K4D | Knowledge, evidence and learning for development

Strengthening research systems: concepts, actions and actors

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Questions

1. Identify conceptual frameworks for understanding and strengthening research systems

2. Identify examples of actions or policies to improve research management or strengthen research systems; and

3. Identify supra-national organisations engaged in research management and/or strengthening research systems in Sub-Saharan Africa (including both donors and implementers)

Contents

1. Summary

Conceptual frameworks for understanding and strengthening research systems: discussions with key informants and a scan of the grey and academic English language literature suggests there are few frameworks that explicitly conceptualise social science research systems in a 'developing' country context. What frameworks there are tend to focus on health and agriculture. However, drawing on related or tangential bodies of knowledge, one comes across frameworks which conceptualise, for instance, innovation, mainly in a 'developed' country context as well as knowledge systems in both 'developing' and 'developed' country contexts. In fact there is a considerable body of literature exploring knowledge systems, which due to time constraints was not assessed in any depth.

Nevertheless, these and other frameworks all provide important lessons for conceptualising research systems in a developing country context, especially those in sub-Saharan Africa. Key lessons include that the interaction between (knowledge) actors in a system is as important for processes and outcomes as the actors themselves; that development is driven, not by research, scientific or technological change, but by the institutional (and political) context in which (social and natural) scientific and technological change occurs; and that formal research institutes only produce a fraction of the knowledge that society needs to grow and develop.

Examples of actions to improve research management or strengthen research systems: most actions that provide research capacity strengthening in a 'developing' country context tend to happen in the health and agricultural sectors. In addition, in those sectors, only a fraction of actions support improvements to the broad research system or environment. Amongst these, support to strengthening research systems is delivered mainly through three modalities: 1) centres of excellence, 2) north-south partnerships and 3) networks and consortia. The actions taken by funding and implementing actors to strengthen research systems (which were surveyed, mostly in Anglophone sub-Saharan Africa) can broadly be grouped into the following categories: 1) generating and sharing knowledge about research systems and their evolution; 2) priority setting and financing; 3) governance and regulation; 4) managing and coordinating research; 5) research leaders and centres of excellence; 6) strengthening ties and connections between stakeholder groups; and 7) support to female researchers and gender mainstreaming.

Supra-national organisations engaged in research management and/or strengthening research systems in sub-Saharan Africa: there are relatively few funders and international organisations that focus on system-level research capacity strengthening. Key funders and international organisations include (in alphabetical order): the Association of Commonwealth Universities (ACU), Agence Universitaire de la Francophonie (AUF) Bill and Melinda Gates Foundation, Carnegie Corporation of New York, European Commission (EC), International Development Research Centre (IDRC), International Network for the Availability of Scientific Publications (INASP), National Institutes of Health, Royal Society, Swedish International Development Cooperation Agency (Sida), UK DFID, United Nations Educational, Scientific and Cultural Organisation (UNESCO), the Wellcome Trust and the World Bank.

There appear to be several bodies who either make or deliver policy with respect to research systems in sub-Saharan Africa. Some of these include: the African Union's (AU) New Partnership for Africa's Development (NEPAD), African Academy of Sciences (AAS), Africa Capacity Building Foundation (ACBF), African Institute for Development Policy (AFIDEP), African Network for Economics of Learning, Innovation, and Competence Building Systems (AfricaLics), African Observatory for Science, Technology and Innovation (AOSTI), the Organisation for Women in

Science in the Developing World (OWSD) and Southern African Research and Innovation Management Association (SARIMA).

Key projects, programmes, partnerships and platforms which have played (or are playing) a role in strengthening research systems in sub-Saharan Africa include: Alliance for Accelerating Excellence in Science in Africa (AESA); African Science Academy Development Initiative (ASADI); DELTAS Africa; ESSENCE on Health Research; European & Developing Countries Clinical Trials Partnership (EDCTP); the Strategic Partnerships for Higher Education Innovation and Reform (SPHEIR) and the Science Granting Councils Initiative (SGCI). However, due to linguistic constraints, the search for policy and delivery partners as well as important projects and programmes was mainly Anglophone-centric in sub-Saharan Africa and may have missed those found in Francophone sub-Saharan Africa.

2. Conceptual frameworks

Gavaudan (2017) suggests that relatively little has been written about how social science research is produced in developing countries, compared to developed countries, and there is no defined framework for research systems in developing countries (with the exception of GDN's own work, described later). The findings of this review largely supports this. Hence, the review was subsequently broadened to include frameworks that conceptualised processes and systems that were somewhat tangential to, but provided lessons for how one might conceptualise, social science research systems in developing countries. This section is in five parts:

1. The first part looks at frameworks that explicitly explore research including quality, management and systems
2. The second part explores frameworks that conceptualise the use of Research and Development (R&D), Science and Technology (S&T), innovation and transformation
3. The third part describes frameworks that conceptualise the production of knowledge (going beyond formal research)
4. The fourth part explores frameworks that explore the higher education system (given its closeness to the research system in many contexts)
5. The fifth and final part explores how political economy has been used to map the knowledge system

Research quality, management and systems

This part has six elements which explore 1) research quality; 2) research management; 3) research eco-systems; 4) research systems in a developed' country context; 5) research systems in a 'developing' country context; and 6) sector specific research systems in health and agriculture.

Research quality

The International Development Research Centre (IDRC) is guided by the concept of ***Research Quality Plus (RQ+)***, which is an approach for advancing the quality of research, as illustrated in figure 1.

Figure 1: IDRC's RQ+ model

Source: IDRC (n.d.)

IDRC (n.d) suggests that RQ+ encompasses three components:

1. Acceptance of a multi-dimensional view of quality in research. This includes scientific rigour but also integrity, legitimacy, importance, and positioning for use.
2. Accounting for the political, organisational, disciplinary and data settings in which research happens.
3. Acknowledging that assessments of research quality must be informed by a robust evidence base. This evidence base might include insights of research users, the voice of beneficiary communities, other researchers and bibliometrics amongst other forms of evidence.

Research management

To benchmark research management in an exercise for the Wellcome Trust, *Consort* (2017a and 2017b) focussed on:

1. Finding Funding;
2. Developing Proposals;
3. Financial Management and;
4. Research Uptake and Innovation.

These were seen as the principal areas of research management which extended across the research project lifecycle.

Consort (2017a and 2017b) also identified two cross cutting areas of activity that were seen as integral to each of the above areas, including:

5. Sustainability and;

6. Legal and Regulatory Requirements,

The figure below elaborates on these six areas:

Figure 2: Benchmarking research management

FINDING FUNDING

• Horizon scanning for funding opportunities
  ○ Maintaining expert knowledge about national and international funder priorities and calls
  ○ Maintaining specialist knowledge about institutional priorities, researcher expertise and their career stage
  ○ Disseminating information to researchers in an efficient and timely manner

DEVELOPING PROPOSALS

• Understanding funder terms and conditions
• Presenting the science as a cohesive, fundable grant proposal
• Planning for research execution, impact and uptake
• Pre-award financial management (developing a project plan, costing, pricing and submitting funding proposals)
• Research development and facilitation
  ○ Helping to build new collaborations and communities
  ○ Understanding and supporting interdisciplinary research, cross-sectoral partnerships, and industry engagement

FINANCIAL MANAGEMENT
• Drafting, negotiating and accepting contracts • Post-award project finance • Employing staff on research contracts • Reporting to funders • Supporting audit, compliance and risk management • Making statutory returns
RESEARCH UPTAKE AND INNOVATION

• Collating data, measuring and articulating research impact (uptake)
• Knowledge exchange and business development
  ○ Commercialisation, social enterprise and new business support
  ○ Intellectual Property
• Consultancy
• Technology transfer
• Supporting researcher CPD
  ○ Enterprise skills and entrepreneurship
• Public engagement
  ○ Marketing and science communications

SUSTAINABILITY

• Developing research strategy and policy
  ○ Institutional, Regional and/or International
• Training and capacity building
  ○ Postgraduate development
  ○ Supporting fellowships
  ○ Doctoral training
  ○ Administrator and manager training
• Institutional research portfolio management
• Management information systems and KPIs
• Networking and relationship management
  ○ Collaborators, funders, government, industry, competitors, professional RMAs, etc
• Organising, structuring and managing a research support service
• Alternate sources of research funding
  ○ Fundraising
  ○ Philanthropic giving

LEGAL AND REGULATORY REQUIREMENTS

• Developing and/or contributing to research policy and strategy
  ○ Open Access
  ○ Data management
• Supporting research integrity and monitoring compliance
  ○ Governance, ethics, good practice, misconduct, animal welfare, clinical trials, etc

Source: Consort (2017a)

Research ecosystems

The Wellcome Trust are supporting researchers in Africa and Asia to build strong research ecosystems, which it says include[1]:

- researchers and the outputs they produce
- research managers and the institutions they work for
- funders and governments who support research
- policymakers who use the research to drive change to achieve better health
- engagement and communication specialists, who share and discuss the findings with the public
- private sector and global pharmaceutical companies, who develop innovative products and employ researchers.

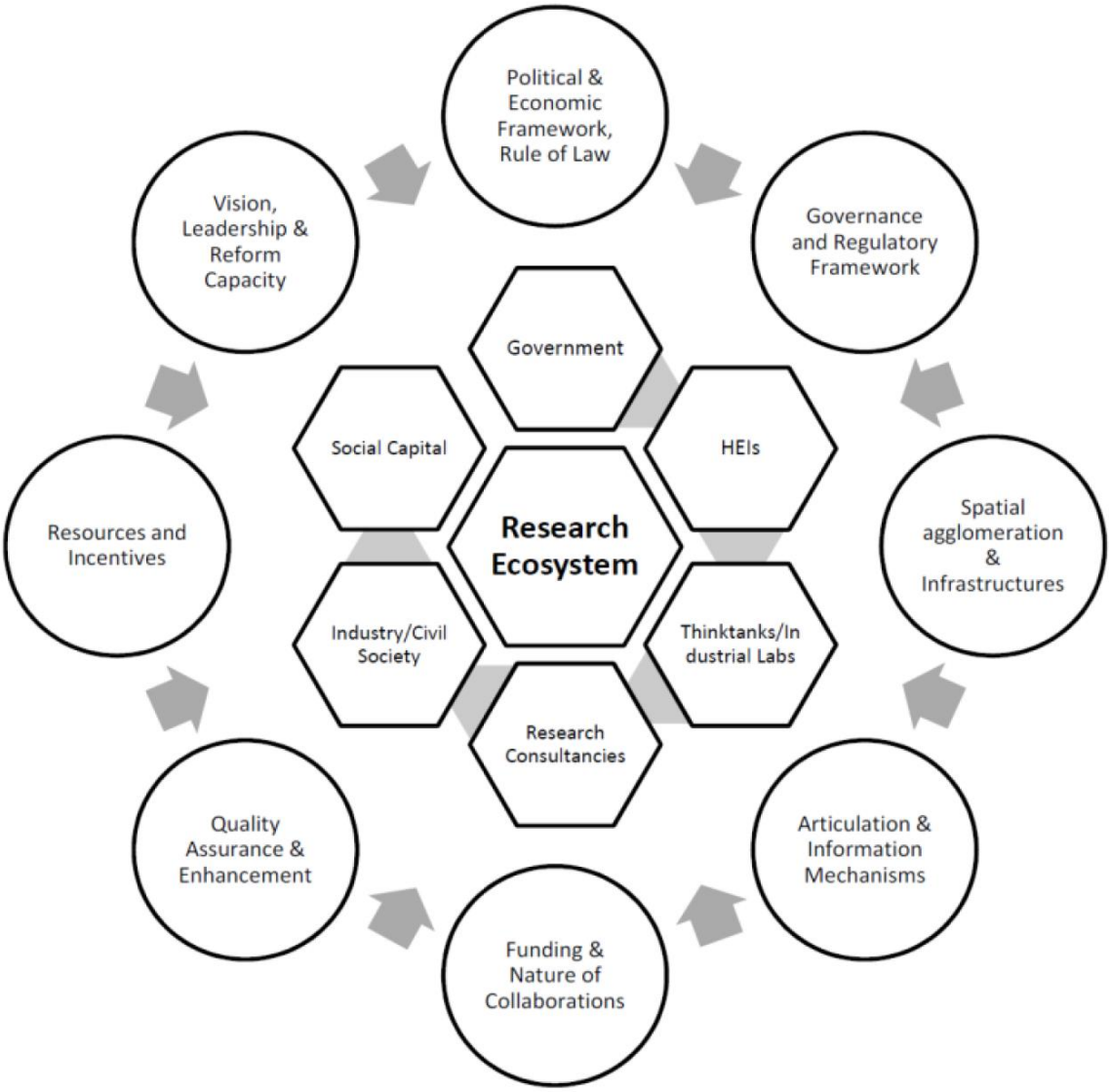
For Salmi (2011), research that takes place within higher education institutions is shaped by eight factors (see figure 3):

1. **Macro environment:** the overall political and economic situation of a country, together with the rule of law and the enforcement of basic freedoms, which influence, in particular, the governance of tertiary education institutions (appointment of university leaders), their level of funding, academic freedom, and safety in the physical environment.
2. **Leadership at the national level:** the existence of a vision and a strategic plan to shape the future of tertiary education and capacity to implement reforms.
3. **Governance and regulatory framework:** the governance structure and processes at the national and institutional levels that determine the degree of autonomy that tertiary education institutions enjoy and the mechanisms of accountability they are subject to (especially important from the viewpoint of the human resources policies and management practices that allow emerging research universities to attract and keep qualified academics).
4. **Quality assurance framework:** the institutional setup and the instruments in place for assessing and enhancing the quality of research, teaching, and learning.
5. **Financial resources and incentives:** the absolute volume of resources available to finance tertiary education in a country (mobilisation of public and private resources) and the mechanisms through which those resources are allocated to various institutions.
6. **Articulation and information mechanisms:** the links and bridges between high schools and tertiary education and the pathways and procedures integrating the various types of institutions that constitute a tertiary education system, all of which affect the academic characteristics of incoming students and their academic results as they move through the tertiary education system.
7. **Location:** the quality of economic, social, and cultural characteristics and infrastructures available in the specific geographical setting of a tertiary education institution that determine, in particular, its ability to attract outstanding scholars and talented students; these characteristics include public services, recreational amenities, housing, transportation, and environmental quality.

