

Supplementary Table 1: Scoping review results

Characteristics	Enablers	Barriers	Behaviours
<ul style="list-style-type: none"> • Need for achievement • Desire for independence • Personality • Entrepreneurial attitude • Internal locus of control • Extraversion • Self-esteem • Knowledge • Business / Marketing acumen • Ability • Aptitude • Entrepreneurial experience • Motivation • Resilience • Openness to suggestions / criticism • Hunger for success • Creativity 	<ul style="list-style-type: none"> • Entrepreneurship incentives (financial and academic status) • Generous intellectual property policies • Local knowledge promotion • A functional research platform • Foreign collaboration • Strong regulatory systems • Ability to work in groups to solve complex problems • To form entrepreneurial teams • Funding resources • Workforce resources • Entrepreneurial ecosystem • Donor funding • Venture capital funding 	<ul style="list-style-type: none"> • Difficulties establishing a new business • Poorly implemented government science and technology policy • Low government expenditure on science and technology research • Lack of government incentives for joint university and business research collaboration • Import substitution industrialisation policies • Reliance on imported solutions to local problems • Restrictive trade barriers • Poor socioeconomic context • High-technology 	<ul style="list-style-type: none"> • Engagement in translational research • Publications • Academic position in university • Awareness of technology transfer • Prior industry work experience • Academic reputation • Collaboration with industry • Research funding • Supervising post-graduate students • Research workload in relation to total workload

Characteristics	Enablers	Barriers	Behaviours
<ul style="list-style-type: none"> • Innovation • Leadership ability • Futuristic thinking 		<p>challenges</p> <ul style="list-style-type: none"> • Research skills shortages • Role definition challenges with industry partners • Fragmented environment / economy • Poor / weak entrepreneurial ecosystem • Crime • Full burden of commercialisation placed onto individual researchers • Institutional factors (poor reward systems for innovation, absence of collaboration with private sector) 	

Supplementary Table 2: Round 1 unranked consensus opinions on Characteristics, Enablers, Barriers, and Behaviours related to Entity academic entrepreneurship

Characteristics (Question 1)	Enablers (Question 2)	Barriers (Question 3)	Behaviours (Question 4)
<ul style="list-style-type: none"> • Perseverance and resilience • Displays professional confidence • Building collaborative relationships • Calculated chance-taker • Curious and intellectually adventurous • Creates and innovates • Research competence • Acts ethically, applies ethical judgement, displays honesty and personal integrity • Drive for results (includes ambition) • Networking and connecting • Coaches and 	<ul style="list-style-type: none"> • Networks and collaborators • Reduced Bureaucracy • Organisation brand (Entity) • Wide and varied funding options • Research infrastructure • Seed funding • Association with a prestigious university • Manageable balance between research, clinical, administration and teaching obligations • Available and willing experienced mentors • Values intellectual independence and freedom • Entrepreneurial organisation 	<ul style="list-style-type: none"> • Lack of appreciation for the work of the science leader • Financial sustainability of Entities • Limited funding opportunities – low success rate • Bureaucracy • Inefficiencies when both the Wits and the Consortium are involved as parties to the contract • Shortage of discretionary funds for ongoing, unfunded activities • Non-responsive shared services support • Innovation not valued or prioritised internally • Finding and employing 	<ul style="list-style-type: none"> • Communicate effectively • Manage teams effectively • Be determined and tenacious • Demonstrate leadership ability • Manage projects with discipline • Publish in order to develop reputation • Take risks mindfully • Acts with courage • Identify, choose and master academic niche area • Work hard and consistently • Be open-minded about opportunity and ideas • Act with integrity and be trustworthy in

Characteristics (Question 1)	Enablers (Question 2)	Barriers (Question 3)	Behaviours (Question 4)
<p>mentors</p> <ul style="list-style-type: none"> • Decision to lead • Programme and project management • Displays wide-ranging expertise • Big picture, holistic and connective thinking • Engages and empowers • Anticipating and managing change • Social activism • Displays entrepreneurial leadership • Applies a design-thinking mindset • Focused for sustained periods • Realistic 	<p>culture</p> <ul style="list-style-type: none"> • Administrative and operational training and support • Works as part of an established unit • Structured systems and operating procedures • Aligned research team with complimentary skills mix • Early and frequent publication • Experience of and compliance with funder administrative requirements • Early success • Strong Entity leadership • Clear and valued benefits from research • Appropriate rewards and 	<p>talented staff</p> <ul style="list-style-type: none"> • Inefficient research regulatory environment • Academic politics • Even though the Consortium is wholly owned by Wits it operates according to its own rules with the risk of misalignment • Lack of business and operational advisory support • Increasingly complexity of research environment • Organisational growth expectations are relentless • Inadequate academic credentials • Organisational limitations on remuneration levels • Departmental and 	<p>relation to other research leaders</p> <ul style="list-style-type: none"> • Act to influence people and situations • Support, value and reward innovation • Align and work with the best, collaborate with those you admire the most • Think independently, beyond current constraints • Prioritise personal development and make use of opportunities • Acts with optimism • Act with humour, be prepared to smile and laugh • Maintain a steady, functional and calm work environment • Assist others regarding how to

