of GloCal, co-operative innovation networks and knowledge clusters. In this manner, industrial firms would be able to maintain a continual qualitative upgrading of their technological and innovation infra-structures and especially their glocal knowledge logistics systems.
- We intend to pursue the commercialisation of GKL-Tool as an ASP, web-service configuration that would aim to sufficiently affordable, functional, user-friendly and effective for a wide adoption or take-up by SMEs which are typically not using such decision support modalities unlike large firms and are part of the large industrial firm's ecosystem (suppliers, customers, complementors). This would enhance the competitiveness of the entire value-adding and supply-chain of large industrial firms per the next point. Licensing of GKL-Tool to large firms could then be used to disseminate the results across the industrial ecosystem and thus establish and leverage the GKL-Tool as a competitively differentiating golden standard for next generation logistics.
- Formation of a consulting *Green Paper for UK policy* for the research and innovation systems and their contribution to growth and competitiveness.

- Establishing of a network of knowledge logistics stakeholders that will act as an experiential learning knowledge cluster via person-to-person and virtual interactions to further provide insights for continued improvement of outputs mentioned above.

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