[1] See Wellcome Trust web page on building strong research eco-systems: https://wellcome.ac.uk/what-we-do/our-work/research-ecosystems-africa-and-asia

8. **Digital and telecommunications infrastructure:** the availability of broadband connectivity and end-user devices to support the delivery of educational, research, and administrative services of tertiary education institutions in an efficient, reliable, and affordable way.

Figure 3: determinant of research in higher education

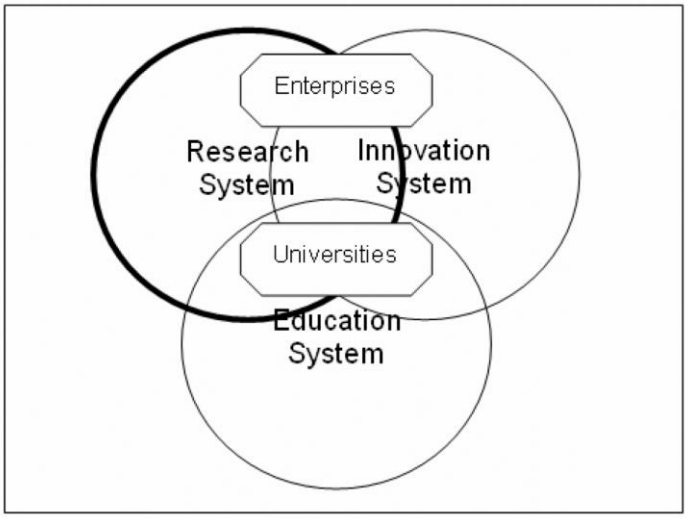


Source: Gevaudan (2017) adapted from Salmi (2011)

Research systems in developed countries

EC (2009) stated that research knowledge is not the same as innovation relevant knowledge and that much of the knowledge generated by the research system stayed within the research system (given that the focus of the research system was knowledge creation not transformation and commercialisation of knowledge). It also suggested that the research system was connected to other sub-systems such as the education system (as illustrated in figure 4 below). For instance, education was a pre-requisite to produce high quality research (i.e. it provides the means to interpret information, generate new knowledge and upgrade existing knowledge). It also provided a means to transfer knowledge from research and innovation to society.

Figure 4: Interaction of the research system with other sub-systems



Source: EC (2009)

In addition, EC (2009) says that with regards to actors, research systems cannot be limited to organisations conducting research. In practice, research will very often be conducted by organisations that also educate and/or innovate. Universities function as the organisational bridge between education and research, while enterprises serve as bridging organisations between research and innovation.

In this view, a research system rests on three pillars:

- research in higher education institutions,
- private-enterprise research connected to industrial development, and
- non-university public research carried out in governmental research or private non-profit organisations.

The relevant actors in a regional research system are subsequently listed as follows:

- Higher education institutions (e.g. research universities, universities of applied sciences, technical colleges),
- Enterprises,
- Government research organisations, and
- Private non-profit organisations

Consequently, research policy has to address private enterprises and the higher education sector to the same degree as research institutes. Additionally, beyond organisational attribution, research comprises a broad spectrum of activities from pure basic research to highly application-oriented research connected to industrial development.

Research systems in developing countries

Mouton and Waast (2009) describe a 'template' for studying research systems, which is the result of a comprehensive review of research systems in 52 developing countries, conducted over two years. The template proposes ten categories (or topics) to be covered in a typical country study.

Of the ten categories, four are included under context: General country context; History of science in the country; Governance of science in the country; and Informal science and technology (S&T) structures. The next five categories refer to the components of the S&T system: the Performers (universities, 'schools' for engineers, research centres – public, private and international); the Human resources; the Funding; the Cooperation agreements (formal or not); and finally, the Output.

The tenth category captures the dynamics of research systems and is called Tensions, dynamics and challenges. This includes: the social inscription of science; the values and the ethos of science; the legitimacy, credibility, accountability of science; the link with the state; the link with different parts of the society; science and its publics: popularisation, controversies around science; and the debates about the 'usefulness' of science.

The template proposes three different kinds of information and data to be collected and presented in a study.

- Statistical indicators (Social, Demographic, Health, Educational, Science, Technology and Bibliometric)
- Descriptors: quantitative or visual descriptions that present the facts of a certain category of entities or events.
- Narratives: more elaborate and deep historical and contemporary descriptions of aspects of the research system in a country.

The template is organised around three 'dimensions' that each captures a different purpose when reviewing research systems: 1) the context within which the research system operates; 2) the components that constitute the system and the 3) dynamics of the system.

Chattopadhyay and Pathak (2016) in their assessment of social science research in India draw on the following concepts:

- Inputs: physical infrastructure; human resources; and modes of funding.
- Structure and processes: autonomy (choice of area, freedom to decide allocation of time); incentives (API additional pecuniary benefits); governance and administration; network governance and collaboration; leadership qualities.
- Output: medium, quality and integrity.
- Accountability: to society (peer and public driven by prestige and recognition); to the funding agency (to fulfil their objectives).
- Policy impact: indirect (lagged and through media and public debate); direct (determined by the funding agency subject to willingness or think tanks).

Buclet (2017) and Gevaudan (2017) state that the starting point for GDN's 'Doing Research' programme was a general analytical grid, composed of seven categories:

- Context and institutional framework

- Supply actors
- Demand actors
- Human resources
- Financial inputs
- Production processes
- Output and social utility

Each category is elaborated in the following table:

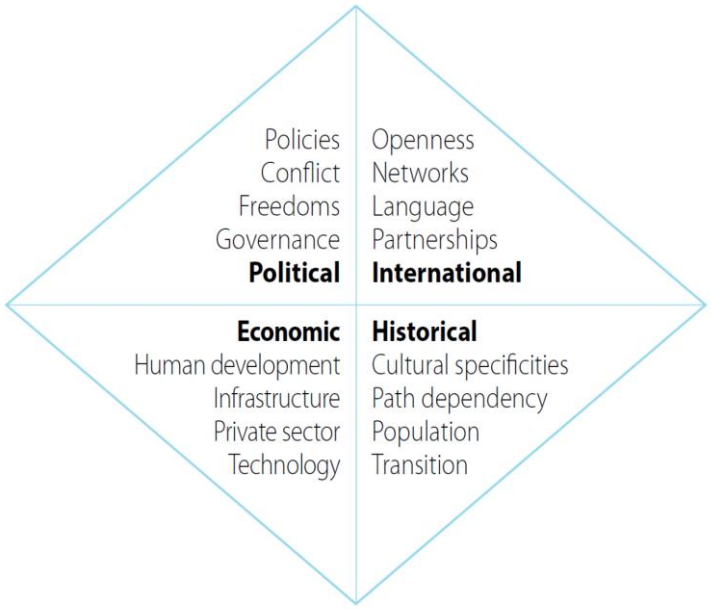
Category	Components
Context and institutional framework	a. Type of political regime b. Degree of political stability c. Diversity of funding d. Clarity of national agendas / national research strategy e. Clarity and stability of rules (at all levels) f. Promotion of multidisciplinarity by authorities g. International exposure (a lack of which leads to inbreeding and/or insularity) h. Promotion of regional and international research i. Existence of an administrative structure dedicated to research j. Ability to research politically-sensitive issues k. Clarity of the legal and financial rules for consulting l. Level of disparities within the country m. Gender balance
Supply actors	a. Public and private universities b. Public and private research centres c. Public and private think-tanks (producing knowledge) d. Other knowledge producers (such as donors or non-academic public institutions) e. NGOs producing knowledge f. Availability and access to local networking and collaborations, particularly intersectoral g. Average age of researchers h. Average levels of education of researchers
Demand actors	a. Clarity of the role of the authorities b. Effective national funding agencies c. Channels of expression for civil society demand (indirect) d. International donor-driven demand e. Use of research by the private commercial sector f. Strength of relationship between supply and demand
Human resources	a. Dynamism of the employment research market b. The degree of 'inbreeding': the number of researchers holding a PhD obtained from the university where they work c. Management of life-long capacity building and career development plans d. Incentives for researchers (blame/reward systems) e. Salary levels f. Structural constraints g. Opportunities for hiring international students for teaching (related to international exposure) h. Incentives for research; publications included in performance measurement i. Flexibility to contract lecturers and researchers j. Correlation between salary and research productivity k. Incentives for internal publishing l. Gender balance m. Availability of student grants n. Research training in first year of graduation o. Workload p. Level of English language skills
Financial resources	a. Autonomy versus security b. Number of possible grant schemes c. Success rate for grant applications d. Flexibility of funding (bound to the fiscal year?) e. Management system following quality norms (International Standard Organisation norms) f. Existence of a quality assurance body g. Funding availability at national/regional/ international level
Production process	a. Quality of available data (statistics) b. Availability of research infrastructure and facilities c. Availability of administrative support for writing research and grant proposals d. Norms/rules for publication e. Access to current research resources f. Characteristics of projects (long-term, short-term, etc.) g. Access to academic journals h. Availability of support for management of financial resources, publications, etc. i. Share of published research on a country carried out by local researchers j. Opportunities for cross-sectoral knowledge production k. Quality of

	the peer culture l. Gap between researcher's areas of interests and themes promoted by donors /governments m. Proportion of scholars promoting research projects
Output/social utility	a. Number of journals for communicating findings for policymakers b. Perception of improvement or deterioration of activity c. Quality of dissemination and communication practice d. Accessibility of outputs (in the local language, for example) e. Quantity/quality of local journals f. Balance between publications in local and international journals g. Existence/possibility of spin-off companies within universities h. Quality of evaluation of research output

Based on an application of this grid in 11 countries and a synthesis of this work, GDN developed the Doing Research Assessment Framework which comprises three main steps (Gevaudan, 2017):

1. Context Analysis: an overall assessment of the economic, political, historical and international context for doing research.

Figure 5: understanding context within which research takes place



Source: Gevaudan (2017)

2. Stakeholder Mapping: the mapping of national research actors to identify research producers and users

Steps 1 and 2 are used to develop a deeper understanding of the context and stakeholders, which then inform the inputs for Step 3.

3. The Doing Research Assessment Framework (DRAF): The Framework provides a structured approach to analysing the research system's functions and processes – specifically in terms of production, diffusion and uptake A combination of secondary data, surveys and interviews is used to populate the DRAF.

The DRAF, illustrated in the table below describes the key determinants for each of the three main functions of the research system – namely the production, diffusion and uptake of research. A combination of secondary data, surveys and interviews is used to populate the DRAF.