Characteristics (Question 1)	Enablers (Question 2)	Barriers (Question 3)	Behaviours (Question 4)
	incentives <ul style="list-style-type: none"> • Access to information • Presence of compelling career path • Gender sensitive organisation support 	teaching workload compromises time available for research activities <ul style="list-style-type: none"> • Institutional culture preferring conformity over independent thinking and entrepreneurialism • Competition from within Wits or from other universities • Inappropriate conflicts of interest • An organisational environment apparently lacking in values, principles and accountability • Inaccessible role models or mentors • Lack of motivation • Lack of leadership support • Opaque administrative and operational organisational 	work with the Consortium

Characteristics (Question 1)	Enablers (Question 2)	Barriers (Question 3)	Behaviours (Question 4)
		<p>processes</p> <ul style="list-style-type: none"> • Clashes of ideas and duplicated work • Paucity of South Africans wanting to collaborate as there is a preference for international collaborations • Entity leadership directs opportunities to be pursued, at times without regard for skill set realities or staff preference • Too many big and small obstacles • The Wits name, as a powerful brand, can dissuade other South African institutions from working with us • Paucity of entrepreneurial training for academics • Establishing individual credibility is incredibly difficult and time 	

Characteristics (Question 1)	Enablers (Question 2)	Barriers (Question 3)	Behaviours (Question 4)
		consuming <ul style="list-style-type: none"> • Funds are controlled by the Consortium and not the Entity • The Consortium is not fit for purpose • Closed networks • It takes too long to establish an Entity in the Consortium • Organisational leadership is inaccessible • Inadequate support or guidance for young female scientists • Registry of collaborators and networks not available 	

Supplementary Table 3: NGT: Summary of discussion

Challenges	Solutions
<p><u>Professional Aloneness</u></p> <ul style="list-style-type: none"> • Entity leadership feel alone and isolated. • Pressure for the establishment, maintenance, and growth of the Entity rests solely with the Entity leader, irrespective of growth maturity stage. • “Whatever the Entity size, the director is always visibly responsible”; they shoulder a lot, from strategic direction and capacity to adapt as requirements change, to operational escalations, from finance and funding to staff issues and a wide range of other tactical challenges. • Pressure of unrealistic growing expectations from Wits and the Consortium placed solely on Entity leadership as the different stages in growth maturity are reached. • Challenges collaborating within Wits and the Consortium or with other local collaborators and institutions, trend is to international collaborations 	<ul style="list-style-type: none"> • Mentoring and coaching by more experienced peers would be beneficial and should be part of Wit’s programme. A different approach was required for junior Entity members (problem solving orientation) and Entity leadership (networking and collaboration development support). • Developing professional networks - Another solution to the issue of professional aloneness is the creation of networks of peers. Several study participants acknowledge their development of networks to have played a significant role in their own success. Regardless of the person’s own orientation towards, or away from collaboration and networking, it is seen as central to entrepreneurial success. Networking is as important as mentoring and the group recognised that there is strong institutional knowledge available between the group and other peers, but that there is no mechanism to share it. • Physical structure to enable collaboration – The group suggest that a shared meeting and eating area could help them connect and share ideas or experiences informally. • Network map - Some of the group suggested that a network map, showing their peers and their areas of focus might help with the process of connecting and networking.
<p><u>Busyness or Workload</u></p> <ul style="list-style-type: none"> • Entity Directors over-stretched. The panel describe perpetual busyness; being flooded with expectations of delivery, 	<ul style="list-style-type: none"> • Personal administration support - One of the solutions discussed was for Entity leaders to receive personal administrative