	Research system functions →	1. Production	2. Diffusion	3. Uptake
Research system processes ↓	Determinants of the research system ↘	Process through which research is created by researchers and research organizations, including necessary inputs and activities which directly enter the production function.	Research-based products and the channels through which they are diffused to different audience groups (incl. academia, policymakers, civil society, the private sector) and discussed within these circles.	Action of exploiting and adopting research-based products for practical use, or applying research results and methods in specific and direct ways.
Inputs	People and resources needed to produce robust social science research	**1.1 RESEARCH INPUTS**	**2.1 ACTORS & NETWORKS**	**3.1 POLICY-FRIENDLY RESEARCH**
Activities	Set of rules, ethical principles, activities and interactions producing and promoting research	**1.2 RESEARCH CULTURE AND SUPPORT SERVICES**	**2.2 RESEARCH COMMUNICATION PRACTICES**	**3.2 RESEARCH-BASED POLICY MAKING**
Outputs	Tangible products of research including publications, communications & people trained in producing and using good research	**1.3 RESEARCH OUTPUT & TRAINING**	**2.3 RESEARCH COMMUNICATION PRODUCTS**	**3.3 RESEARCH-BASED POLICY TOOLS**
Outcomes	Policymakers, practitioners and the public actively support and use research-based evidence and knowledge in addressing societal problems	**1.4 OPPORTUNITIES & SUSTAINABILITY**	**2.4 POPULARIZATION OF SCIENCE**	**3.4 RESEARCH FOR BETTER POLICIES**

Sector specific National Research System approaches

National Agricultural Research Systems (NARS)

There is a body of knowledge which explores how national agricultural research systems (NARS) affect technological change through a linear model of research, development, and extension. The NARS perspective highlights the public-goods nature of agricultural research and the absence of market access or purchasing power among many farmers, thus emphasising the state's role in fostering technological change. Yet the NARS approach tends to be a linear one as the movement of knowledge is described as originating from the scientific researcher and flows to the farmer, assuming that the social and economic institutions in which this process occurs are largely exogenous and unchanging (Spielman, 2006).

National Health Research Systems (NHRS)

Kennedy and IJsselmuiden) (2006) articulated the concept of a National Health Research System (NHRS), defining it as the people and institutions that generate or use research evidence to maintain, promote and restore health and development of a population; and the activities and environment that facilitate these processes. The emergence of this concept reflected discourse about the need for a comprehensive framework which articulated how research was coordinated, produced, translated and put into practice - beyond setting national priorities and monitoring resource flows for health research. The NHRS concept emerged in an environment where 'systems' and re-engineering theories were being transferred to the health sector from the quality improvement field (in engineering).

Kennedy and IJsselmuiden) (2006outlined a National Health Research Systems (NHRS) assessment tool which comprised a mapping questionnaire and research producer questionnaire. Both of these consisted of a series of questions to structure and guide the description of an NHRS, in four sections:

- actors involved in governance and management of the NHRS;
- institutions engaged in research for health;
- key stakeholders involved in research for health; and
- available literature and a data review on research for health.

The questionnaires systematically approach NHRS assessment by creating a virtual map of the current health research environment in the country: who the actors are, what their role(s) are in health research and policy formation; how they operate; and what resources are available and how well they are performing. Kennedy and IJsselmuiden (2006) urged mappers to focus on the details of structures, policies or statements dealing with overall national research and health research system rather than on individual components of the system, e.g. the Ministry of Health or specific research institutions.The author is unaware if the assessment tool was used and to what effect.

R&D, S&T, innovation and transformation

This part has six elements to it which explore: 1) research and development; 2) science and technology; 3) innovation processes; 4) innovation systems; 5) democratic innovation systems; and 6) transformative change.

Research and development

The OECD's Frascati Manual (OECD, 2015) is a tool designed for statisticians and science and innovation policy makers. It includes definitions of basic concepts, data collection guidelines, and classifications for compiling R&D statistics.

It aims to increase understanding of the role played by science, technology and innovation and to analyse national systems of research and innovation. It also contributes to intergovernmental discussions on good practices for science and technology policies (OECD, 2015).

The guidelines are in three parts:

1. Defining and measuring R&D: general guidance:
    - concepts and definitions for identifying R&D,

- institutional sectors and classifications for R&D statistics
- Measurement of R&D expenditures: performance and sources of funds
- Measurement of R&D personnel: persons employed and external contributors
- Measuring R&D: methodologies and procedures

2. Measuring R&D: sector specific guidance
    - Business enterprise R&D
    - Governance R&D
    - Government R&D
    - Higher education R&D
    - Private non-profit R&D
    - Measurement of R&D globalisation
3. Measuring government support for R&D
    - Government budget allocations for R&D
    - Measurement of government tax relief for R&D

Science and technology policy

The Sábato triangle was developed during the 1960s and 1970s by the Argentine physicist and metallurgist Jorge Alberto Sábato, from the National Atomic Energy Commission (the Argentine government agency overseeing development of nuclear power in the country). It was developed to conceptualise policy-making in science and technology and has informed discussions of science policy throughout Latin America.[2]

The model is based on the idea that in order for a scientific-technological system to exist in practice it is necessary for three sectors to be strongly linked together over the long term: the State (which formulates and implements policy); the scientific and technological infrastructure (which provides technology); and the productive sector (which uses technology). These interrelationships are portrayed in the form of a triangle as in figure 6.[3]

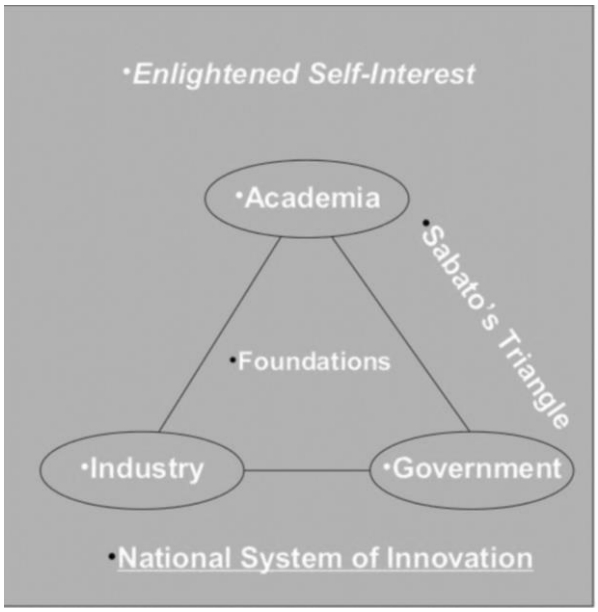
Further, each ’vertex’ needs to have strong internal relations, that is to say, relations between the different institutions contained within itself. For example, within the State there needs to be coherence between ’implicit’ policy and ’explicit’ policy, between different ministries and autonomous organisations, and so on. The other factor considered is the external relations between the ’vertices’ and outside entities.[4]

[2] see https://en.wikipedia.org/wiki/Sabato_triangle

[3] See https://en.wikipedia.org/wiki/Sabato_triangle

[4] See https://en.wikipedia.org/wiki/Sabato_triangle

Figure 6: the Sabato triangle



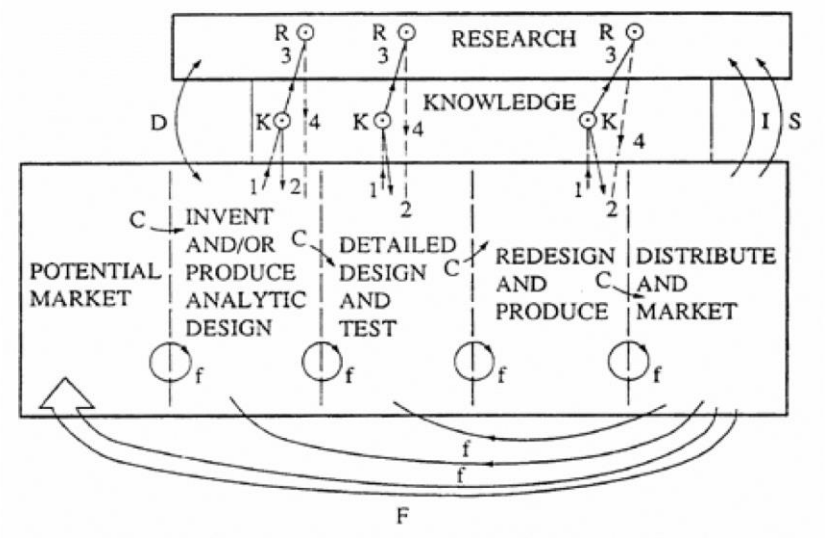
Source: https://www.slideshare.net/3helix/wayne-johnson

Innovation processes

Innovation is defined as “the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organization method in business practices, workplace organizations or external relations” (OECD and Eurostat 2005: para 146). OECD (1999) meanwhile defines innovation as any new knowledge introduced into and utilised in an economic or social process.

Kline and Rosenberg took the first important step towards a systemic understanding of the innovation process in 1986. Their chain linked innovation model (see below) encompasses the notion of systemic interaction and clarifies both inter-linkages and differentiating characteristics of innovation and research systems. According to Kline and Rosenberg, innovation is based on the accumulation and transformation of knowledge. This knowledge base, in different and interactive ways, is fuelled by knowledge created by research (defined by the OECD as "creative work undertaken on a systematic basis"). Hence, research provides an important and indispensable input for innovation activities (EC, 2009)

Figure 7: the chain linked innovation model



Source: EC (2009)

Innovation systems

An innovation system is defined as a network of agents, their interactions, along with the institutions, organisations, and policies that condition their behaviour and performance with respect to generating, exchanging, and utilising knowledge (Spielman, 2006). The whole is seen as more than the sum of its parts, whilst the interaction between actors is as important for processes and outcomes as the actors themselves. The approach underlines the importance of understanding the history and trajectory of interactions between actors and the evolution of institutions, which have led to current organisational arrangements. As such, each (national) system may be expected to develop its own unique dynamics. EC (2009) highlights similarities between innovation systems and research systems, as both systems involve producers and users of knowledge and both are pluralistic in nature: they use existing knowledge and skills to create new knowledge and new skills.

The innovation systems perspective presents a shift from the conventional, linear approach to research and development. It provides an analytical framework that explores complex relationships among diverse actors, social and economic institutions, and technological and institutional opportunities.

The innovation systems approach also presented an important break from the neoclassical principles of optimising agents and equilibrium outcomes (Spielman, 2006). Moreover, the approach challenged what became known as the Washington Consensus and encouraged an active role for government policy in countries that were attempting to ‘catch up’ (Lundvall, 2007). The perspective also challenges claims that technological change drives social and economic development, suggesting instead that development is driven by the institutional context in which technological change occurs.

The innovations systems framework emphasises (the following bullet points draw largely from Spielman, 2006):

- *The role of actors, who are the driving force of the system*. They are not rational maximisers, but strategists responding to other actors' behaviours and their institutional context. In agriculture, for instance, actors include multinational and national agribusiness companies, small/medium agro-enterprises, individual entrepreneurs, farmer/producer associations, rural cooperatives or other community based groups.
- *Interactions or relationships between and among actors*, which might be characterised as collaborative and/or competitive, or by learning and feedback processes.
- *Processes of knowledge creation, dissemination and application*, which actors are engaged in, through both market and non-market relationships
- *Various types of knowledge*: knowledge may be classified according to form - for example, as scientific/technical knowledge or organisational/managerial knowledge, as well as codified/explicit and tacit/implicit knowledge (Hall et al., 2002). Knowledge may also be embodied in some good, service, or technology; or it may be distinct, disembodied, and complementary. Knowledge may be further characterised by its degree of accessibility and accumulation over time or among actors, depending on an agent's capacity to exchange, learn, and absorb.
- *Knowledge can emerge from different sources*: knowledge sources may be external to a given agent within an innovation system - for example, a scientific journal article documenting a laboratory breakthrough, or a neighbour who introduces one to a new way of achieving something. Alternatively, the knowledge source may be some internal process - for example, the reorganisation of human and scientific resources within a company to improve efficiency (Malerba, 2002). In sum, knowledge sources are not simply those entities producing cutting-edge science; rather, they are any entities that introduce knowledge into a social or economic process.
- *The formal and informal institutions that shape the interaction of actors*, how they learn from each other, how they produce, disseminate and apply knowledge, and, consequently, how innovations emerge. These include laws, regulations, the package of fiscal, monetary and trade policies, which make exporting attractive or difficult, education systems, labour markets, financial markets, intellectual property rights, competition in product markets, welfare regimes, conventions, traditions, routines, and norms of society, amongst others.
- *An innovation system requires a unit of study* (Metcalfe, 1997; Carlsson et al., 2002). Analysis may focus on the spatial (local, national, and regional economic or geopolitical units); the sectoral (manufacturing, agriculture); or the technological (for example, information and communications technology, agricultural biotechnology). Analysis may also focus on the material, such as a particular good or service that forms the focal point of a given commodity value chain. Analysis may also focus on a temporal dimension by studying how relationships among agents change over time as a result of knowledge transfers, feedback mechanisms, institutional learning, decision rules, adaptive behaviour, and organisational transformation (Nelson and Winter, 1982).
- *Actors belonging to different sectors differ in how they innovate, interact* with other firms, interact with the knowledge infrastructure and draw upon markets for labour, finance and intellectual property.

However, some commentators have identified problems with the framework in its application, especially in developing countries:

- Lundvall (2007) suggests populations in developing countries are less engaged in innovation and learning to begin with. Secondly, it might be virtually impossible to gather data on what goes on inside firms through surveys and register data may also be scarce and unreliable. Standard indicators on research, innovation and competence may not capture the reality of the innovation systems.
- Innovation systems has focussed on formal networks and institutions. However, knowledge flow is not limited to 'formal' production networks. Instead, a multitude of 'informal' social networks—such as professional associations, alumni associations or geographical locations of households; social networks such as parent–teacher associations—coexist and influence knowledge flow (Spielman, 2006).

Egbetokun et al. (2017) subsequently proposes a number of changes/additions to the framework:

- Inclusion of non-technological innovation in the definition of innovation, especially in the context of developing countries which have viable service sectors driving their economies.
- The informal sector ought to be included as a major actor in the innovation system owing to the strategic role it plays in employment, production of goods and services, and their immense contribution to economic activity in developing countries.
- A need to disaggregate actors: Actors within each element play different roles; therefore interaction among broad range of actors across element smears the defined analysis of the innovation systems theory.
- The role of private institutions and collective action in overcoming innovation barriers is yet to be suitably explored in literature and is conspicuously missing in the innovation system approach.
- There has to be a shift from systems to networks, i.e. network of actors within same element and across elements.

Democratic innovation systems

Carayannis and Campbell (2012) present the **'Quadruple Helix**' model, through which government, academia, industry, and civil society are seen as key actors promoting a democratic approach to innovation. Strategy development and decision-making are exposed to feedback from key stakeholders, resulting in socially accountable policies and practices

The authors describe mode 1 of knowledge production as basic university research organised in a disciplinary structure and mode 2 as knowledge application and problem solving that is practically oriented, transdisciplinary, heterogeneous, organisationally diverse, socially accountable, reflexive and of high quality. Mode 3 consists of innovation networks and knowledge clusters for knowledge creation, diffusion and use. It is a multi-layered, multi-modal, multi-nodal, and multilateral system, encompassing mutually complementary and reinforcing innovation networks and knowledge clusters consisting of human and intellectual capital, shaped by social capital and underpinned by financial capital.

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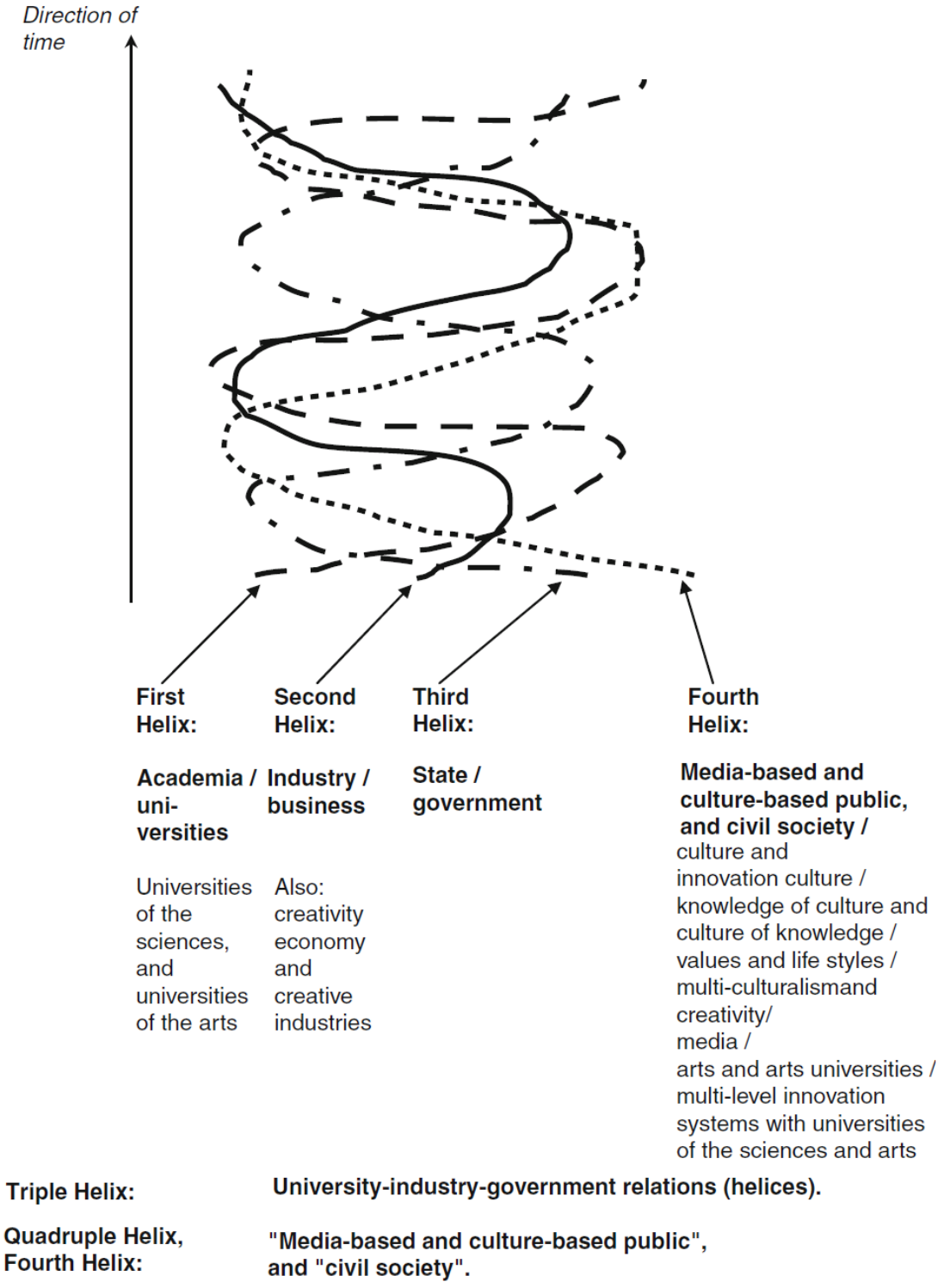
Figure 8: the quadruple helix model



Source: Carayannis and Campbell (2012)

The concept of the Quadruple Helix innovation systems (as illustrated in figure 8 above) broadens understanding asit adds the ’media-based and culture-based public’ and ’civil society’ to the

picture. The 'Quintuple Helix' is even broader, by contextualising the Quadruple Helix by referring to the 'natural environments of society'.

"Mode 3, in combination with the widened perspective of the Quadruple Helix and Quintuple Helix, emphasises an Innovation Ecosystem (social and natural systems and environments) that encourages the co-evolution of different knowledge and innovation modes as well as balances nonlinear innovation modes in the context of multilevel innovation systems." (Carayannis and Campbell: 49))

Transformative change

This is an emerging framework the University of Sussex's Science Policy Research Unit that is not just national or regional in focus but multi-scalar, focussing on grand challenges linked to the Sustainable Development Goals (SDGs) that extend to multiple scales exceeding geographical, sectoral, technological and disciplinary boundaries. Key actors are Governments, science, industry, civil society, end-users and non-users (as potentially affected parties and contributors to the innovation processes). Its emergence is explained by previous/existing approaches to promoting innovation not having led to solving important social and environmental problems.

This approach aims to solve social and environmental challenges by influencing the regulative playing field on the global level and provide more space for experimentation with niche solutions on the local level, enabling socio-technical systems change. Important knowledge is emergent and co-produced: generated through dialogue between multiple actors as part of a collective search process. Areas of focus include socio-technical systems: stress on fundamental transformation of system architecture, changing both its components and its directionality of development.

Typical policy activities include: stimulation of experimentation with niche technologies, scale-up and acceleration of sociotechnical transitions; new institutional solutions for changing the direction of existing R&D and innovation activities; promoting social, inclusive, frugal and pro-poor innovation; and bridging science/engineering, social sciences and humanities in the education system.

The underlying model of innovation is systemic and experimental. Key characteristics include its quasi-evolutionary nature, non-random (purposeful) variation, selection and retention; feedback loops between invention, innovation and use; and ongoing interactions between actors, networks, institutions and technologies.

The basic assumptions about how innovation occurs include: a blurred division labour with multiple actors crossing various domains and enacting overlapping roles, resulting in the co-production of science, technology and society; a mix of competition and cooperation is required to achieve disruptive socio-technical systems change; whilst technology is non-neutral, specific technological designs and the direction of innovative activities might serve to create, solidify or amplify environmental and social problems (the last six paragraphs draw from SPRU, n.d and Schot and Steinmueller, 2016) .).

Knowledge production and processes

This part has four elements which explore: 1) modes of knowledge production; 2) scientific, professional and local forms of knowledge; 3) political knowledge regimes; and 4) knowledge systems for sustainable development.

Modes of knowledge production

Several authors have conceptualised knowledge production, which has implications for the recognition of key actors within a 'system'.

For instance, Gibbons et al. (1994) define two modes of knowledge production:

1. A traditional form of scientific research, which is academic, investigator-initiated and discipline-based knowledge production. Here knowledge production is located primarily at scientific institutions (universities, government institutes and industrial research labs).
2. A more context-driven, problem-focused and interdisciplinary form of knowledge production that emerged in the mid-20th century. Locations, practices and principles are much more heterogeneous.

The table below summarises the main attributes of each mode of knowledge production.

Mode 1	Mode 2
Academic context	Context of application
Disciplinary	Transdisciplinary
Homogeneity	Heterogeneity
Autonomy	Reflexivity/social accountability
Traditional quality control (peer review)	Novel quality control

Scientific, professional and local forms of knowledge

Hall et al. (2015) argue that "Universities must recognize the limitations of their knowledge, however advanced, and admit that their elite, exclusive knowledge is representative of only 1 or 2% of the population who have historically entered the space of university research and academic knowledge creation. Beyond the borders of university life and academic knowledge lies the embodied and experiential learning of the other 98% of the human race and their ancestors before them. Knowledge democracy calls upon us in the university to normatively and practically look to the wider world as collaborators and allies in the quest to address the world's great challenges" (Hall et al, 2015: 19).

Resonating with this point, Fred Carden in a blog post suggests that evaluators tend to rely on scientific, 'objective' data and evidence. Evaluators have been socialised to view it as the most reliable and honest evidence and privilege this knowledge over other forms of knowledge. The producers of scientific knowledge are hence privileged over other producers of knowledge. However, scientific knowledge comes with its own cultural, gendered, political and class assumptions, so evaluators (and other 'consumers' of knowledge) need to be cautious in how they understand its findings.[5]

[5] See http://zendaofir.com/yees-whose-knowledge-matters/

Carden goes on to say that professional knowledge is the knowledge held by bureaucrats, intermediaries (such as think tanks), and advocates. Professional knowledge synthesises and consolidates ideas from a range of sources and, most importantly, connects them to context. It is the process knowledge that brings evidence and ideas to a community in ways it can be effectively used.[6]

Further, he says that local knowledge emerges from a society's experiences and practice. Local knowledge is learnt through experience and observation of citizens in their communities. It is the social capital that allows individuals to become citizens and form communities. Local knowledge is most often co-produced between communities and their environments. It is often tacitly held and passed on orally from generation to generation. Importantly, like other forms of knowledge, it evolves and changes over time.[7] Nugroho et al. (2018) make the case that policy and policy influence is strengthened when local, professional and scientific knowledge work together.

Political knowledge regimes

Campbell and Pederson (2008) develop the concept of 'Knowledge Regimes'. Knowledge Regimes (KRs) are the "organisational and institutional machinery that generates data, research, policy recommendations and other ideas that influence public debate and policy-making" (Campbell and Pedersen 2014:6).

According to Campbell and Pederson (2008), to determine the KR of a country, one needs to study the type of policy-making regime and the type of economic production. Both directly influence the type of research units that emerge and the marketplace of ideas (Garce et al., 2018)

With respect to types of production regimes, they identify 1) liberal market economies where economic activity is structured primarily through markets and corporate hierarchies where managers respond to price signals and make strategic decisions without consultation with other organisations in their environment and 2) coordinated market economies which structure economic activity more through non-market relationships such as informal networks, formal corporatist bargaining, associations and other forms of state intervention and regulation.

The authors then identify two policy making regimes: 1) centralised and closed states where policymaking is located in a few policy making arenas that tend to be insulated from external influences of civil society; 2) decentralised, open states where policymaking is much less insulated from external influences, where policymaking authority is often shared or delegated to lower levels of government.

Putting these two dimensions together, they arrive at four ideal KRs:

Liberal market economies with decentralised, open states: knowledge regimes will be characterised by many privately funded scholarly and advocacy research units, some state research units, and no party research units to speak of. This market-oriented knowledge regime represents an intensely competitive market place of ideas. It is marked by partisan and adversarial contests among knowledge producers trying to influence both public opinion and policy makers. Of the four types of knowledge regimes, this one is probably the most competitive and the most

[6] See http://zendaofir.com/yees-whose-knowledge-matters/

[7] See See http://zendaofir.com/yees-whose-knowledge-matters/

heavily reliant on private financing, both corporate and philanthropic, although there are plenty of government contracts and grants. The state research units also compete against one another and against research units in civil society for the attention of policy makers.

Liberal market economies with centralised, closed states: knowledge regimes will have fewer scholarly and advocacy research units. These will be supported by a mixture of public and private funds. It will also have a much more substantial set of state research units. There will be few significant party research units.Compared to the liberal market economies with decentralised, open states, the mixture of types of research units will be a bit more balanced. Like its decentralised, open state counterpart, this knowledge regime will be a partisan, adversarial, and competitive market place for ideas. However, the importance of the competitive market place for ideas will be tempered by the significant role that state research units play, particularly within the well-established civil service. As a result, this is called the politically-tempered knowledge regime.

Coordinated market economies with decentralised open states: knowledge regimes will have a moderately sized set of research units in civil society, dominated primarily by scholarly research units rather than advocacy research units. These organisations will be heavily dependent on public funding. There will also be an important array of party research units and a reasonable number of state research units. The comparative absence of advocacy research units is indicative of the fact that this knowledge regime is less oriented to competitive, partisan, and adversarial competition, and more oriented toward the production of knowledge for a consensus-oriented policy process. This consensus-oriented knowledge regime is consistent with the surrounding corporatist institutions and system of proportional representation in electoral politics, which puts a premium on consensus building and moderation in policy making. Whereas ideational competition is tempered by the state in liberal market economies with centralised, closed states, ideational competition is tempered in coordinated market economies with decentralised, open states by a generally accepted and institutionally supported concern with compromise.

Coordinated market economies with centralised, closed states: knowledge regimes will have few advocacy or party research units. There will be more publicly funded scholarly research units and state research units of various sorts. Economic coordination depends far more on the state in this type of political economy than in the rest, which is why the production of policy relevant knowledge will also be left largely to the state. Again, the absence of advocacy research units signals that knowledge production in these countries is relatively non-partisan. In contrast to coordinated market economies with decentralised, open states, where knowledge regimes exhibit tendencies toward ideational consensus building, coordinated market economies with centralised, closed states will likely have knowledge regimes that are highly technocratic in orientation. Ideational competition that might occur otherwise will be tempered. This type is called a statist-technocratic knowledge regime (The last four paragraphs draw heavily on Campbell and Pederson, 2008).

Garce et al. (2018) suggests that Campbell and Pederson (2008)'s framework has two significant limitations. First, the focus of analysis is on the supply side of research. The demand side, as well as the institutions and actors on this side, receive less attention. Secondly, the KR typology presented by Campbell and Pederson is closely linked to economics. Garce et al. (2018) suggest it important to consider the context and role of the State when studying the role that specialised knowledge plays. The emphasis on the economic structure and its central actors (companies) leaves behind political institutions, political parties and their key organisations (Garce et al, 2018).

Garce et al. (2018) keep one of the two analytic variables proposed by Campbell and Pederson - the policy making regime - but replace economic production with a variable that considers the role of knowledge and science in politics and society. In their framework, this variable considers two positions: rationalist enlightenment in one extreme, and pragmatism / anti-intellectualism on the other. Garce et al., (2018) suggests this variable helps to better understand why there is greater demand for specialised knowledge in some countries than in others.

Garce et al. (2018) thus present the following typology:

		General evaluation of science in the political system (Predominant cultural tradition)	
		Rationalist Enlightenment	Rationalist Enlightenment
Type of *Policy Making Regime*	Centralized	**I** Technocratic Elitism (Chile)	**III** Plebeian Majoritarism (Argentina)
	Decentralized	**II** Technocratic Pluralism (Brasil)	**IV** Plebeian Pluralism (Uruguay)

Type I. Technocratic Elitism. The combination of centralisation and rationalism generates a State-driven use of social research. Political parties frequently turn to experts and tend to delegate important responsibilities to them in the development of public policies. Academic knowledge is very important, and often acts as a trampoline for people's political careers and is a requirement for them to attain positions in government. A good example of this type of Political Knowledge Regime (PKR) in Latin America is Chile, where science is highly valued.

Type II. Technocratic Pluralism: The combination of pluralism and rationalism generates an open market for ideas in which alternative policy paradigms compete. Science is highly valued and this generates considerable developments in the social sciences and in research applied to public policy. As in Type I, there are State structures that favour the use of knowledge in policymaking. University education and academic merit are important to attain a position in government. A good example of this type of PKR is Brazil.

Type III. Plebeian Majoritarianism: The combination of centralisation and anti-intellectualism does not favour the formation of a competitive or demanding market for ideas. While there is not necessarily a low-intensity use of research, leading actors will tend to refer to experts when they want to give their decisions legitimacy and strengthen their hegemony. Argentina would be an example of this type of PKR.

Type IV. Plebeian Pluralism: The combination of pluralism and anti-intellectualism generates a comparatively low level of specialised knowledge use. Pluralism favours a market of ideas that is open and competitive, but politics clearly dominate technical rationality. Specialised knowledge is essentially a weapon in the power struggle amongst the main political actors. The way in which the State is structured, like in a type III system, clearly illustrates the predominance of political rationality. A good example of this type is Uruguay.

Knowledge systems for sustainable development

Informed by a number of case studies in knowledge systems for sustainable development, Cash et al. (2003) suggest that efforts to mobilise science and technology for sustainability are more likely to be effective when they manage boundaries between knowledge and action in ways that simultaneously enhance the salience, credibility, and legitimacy of the information they produce. They characterise the three functions that contributed most to such ‘‘boundary management’’ as ‘‘communication’’, ‘‘translation’’, and ‘‘mediation’’:

- **Communication.** Active, iterative, and inclusive communication between experts and decision makers proves crucial to systems that mobilise knowledge that is seen as salient, credible, and legitimate in the world of action;
- **Translation.** Linking knowledge to action requires open channels of communication between experts and decision makers but also requires that participants in the resulting conversation understand each other. Mutual understanding between experts and decision makers is often hindered by jargon, language, experiences, and presumptions about what constitutes persuasive argument. Systems mobilise knowledge for action by translations that facilitate mutual comprehension in the face of such differences.
- **Mediation.** Translation can facilitate information flow between experts and decision makers when, as is often the case, they are divided primarily by different languages, usages, and histories. However, the trade-offs among salience, credibility, and legitimacy are fundamental. Conflicts among efforts to attain them cannot always, or even often, be resolved merely by improving understanding. Mobilising S&T for sustainability often requires active mediation of those conflicts.

The ‘‘boundary management’’ functions summarised above - communication, translation, and mediation - can be performed effectively through various organisational arrangements and procedures. These functions can be institutionalised in ‘‘boundary organisations,’’ organisations mandated to act as intermediaries between the arenas of science and policy. Boundary organisations have at least three features:

(i) they involve specialised roles for managing the boundary;

(ii) they have clear lines of responsibility and accountability to distinct social arenas on opposite sides of the boundary and;

(iii) they provide a forum in which information can be co-produced by actors from different sides of the boundary through the use of ‘‘boundary objects’’ (this draws on Cash et al, 2003).

Three institutional features stand out as characteristic of systems that effectively harness S&T for sustainability:

- **Treating Boundary Management Seriously.** Those systems that make a serious commitment to managing boundaries between expertise and decision making more effectively linked knowledge to action than those that do not.
- **Dual Accountability.** Although taking systematic boundary work seriously is important, several specific structures and strategies emerged as important to performing the work effectively. One of the most important of these involve the accountability of boundary managers.

- **Use of Boundary Objects.** A third strategy for harnessing S&T for sustainability involves joint production, by experts and decision makers, of models, scenarios, and assessment reports. Such ‘‘boundary objects’’ are collaborative efforts that ‘‘are both adaptable to different viewpoints and robust enough to maintain identity across them’

Higher education

This part has three elements which explore: 1) the higher education system; 2) university – firm interactions; and 3) improving the role of universities in economic development in Africa.

The Higher Education System

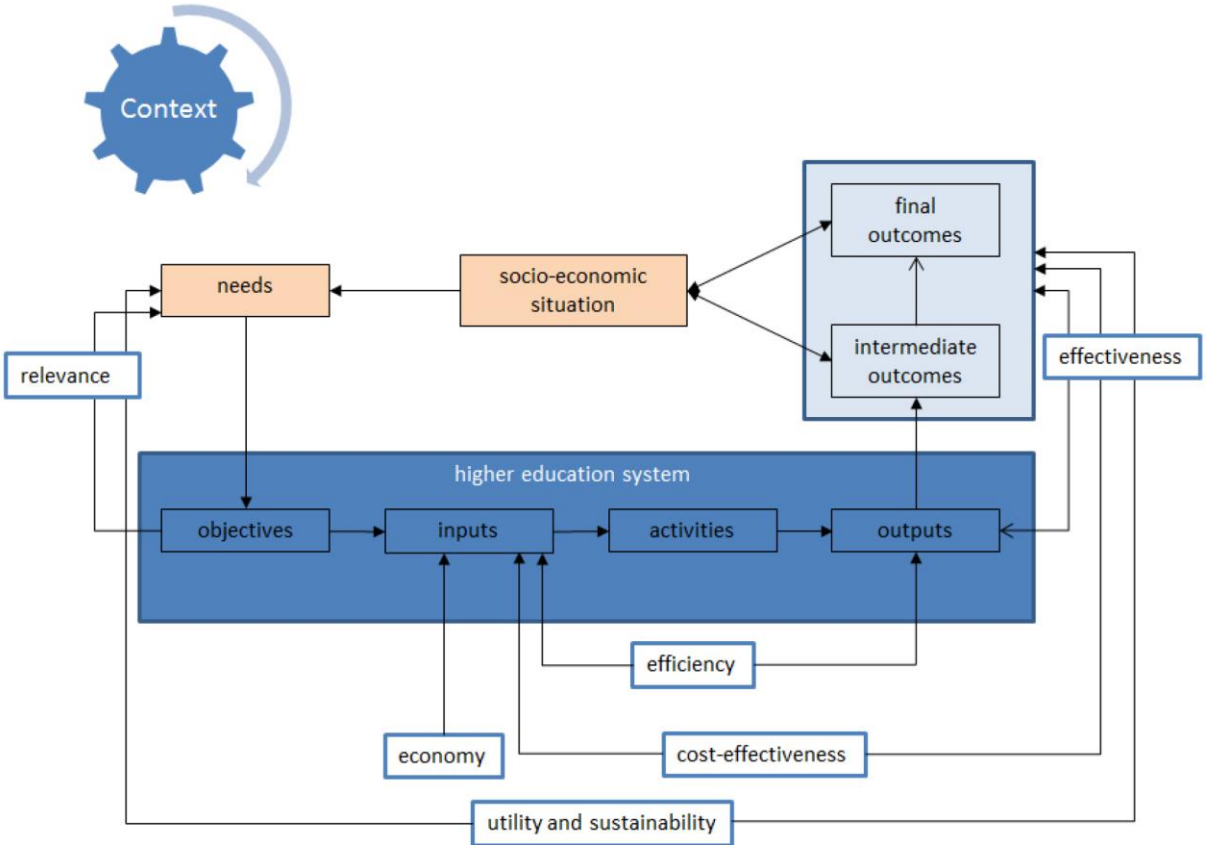
Williams and de Rassenfosse (2013) argue that four key elements shape the quality of the tertiary education system (including their ability to produce high quality research). These are:

- **Resources:** higher education institutions are funded for teaching and research from governments, persons and corporations. Governments at different levels (federal and provincial) provide core funding for teaching in public institutions.
- **Environment:** the regulatory environment is important for ensuring that resources are used efficiently. Excessive regulation of employment conditions will limit the contributions of academics and the capacity to attract and retain globally competitive talent. Restraints on competition may hinder innovation in teaching methods.
- **Connectivity:** the worth of a national higher education system is enhanced if it is well connected with the rest of the nation’s society and is linked internationally in education and research.
- **Output:** Output measures need to cover research, teaching and training. Research performance is measured by publications and their impact; education and training is measured by student throughput and the national stocks of graduates and researchers.

The OECD’s higher education system performance model draws on a long history of performance measurement and management of the public sector. OECD (2017) states that the model “enables an assessment of the complete 'span of performance': economy, efficiency and effectiveness, by covering the whole chain of production from input to outcome. The inclusion of the socio-economic situation and needs of society also enables an assessment of the relevance, utility and sustainability of systems” (OECD, 2017:60).

As figure 9 shows that the higher education system sits within a wider socio-economic situation. Socio-economic issues induce policies for meeting society's needs. These societal needs are defined by higher education stakeholders, which prompt action from the political system to determine priorities. These priorities are translated into objectives for the higher education system. Inputs of capital and labour are acquired to conduct activities of the three processes of higher education - education, research, and engagement - in pursuit of the defined objectives. The outputs are the products of these processes - what higher education delivers to the outside world (such as graduates, publications, start-ups and spin-offs). The outputs then interact with the environment leading to intermediate and final outcomes (such as students getting jobs and being competent in them). In the end, the value of processes and outputs results from their outcomes.” (OECD, 2017: 60)

Figure 9: the higher education system



Source: OECD (2017)

The model inspires thinking about the following aspects of performance:

- Relevance – are policies meeting societal needs?
- Economy – can money be saved?
- Efficiency – can the system be more productive?
- Effectiveness – is the system achieving the intended outcomes?
- Utility and sustainability – how useful and durable are the outcomes?

The model can be criticised for its mechanistic and rational approach to understanding the complex nature of the public sector in general and higher education in particular. However, OECD (2017: 61) suggests the model is just that, “a simplified and idealized understanding of reality, which allows us to conceptualise and analyse a higher education system in order to better understand it”.

University-firm interactions

Albuquerque (2015) suggest a typology to conceptualise the global interactions between universities and firms.

1. Only local interactions: These interactions between local firms and local universities do not involve cross-border transfer of knowledge.

2. Transnationals interacting only with home-country universities: this would be the typical relationship reported in the literature on internationalisation of R&D. Multi-National Enterprises (MNEs) have connections with their home country universities, but either the host countries do not have R&D activities or the R&D activities are completely centralised at the MNE headquarters
3. Transnationals interacting both with home-country and host country universities: this is the most recent pattern of interaction. There is a broader division of innovative labour within the MNE, with the possibility that a subsidiary assumes contacts and performs contracts with the host-country university;
4. International consortia between firms and universities: this type of interaction involves firms, universities, and research institutions, but might be proposed and coordinated by the academic side of the interaction. Intergovernmental cooperation and international institutions, such as the World Health Organisation (WHO), could trigger this kind of interaction. They could be 'mission oriented' and necessarily non-hierarchical. They could also be characteristic of a global innovation system.

Improving the role of universities in economic development in Africa

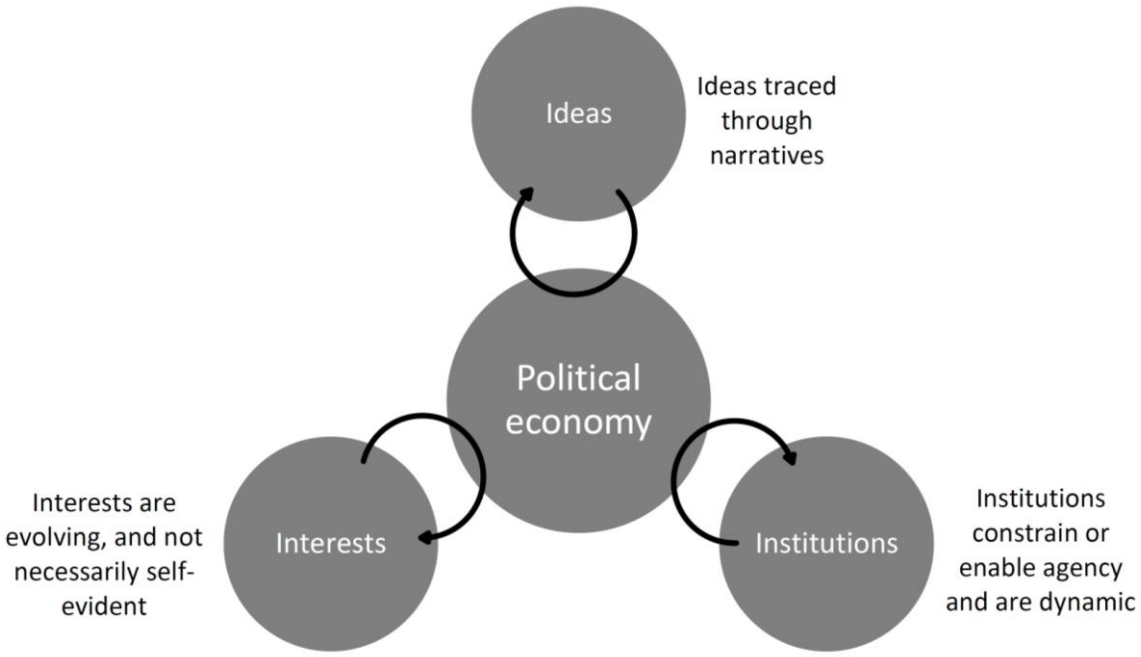
In their review of the relationship between higher education and economic development in Africa, Cloete et al. (2011) formulate the following analytical propositions:

- A condition for effective university contributions to development is the existence of **a broad pact between government, universities and core socioeconomic actors** about the nature of the role of universities in development.
- As a core knowledge institution, the university can only participate in the global knowledge economy and make a sustainable contribution to development if its **academic core is quantitatively and qualitatively strong**.
- For linking universities effectively to development, a country needs various forms and methods of **knowledge policy coordination**. In addition, the **connectedness** between the larger policy context, universities and development is crucial.

Political economy

Chataway and Ochieng (2017) draw on Byrne and Mbeva (2017)'s analytical framework based on analysing ideas, institutions and interests to understand the evolution of science funding in sub-Saharan Africa, illustrated in figure 10 below. They subsequently compiled and analysed relevant data on financial support to science organisations in sub-Saharan Africa to reveal material **interests and realities**. They looked at peer reviewed and grey literature and conducted a limited number of semi-structured interviews to gain insight into agents' (actors') **ideas and narratives** and their understanding of their own and other's activities and roles in the context of structural factors. Finally, to the extent possible, they researched and analysed **institutions** to understand how they set routines and patterns that enable or constrain agency.

Figure 10: taking a political economy approach



Source: Byrne and Mbeva (2017)

3. Key policies and actions

This section describes the key policies and actions that actors are taking to strengthen research systems in 'developing' countries. However, actions are not great in number and most of these tend to be in the health sector.

Enoch (2015) reports that the bulk of scientific research, initiatives and capacity strengthening support is focussed on health and agriculture. In the health sector schemes focussing on strengthening the enabling environment or 'ecosystem' for health research in Low- and Middle-Income Countries (LMICs) represented only 11% of all (health research capacity strengthening) schemes profiled Enoch, 2015).

Intervening at the environmental or systems level may be seen as a relatively risky venture. This level of capacity strengthening may also take the longest to demonstrate tangible progress, making shorter-term evaluations challenging and requiring a more flexible approach. This creates a tension between ensuring long-term sustainable improvements in capacity and the short-term results agenda (Enoch, 2015).

This section is in two parts. The first part identifies key modalities through which support to strengthen research systems is provided whilst the second identifies specific strategies that actors have taken to strengthen research systems.

Key modalities to providing support

This part discusses key modalities through which capacity strengthening support (at a systemic, but also organisational and individual level) is provided. It has three elements which discuss: 1) centres of excellence; 2) North-South partnerships and 3) Networks and consortia.

Centres of excellence

A common modality for developing long-term capacity to conduct advanced research LMICs is 'centres of excellence'. These generally concentrate investment within a few institutions that show potential to excel and become high-quality self-sustaining sites (also known as islands of high capacity). Centres of excellence can bring about transformative change because they increase the likelihood of high-quality research and renewed investment in an otherwise challenging environment (Franzen et al., 2017).

Early forms of this concept were criticised as being led and managed by expatriate staff and run in parallel to national research systems. This was seen to further deplete the local resource pool by diverting investment and human resources towards these better funded sites. More recent forms of centres of excellence, such as those championed by the European and Developing Countries Clinical Trials Partnership (EDCTP) however strive for greater Southern leadership and better integration with local research systems (Franzen et al, 2017).

North-South partnerships

The Global Forum for Health Research and EDCTP are delivered through North-South partnerships. Despite their popularity, problems with North–South partnerships have been discussed extensively in the capacity strengthening literature. For instance, too few benefits are accrued by the Southern partner because they are forced to collaborate with High Income Country institutions to meet funding requirements (Franzen et al., 2017).

Networks and consortia

Networks and consortia development models emerged in the mid-1990s. By the mid-2000s, they were used to tackle whole programmes of research and are now very popular with funders. they encourage less-hierarchical leadership and competitive and individualistic attitudes. Networks are seen as particularly important where groups may be isolated or when one group alone would have insufficient capacity to address an issue. Networks are also thought to: help focus on common research priorities; increase knowledge exchange and speed diffusion of innovations; and help forge long-term relationships and sustainability. However, some authors point out that most networks focus on highly thematic research projects and only develop capacity of individual research groups, not research systems (Franzen et al., 2017).

Strategies to strengthen research systems

This part describes strategies being pursued to strengthen research systems. It has eight elements which cover: 1) Generating and sharing knowledge about the evolution and trajectory of the research system; 2) Priority setting and financing; 3) Governance and regulation; 4) Managing and coordinating research; 5) Research leaders and centres of excellence; 6) Strengthening ties between stakeholder groups; and 7) Support to women and gender mainstreaming.

Some of the above strategies might appear to be focussed at the individual or organisational/institutional level (e.g. support to research leaders). However, they have been included, as they have previously been deployed as a means to improve the (national) system or environment in which research takes place.

Generating and sharing information about the nature of research/science systems

- The Royal Society's **Atlas of Islamic-World Science and Innovation** explored the changing landscape of science and innovation across a diverse selection of countries with large Muslim populations in the Middle East, Africa and Asia. The project charted the interplay between science, innovation, culture and politics and explored new opportunities for partnership and exchange with the wider world. Looking in detail at a geographically and economically diverse set of countries, the Atlas project offered an independent assessment of how their science and innovation capabilities are changing, and the opportunities and barriers to further progress; and explored new opportunities for partnership and exchange.[8]
- Global Development Network (GDN)'s **Doing Research Programme** aims to identify barriers to good, policy-relevant research being produced and used in developing countries and to benchmark these systems, with the ultimate goal of improving research policies and underlying conditions for carrying out research. Assessments of research systems were undertaken in 11 countries, using different approaches. Based on its conclusions GDN developed a framework which assesses Research Systems in terms of their 3 main functions – Production, Diffusion and Use – and in 5 areas: Context, Inputs, Activities, Outputs and Outcomes. GDN plan to pilot this framework in three countries, one each in Africa, Asia and Latin America. GDN aim to generate an interactive publicly available dataset, benchmark social science research systems, and produce a periodic global report on doing research in social sciences in developing countries (Gevaudan, 2017).
- The Higher Education Research and Advocacy Network in Africa (HERANA) sought to establish **how national and institutional stakeholders conceptualise the role of higher education and of universities in development**. It also aimed to investigate the complex relationships between higher education and economic development in selected African countries with a focus on the context in which universities operate, the internal structure and dynamics of the universities, and the interaction between the national and institutional contexts. It also aimed to identify factors and conditions that facilitate or inhibit universities' ability to make a sustainable contribution to economic development. Lasting ten years, it was managed in three phases, ending in 2017. [9]
- The **Africa Science, Technology and Innovation Indicators (ASTII)** implemented by NEPAD, aims to develop and promote the adoption of internationally compatible Science, Technology and Innovation (STI) indicators; build human and institutional capacities for STI indicators and related surveys; enable African countries to participate in international programmes for STI indicators; and inform African countries on the state of STI in Africa.[10]
- The **African Citation Index** implemented by the Council for the Development of Social Science Research in Africa (CODESRIA) aims to make knowledge production in Africa accessible and visible. "CODESRIA considers the Index as a continental infrastructure, available to institutions, decision-makers, regional and international bodies, researchers, students and partners interested in gaining a more realistic understanding and knowledge of

[8] See https://royalsociety.org/topics-policy/projects/atlas-islamic-world/ for more information

[9] From http://www.universityworldnews.com/article.php?story=20180328135155625

[10] From http://www.nepad.org/programme/african-science-technology-and-innovation-indicators-astii

the field of African research. It also asserts itself as a tool to deal adequately with African issues on the basis of the realities of African knowledge."[11]

- The Association of Commonwealth Universities (ACU)'s **Benchmarking research management processes** facilitates sharing of experiences and good practice with respect to university management processes. The process features two in-person events, over two years and, in each case, rely on preparatory work by the participants to record their current practices. No more than 16 participating universities participate at a time. Each session produces a series of good practice statements, against which participants and the wider higher education community can review their current practices.[12]

Priority setting and financing

Examples of strategies to enhance priority setting and financing of research include

- Supporting the establishment, or growth, of research funding agencies (DFID and Wellcome Trust have supported this in Kenya and Malawi) (Chataway and Ochieng, 2017).
- Supporting the establishment of a pan-African funding platform.[13]
- Dialogue to encourage African nations to increase investment in R&D and to set their own research agendas, working alongside global partners (supported by the Coalition for Research and Innovation (CARI)).[14]
- Establishing the Indonesian Science Fund (DIPI) – a Government of Indonesia (GOI) commitment to fund multi-year, frontier research projects (Supported by the Knowledge Sector Initiative, KSI and USAID).[15]
- Supporting the Indonesian Academy of Sciences (AIPI) and the Ministry of Research Technology and Higher Education (Kemristekdikti) to produce a white paper on Science, Technology and Higher Education and the National Master Plan for Research (supported by KSI)(KSI, 2016).
- Supporting to AIPI in developing and disseminating 'SAINS 45' - a framework of critical research questions to inspire the scientific community and wider public (Supported by KSI) (KSI, 2016).

Governance and regulation

Examples of strategies to improve governance and regulation of research systems include:

[11] From http://www.unesco.org/new/en/media-services/single-view/news/forum_des_parties_prenantes_sur_lindex_africain_de_citation/

[12] See https://www.acu.ac.uk/focus-areas/research-management-uptake/research-management-process-benchmarking-programme/

[13] See https://wellcome.ac.uk/press-release/african-leaders-and-global-funders-endorse-new-science-funding-platform-africa

[14] see https://aesa.ac.ke/cari/coalition-for-african-research-and-innovation/

[15] See http://www.ksi-indonesia.org/en/news/detail/the-indonesian-science-fund-paving-the-way-for-indonesias-science--research

- Establishing or strengthening ethics review boards and national regulatory agencies through ethics capacity development support grants and ethics training grants (supported by NEPAD and EDCTP) (Enoch, 2015)
- Supporting the Pan African Clinical Trials Registry (PACTR) (Supported by NEPAD and EDCTP) (Enoch, 2015).
- Supporting the AIPI to develop a new code of conduct for research and standard operating procedures for research management, finance, governance and procurement (Supported by KSI) (KSI, 2016).
- Revising the law in Indonesia governing procurement of research by public bodies to enable government agencies to formally commission research when required and dialogue with the ministry of finance to reform the procedures for accounting for research funds in the public sector (Supported by KSI) (KSI, 2016).
- Building regulatory capacity and harmonising regulatory systems (such as the NEPAD-administered African Medicines Regulatory Harmonisation, which helps African countries and Regional Economic Communities to improve access to essential medicines) (Enoch and Thornton, 2015).

Managing and coordinating research

Examples to improve the management and coordination of research include:

- Developing a more coordinated approach to supporting research managers and research systems at higher education institutions (Supported by the Alliance for Accelerating Excellence in Science in Africa, AESA).[16]
- Supporting the development of professional associations for research management, particularly in LMICs (Supported by ACU).[17]
- Supporting the development of research management structures in five African universities (Supported by ACU).[18]
- Developing an innovative standard for the best practices in the management of funds awarded to grantees (Good Financial Grant Practice, GFGP, programme supported by AAS-AESA)
- Strengthening the ability of science granting councils (SGCs) to manage research, monitor programmes and conduct knowledge exchange and partnership activities (Supported by SGCI). [19]
- Improving the knowledge and skills of Granting Council staff to evaluate research impact, facilitate open data, establish policies for effective granting, and run research competitions (Supported by SGCI) (key informant interview, August 2018).

[16] See https://aasciences.ac.ke/programmes/easa/alliance-for-accelerating-excellence-in-science-in-africa-aesa/

[17] See https://www.acu.ac.uk/focus-areas/research-management-uptake/

[18] See https://www.acu.ac.uk/focus-areas/research-management-uptake/

[19] See https://sgciafrica.org/en-za/about-sgci/Pages/Research-Management.aspx

- Setting up a Funders Forum to facilitate conversation, dialogue, and exchange between developing country universities and the funders and other organisations that work with them (supported by the ACU).[20]
- Establishing an on-line platform to inform higher education institutions about research grant opportunities (Supported by Performing and Responsive Social Sciences, PERFORM in Albania and Serbia) (key informant interview, August 2018).
- Establishing a resource unit in a public research institute (on a pilot basis) to acquire and administrate research grants (Supported by PERFORM) key informant interview, August 2018).
- Establishing an alliance amongst policy research institutes to advocate for quality research, including collaboration for peer review processes, access to government data, amongst other things (Supported by KSI) (KSI, 2016).

Research leaders and centres of excellence

Examples to foster research leaders and establish/strengthen centres of excellence include:

- Awarding talented researchers fellowships/resources, to do important research, receive training and mentoring, and to network regionally and internationally (examples include the Obsanjo Prize for technological innovation from the AAS, FLAIRE fellowships from the Royal Society and the African Postdoctoral Training Initiative (APTI) (key informant interviews, August 2018).
- Pairing of top research talent from universities in developing countries with counterparts in developed countries, such as Canada to address key development challenges (Examples include IDRC's International Research Chairs Initiative) (key informant interview, August 2018)
- Increasing scientific collaboration between research leaders (Examples include the Science and Language Mobility Scheme Africa, the Africa-India Mobility Fund, AIMF) (key informant interview, August, 2018)
- Supporting centres of research excellence. Examples include the World Bank's African Higher Education Centres of Excellence (ACE) projects in West and Central Africa (ACE I) and Eastern and Southern Africa (ACE II) and; the Islamic Development Bank (IDB) support to COMSTECH, the Organisation of Islamic Cooperation's Science and Technology standing committee, to strengthen centres of research excellence across North and West Africa, the Middle East and South Asia. The IDB is also funding a programme to strengthen laboratory capacity in West Africa together with the French Development Agency and Fondation Mérieux, which is currently building research expertise on Ebola and other haemorrhagic fevers (Chataway and Ochieng, 2017; Enoch and Thornton, 2015).

Promoting interactions between key actors

This element has six units to it, which explore actions that:

1) Bring together researchers nationally, sectorally, regionally and/or internationally.
2) Bring together researchers and policymakers.

[20] https://www.acu.ac.uk/focus-areas/research-management-uptake/funders-forum

3) Support policymakers in government to reach out to other actors
4) Bring together researchers and representatives from the private sector and industry
5) Support the media to work with researchers
6) Facilitate the convening of multiple actors

Within the research sector (nationally, regionally, internationally)

Examples of actions that aim bring together researchers include:

- Developing a community of (300) researchers and (80) organisations within the country to amongst other things promote joint grant applications (PERFORM) (key informant interview, August 2018).
- Networking between research groups in Albania and counterparts in Western Europe and Albanian-speaking science diaspora (PERFORM) (key informant interview, August 2018).
- Supporting a thematic regional research network (on social protection policies) (PERFORM) (key informant interview, August 2018)
- Enhancing cooperation among African science academies (ASADI).[21]
- Supporting the formation of the Indonesian Association of Young Scientists (ALMI) providing a network of progressive and influential thought leaders able to set joint agendas to promote reforms and improve interaction between producers and users of knowledge (KSI) (KSI, 2016).
- Supporting networks of excellence across sub-Saharan Africa to encourage collaboration and good practice in clinical research, leveraging buy-in and financial support from African governments to ensure their long-term sustainability and local ownership (EDCTP) (Enoch and Thornton, 2016).
- Supporting collective action to improve access to research. In Sierra Leone, INASP brought together librarians, IT staff, researchers and research leaders, whilst in Ghana they facilitated discussions between three of the country's leading research centres, IT and library leaders.[22]
- Establishing regional networks of centres of excellence (such as the Southern African Network for Biosciences (SANBio) set up by NEPAD's Africa Biosciences Initiative).[23]

Between researchers and governments

Examples of actions that aim to bring together researchers and policymakers include:

- Linking researchers with policy institutions to promote research use (Performing and Responsive Social Sciences, PERFORM in Albania and Serbia) (key informant interview, August 2018).
- Supporting a research support centre to forge links with the Ministries of Health and Education and the Pharmacy, Medicines and Poisons Board in Malawi (CoMMAL project under the NACCAP programme, NWO-WOTRO) (Enoch and Thornton, 2015).

[21] See http://www.nationalacademies.org/asadi/2008WebSite/AboutASADIOverview.html

[22] See http://blog.inasp.info/collective-action-approach-research-capacity-building/

[23] See http://www.nepad.org/programme/southern-african-network-biosciences-sanbio

- Supporting the use of research in decision making by working with intermediary and policymaking organisations (DFID, INASP and other BCURE recipients).[24]
- Strengthening health ministries' capacity to use and share health research to improve regional public health (the RIMAIS initiative in Latin America funded by the Spanish aid agency AECID and EU-LAC) (Enoch and Thornton, 2015).
- Supporting policymakers to map their evidence needs (PERFORM) (Key informant interview, August, 2018).
- Supporting researchers to conduct studies for policymakers on priority issues (PERFORM) (Key informant interview, August, 2018).
- Improving relationships between science academies and governments to foster an appreciation of the value of evidence-based policy advice (ASADI). [25]
- Developing rigorous procedures for providing policy advice (ASADI). [26]
- Supporting the provision of science advice to governments and science-policy dialogue in developing countries by building a network of individuals and organisations able to provide advice and training and research oriented fellowships for researchers policymakers (IDRC-INGSA) (key informant interview, August, 2018).

Within government

Examples of actions which aim to improve the capacity of policymakers to reach out to other actors include:

- Strengthening partnerships between Science Granting Councils and other actors in the science systems (SGCI).[27]
- Supporting capacity development of policy analysts (seen as intermediaries or boundary spanners) in government agencies (KSI in Indonesia) (KSI, 2016).

Between researchers and the private sector

Examples of actions to bring together researchers and representatives from industry and the private sector include:

- Improving knowledge exchange with the private sector (SGCI).[28]
- Supporting industry-research linkages (IDRC support to AIMS) (key informant interview, August, 2018).
- Incentivising universities to work with the private sector, through e.g. joint calls with sectors outside the academic sector (IDRC) (key informant interview, August, 2018)..
- Linking small and medium sized enterprises to research (IDRC) (key informant interview, August, 2018)..

[24] See https://bcureglobal.wordpress.com/

[25] See http://www.nationalacademies.org/asadi/2008WebSite/AboutASADIOverview.html

[26] See http://www.nationalacademies.org/asadi/2008WebSite/AboutASADIOverview.html

[27] https://sgciafrica.org/en-za/about-sgci/Pages/Partnerships-and-private-sector-engagement.aspx

[28] See https://sgciafrica.org/en-za/about-sgci/Pages/Partnerships-and-private-sector-engagement.aspx

Between researchers and the media

Examples of actions that bring together the media and researchers include:

- Working with the media to promote more evidence-informed public debate on policy issues and raise awareness of the importance of using evidence in making policy decisions (KSI) (KSY, 2016).
- Building the capacity of science journalism (AESA).[29]

Between multiple actors

Examples of actions that aim to facilitate multi-stakeholder interaction include:

- Promoting policy debate on social protection issues with governments and civil society at a regional level – through research and a conference (PERFORM) (key informant interview, August 2018).
- Supporting policy dialogue (through knowledge cafes) amongst, think tanks and academia who produce research policy makers who use research, and the media who communicate the policy implications to the public to discuss the evidence base around particular policies (INASP in Zimbabwe).[30]
- Establishing knowledge communities to tackle policy issues collectively. In Indonesia, three knowledge communities were convened in the following areas: research and higher education, bureaucratic reform and on Village Law implementation (KSI, 2016).

Support to women and gender mainstreaming

Examples of actions that aim to improve the role of women researchers and mainstream gender into the 'research system' include:

- Building the capacity of women scientists (IDRC's Early Career Women Scientists (ECWS) fellowships in partnership with UNESCO's Organisation for Women in Science for the Developing World (OWSD) and SIDA).[31]
- Building peer networks of women within institutions, countries and regions to enable and facilitate change and connecting change agents (INASP).[32]
- Promoting dialogue about gender gaps in academia and research (INASP). [33]
- Encouraging the integration of gender into government policies (INASP).[34]

[29] See https://www.aasciences.ac.ke/aesa/en/about/news/aas-provides-funding-to-build-africas-science-journalism-capacity/

[30] See http://blog.inasp.info/evidence-informed-policymaking-zimbabwe-challenges-successes-opportunities/

[31] See https://www.idrc.ca/en/news/call-new-owsd-fellowships-early-career-women-scientists-now-open

[32] See https://www.inasp.info/theme/gender-and-equity

[33] See https://www.inasp.info/theme/gender-and-equity

[34] See https://www.inasp.info/theme/gender-and-equity

4. Key actors with a focus on Africa

This section is in three parts. The first part lists the key funders and international organisations/agencies with an interest in strengthening research systems in sub-Saharan Africa. The second part lists actors who either do or could potentially have a role in strengthening research systems in sub-Saharan Africa either at a policy or delivery level. The third part describes key projects, programmes, partnerships and platforms, which in some way contribute to the strengthening of research systems in sub-Saharan Africa.

Funders and international organisations

The number of funders supporting the enabling environment for research in sub-Saharan Africa is relatively modest (Chataway and Ochieng, 2017). Jones et al. (2007) found few funders focussed on system-level capacity strengthening. A more recent study, based on a rapid mapping exercise and conducted by UKCDS, identifies only 10 actors for whom the environmental or 'systems' level was a primary or secondary priority compared to 40 and 35 actors who prioritised organisational and individual levels respectively (UKCDS, 2015).

Almost no funders saw Research Capacity Strengthening (RCS) at the environmental level as their priority focus. Several funders such as Danida see environmental RCS as a secondary priority, and many contribute indirectly through their support to multilateral organisations or initiatives that support RCS at the environmental level (UKCDR, 2015). In addition, compared to institutional or organisational level schemes, the amounts of money flowing into the environmental level appear relatively small and are often parts of larger programmes rather than standalone initiatives (Chataway and Ochieng, 2017).

Based on interviews with key informants, a review of websites and relevant grey literature, the following international organisations/agencies have provided or are providing funding/support either directly or indirectly towards improving research systems or the research environment in sub-Saharan Africa::

- Association of Commonwealth Universities (ACU)
- Agence Universitaire de la Francophonie (AUF)
- Bill and Melinda Gates Foundation
- Carnegie Corporation of New York
- European Commission (EC): according to Enoch (2015), under Framework Programme 7, the EC has funded several projects at the environmental/systemic level
- International Development Research Centre (IDRC)
- International Network for the Availability of Scientific Publications (INASP)
- National Institutes of Health
- Royal Society
- Swedish International Development Cooperation Agency/Department for Research Cooperation (Sida/SAREC). They are the co-chair of the ESSENCE group
- UK Department for International Development (DFID)
- United Nations Educational, Scientific and Cultural Organisation (UNESCO)
- Wellcome Trust

- World Bank

Formal policymaking and delivery actors and networks

The following policy and delivery organisations either play a role or could potentially do so to strengthen research systems in sub-Saharan Africa:

1. **Africa Centre for Evidence** is an international multi-disciplinary team, based at the University of Johannesburg, working across the continent. They have a track record for collaborative work with governments, universities and non-governmental organisations to promote evidence informed decision making. Amongst other initiatives, they provide the secretariat to the Africa Evidence Network.
2. **African Academy of Sciences (AAS)** is a pan African organisation that aims to drive sustainable development in Africa through science, technology and innovation. It has a mandate of pursuing excellence by recognising scholars and achievers; providing advisory and think tank functions for shaping the continent's strategies and policies; and implementing key science, technology and innovation programmes. The AAS is the only continental academy in Africa, enjoying the support and recognition of NEPAD and the African Union as well as several governments and major international partners.
3. **The African and Malagasy Council for Higher Education (CAMES): i**s an intergovernmental institution for integrating higher education systems made up of 17 Francophone African countries
4. **African Capacity Building Foundation (ACBF)** is the African Union's (AU) Specialised Agency for Capacity Development. It calls itself the "go-to institution for expert knowledge and human resources to facilitate the timely implementation of continental and national development agendas".
5. **African Centre for Technology Studies (ACTS)** is an Intergovernmental organisation founded in 1988 to pursue policy-oriented research to strengthen the capacity of African countries and institutions to harness science and technology for sustainable development.
6. **African Economic Research Consortium (AERC)** is a capacity building institution for the advancement of research and training to inform economic policies in sub-Saharan Africa. It produces high quality economic policy research, postgraduate training and policy outreach within a vast network of researchers, universities and policy makers across Africa and globally.
7. **African Institute for Development Policy (AFIDEP)** is an African-led, regional non-profit policy think tank established in 2010 to help bridge the gaps between research, policy and practice in development efforts in Africa.
8. **African Institute for Mathematical Sciences (AIMS)** is a pan-African network of centres of excellence for post-graduate training, research and public engagement in mathematical sciences. It enables Africa's brightest students to become innovators that propel scientific, educational and economic self-sufficiency.
9. **African Journals OnLine (AJOL)** is the world's largest online library of peer-reviewed, African-published scholarly journals
10. **African Network for Economics of Learning, Innovation, and Competence Building Systems** (AfricaLics) brings together scholars, researchers and policy analysts who study development, innovation, learning and competence building in an African context. The network provides networking opportunities and increases access to education to enhance economic and socially sustainable development in Africa. They provide these opportunities for scholars

through various activities including: conferences, PhDs, a visiting fellows programme for PhD students and post-doctoral researchers and dedicated online networking platforms.

11. **African Observatory for Science, Technology and Innovation (AOSTI)** champions evidence-based policy-making by supporting African countries to manage and use statistical information in accordance with the African charter of statistics. AOSTI Innovation Outlook reports provide a series of quantitative indicators from which to understand the progress of countries in terms of research funding and the capacity of their STI systems.
12. **African Research Universities Alliance (ARUA)** aims to improve the quality of research done in Africa by African researchers.
13. **African Technology Policy Studies Network (ATPS)** is a trans-disciplinary network of researchers, policymakers, private sector actors and the civil society that promote the generation, dissemination, use and mastery of STI for African development, environmental sustainability and global inclusion
14. **African Union (AU)** has adopted the Science, Technology and Innovation Strategy for Africa (STISA) 2024 intended to guide the first ten years of action towards achieving Agenda 2063.
15. **Council for the Development of Social Science Research in Africa (CODESRIA)** is the pioneer African social research organisation but also as the apex non-governmental centre of social knowledge production on the continent.
16. **East African Science and Technology Commission (EASTECO)** was established to promote and coordinate the development, management and application of Science and Technology to support regional integration and socio-economic development in the East African Community.
17. **International Science Council (ISC)** is a non-governmental organisation with a unique global membership that brings together 40 international scientific Unions and Associations and over 140 national and regional scientific organisations including Academies and Research Councils.
18. **International Network for Government Science Advice (INGSA)** provides the forum for policy makers, practitioners, national academies, scientific societies, and researchers to share experience, build capacities, and develop theoretical and practical approaches to the use of scientific evidence in informing policy at all levels of government.
19. **New Partnership for Africa's Development (NEPAD)** is now well-established and continues to evolve in order to more effectively implement the AU's policies alongside other arms of the AU such as its longstanding Scientific Technical Research Commission (AU-STRC). NEPAD now exclusively focuses on the environmental level, supporting coordination to link up bilateral and multilateral arrangements. This represents a shift away from the approach under the Consolidated Plan of Action, which saw NEPAD take a project management role regarding centres of excellence.
20. **Organisation for Social Science Research in Eastern and Southern Africa (OSSREA**) is a research and capacity-building organisation whose mission is to promote dialogue and interaction between researchers and policy-makers in Eastern and Southern Africa with a view to enhancing the impact of research on policy-making and development planning.
21. **Organisation for Women in Science in the Developing World (OWSD)** is an international membership organisation that provides research training, career development and networking opportunities for women scientists throughout the developing world at different stages in their careers. Its programmes include postgraduate and early career fellowships and annual awards for research excellence.

22. **Partnership for African Social and Governance Research (PASGR)** is an independent, non-partisan pan-African not-for-profit organisation that supports the production and dissemination of policy relevant research; designs and delivers suites of short professional development courses for researchers and policy actors; and facilitates the development of collaborative higher education programmes.
23. **Southern Africa Innovation Support (SAIS) Programme** is a regional initiative set up to enhance innovation cooperation in Southern Africa by strengthening the national systems.
24. **Southern African Regional Universities Association (SARUA)** is a membership-based association of Vice-Chancellors of public and private universities in the Southern African Development Community (SADC).
25. **Southern African Research and Innovation Management Association (SARIMA)** promotes research and innovation management for the benefit of southern Africa through a cohort of SADC focal points. These focal points promote research and innovation management in collaboration with the South African Department of Science and Technology. It also manages and co-ordinates a growing portfolio of multilateral programmes and projects and provides a platform for the promotion and facilitation of best practice in research and innovation management in Southern Africa.
26. **West African Research and Innovation Management Association (WARIMA)** is a professional body for research management staff in the West African sub-region.

Projects, programmes, partnerships and platforms

The following are projects, programmes, partnerships and platforms which have been set up to strengthen research capacity in sub-Saharan Africa and provide at least some element of support at the 'systems' or environmental level.

African Science Academy Development Initiative (ASADI) was launched in 2004 by the U.S. National Academies and funded by the Bill & Melinda Gates Foundation. It lasted for ten years and strengthened the capability of African science academies to provide independent, evidence-informed advice to policymakers and the public on issues to do with improving human health.

Alliance for Accelerating Excellence in Science in Africa (AESA) is a platform created in 2015 by the AAS in collaboration with NEPAD. AESA is an agenda setting and funding platform to support the development of Africa's research leadership and promote scientific excellence and innovation to overcome some of Africa's developmental challenges. AESA is funded by DFID, the Bill & Melinda Gates Foundation and Wellcome Trust, and is headquartered in Nairobi, Kenya. Over the last two years, AESA has worked intensively with the support of the funders to develop robust and transparent grant management systems. AESA is managing both DELTAS and H3Africa programmes in partnership with the funders (see below).

ARCADE (African/Asian Regional Capacity Development) is an EC funded project which uses innovative educational technologies to strengthen research on health systems and services across Africa and Asia.

Building research capacity of blood transfusion services in Africa (T-REC) is an EC funded project which aims to build sustainable capacity for research in blood transfusion services in Africa.

Building Sustainable Research Capacity for Health and its Social Determinants in Low- and Middle-Income Countries (SDH-Net) in African and Latin American LMICs is an EC funded programme that has developed courses on theory and methods for studying the social determinants of health, as well as on research management and research communication necessary for conducting locally relevant research.

DELTAS Africa is a £60m research programme funded by Wellcome Trust and DFID. It was established to promote African-led development of research leaders and to support cutting-edge research aimed at tackling some of Africa's most pressing health challenges. Eleven consortia have been funded with an even distribution across East, West and Southern Africa (including three awards led from Francophone Africa).

ESSENCE on Health Research aims to increase the impact of support provided for research capacity strengthening for health in LMICs. It does so by allowing donors and funders to identify synergies, bring about coherence and increase the value of resources and actions for health research. ESSENCE is funded by Sida as a part of its support to TDR, the Special Programme for Research and Training in Tropical Diseases. It promotes policy dialogue, promotes harmonisation, instigates country pilots and provides support to evaluation.

European & Developing Countries Clinical Trials Partnership (EDCTP) scheme is scheduled to receive EUR 2 billion from the EC for its second phase. This scheme combines a focus on strengthening ethical and regulatory frameworks, funding networks of excellence, supporting research projects and training cohorts of scientists.

H3Africa is a major genomics programme that was established in 2012 to apply cutting-edge genomics techniques to diseases that are a health burden in Africa. The Wellcome Trust has made a £9m grant to AESA to run a second phase of the programme in partnership with the US National Institutes of Health (NIH).

Higher Education Research and Advocacy Network in Africa (HERANA) was established in 2008 with funding support from the US Foundation Partnership (Ford, Carnegie, Rockefeller and Kresge) and the Norwegian Agency for Research and Development (NORAD). The network was managed by the Centre for Higher Education Transformation (CHET) in South Africa and currently has more than 50 participating academics and university administrators from Africa, Europe and the US.

Partnership for Skills in Applied Sciences, Engineering and Technology (PASET) brings together African governments, the private sector, and new partners, such as Brazil, China, India, and Korea, to maximise investment in key sectors. While increasing the capacity of universities, research centres and technical and vocational education and training (TVET) centres to generate knowledge and create skilled workforces, researchers and innovators relevant to Africa's development challenges.

Strategic Partnerships for Higher Education Innovation and Reform (SPHEIR) is a DFID programme to support higher education transformation in sub-Saharan Africa, Asia and the Middle East. The programme is managed by a consortium of organisations, led by the British Council in association with PwC and Universities UK International (UUKi). The programme aims to transform the quality, relevance, scale, accessibility and affordability of higher education by catalysing and funding diverse, multi-faceted partnerships, which work collaboratively across different sectors and countries to deliver new and creative solutions to major issues facing higher education

Supporting the Use of Research Evidence (SURE) for Policy in African Health Systems is an EC funded project that aims to support the production of health research syntheses and uptake of these by appropriate policymakers. SURE builds on and supports the **WHO Evidence-Informed Policy Network (EVIPNet) in Africa** and the **Region of East Africa Community Health (REACH)** Policy Initiative.

Sustaining research momentum over the coming decades: mentoring the next generation of researchers for tuberculosis (TBSUSGENT) aims to sustain investigator and scientific capacity in developing countries, where tuberculosis burden is the highest, namely South Africa and India.

Science Granting Councils Initiative (SGCI) aims to strengthen the capacities of science granting councils in sub-Saharan Africa in order to support research and evidence-based policies that will contribute to the continent's economic and social development. The SGCI contributes to strengthening the ability of science granting councils to: manage research; design and monitor research programmes based on the use of robust science, technology and innovation indicators; support knowledge exchange with the private sector and strengthen partnerships between Science Granting Councils and other science system actors. SGCI is funded by IDRC, DDID and the South African National Research Foundation (NRF).

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