Challenges	Solutions
<p>personal involvement and decision-making, as a key barrier to effectiveness.</p> <ul style="list-style-type: none"> • Virtually all of the group experienced being underfunded and in the context of busyness, they describe having no time to prioritise important non-funded tasks. 	<p>support around activities such as “National Research Foundation (NRF) self-ratings, submitting to publications, yearly reports... some admin help would be valuable. None of us have NRF rankings because it just takes too much time”</p> <ul style="list-style-type: none"> • Project management support and training - Entity leaders considered that they would benefit from specific project management skills development. Although there is a project management module available as a masters course component, it would be valuable to project leaders in a more flexible and specific form
<p><u>Shared Services Support</u></p> <ul style="list-style-type: none"> • Entity leaders describe a generally positive relationship between them, and the Consortium’s Shared Services Centre. • There were requirements for extensions to the services offered • Criticisms of current service levels, particularly with regard to routinely occurring operational mistakes. • Insufficient funding was used by the group to explain why they felt the Consortium was unable to successfully address operational issues. 	<ul style="list-style-type: none"> • Additional operational services - The following additional services were suggested: “the SSC should offer a non-technical grant writing support service (methodology, resources, tools). A library of biographies, budgeting tools, and online access to all of the documents required to support a grant application. A library of previous applications with cut and paste sections for inclusion in new applications would help”. • Expansion of shared support services beyond administration and grants management. • Increase funding to the Shared Services Centre - “SSC needs more funding to move from reactive to proactive: they are overwhelmed, they keep making the same mistakes.” • Entities getting closer to their own grants - Empowering Entities to manage their own grants more closely; calling for Entity leaders to be given more real-time

Challenges	Solutions
	<p>access to information about their grants without always going through the shared service centre.</p> <ul style="list-style-type: none"> • The Consortium as a funder – The group raised the idea of the Consortium raising a fund and operating as a funder of research and researchers along similar lines as The National Institutes of Health.
<p><u>Wits structure relative to the entrepreneurial requirements of the Entities</u></p> <ul style="list-style-type: none"> • Difficulties working with the differing policies and procedures of Wits and the Consortium where projects span both organisations. • The group recognised the need for a level of governance and control by Wits, but they were unanimous in describing how its rules are not aligned to the manner in which Entities operate; and are often considered stifling and bureaucratic. • Difficulties accessing funding generated through Entity activity but earned into Wits. A specific barrier was noted involving the required use of university-approved vendors, who the Entities did not typically use in the Consortium. Wit’s policy concerning research incentive (RINC) funding was discussed as a challenge. This includes revenues generated by a department as an award for publications or for graduating student supervision which goes directly to Wits. The rules for Entities accessing these funds are considered onerous. 	<ul style="list-style-type: none"> • Adapt the treatment of RINC funding - RINC funds should be allocated to Entity leaders’ discretionary accounts centre in the Consortium.
<p><u>General Funding Constraints</u></p> <ul style="list-style-type: none"> • There is unanimous acknowledgement that Entity leaders work in a resource-constrained environment. This impedes Entity development with regards to 	<ul style="list-style-type: none"> • Lobbying for additional discretionary funding - The group voiced a need for a mechanism to lobby for increased overhead support from international

Challenges	Solutions
<p>limited funding for non-project related programmes. The grant funding structures are restricted to the achievement of the contracted obligations and there are limited options for leveraging to build the Entity and teams.</p> <ul style="list-style-type: none"> • Lack of institutional funding to support Entities. • Funding needs evolve but securing such remains a challenge irrespective of Entity maturity stage – however being a well-known brand does mean that opportunities are more available than when in an earlier growth phase. 	<p>fundors; this would alleviate strain from Entity directors.</p> <ul style="list-style-type: none"> • The Consortium as a funder – The group raised the idea of the Consortium raising a fund and operating as a funder of research and researchers along similar lines as The National Institutes of Health. • Mentoring with specific reference to funding - Particular mentoring by experienced people around issues of funding and accessing funding specific to the Entity’s tactical and strategic needs.
<p><u>Growth as a Challenge</u></p> <ul style="list-style-type: none"> • The group spoke about the irony of how growth through spawning new Entities often means the loss of key people and talent. It can also mean the loss of funding attached to their projects and contacts or networks. Spawning is seen as a common, if not inevitable consequence of growth and Entity maturity. Spawning “looks like success if you are part of the newly formed entity, but it feels like a failure if you are left amongst the remaining team, with a loss of colleagues and a loss of funding”. There is a reality that break-away units create more competition for the same sources of funding. 	<ul style="list-style-type: none"> • Organisational adaptability - “Organisations (Entities) need to be adaptive to accommodate the changing needs of maturing researchers so that they don’t leave to start spin-offs.”
<p><u>Wits as Commercial Entity</u></p> <ul style="list-style-type: none"> • Universities are not established as corporate entities and the common structures within, and which support, corporate structures are absent in universities. • Not much attention given to developing a 	<ul style="list-style-type: none"> • Need to consider establishing structures that support a commercially oriented university (such as customer relationship management, business development and specialist resources to drive initiatives such as business analysts).

Challenges	Solutions
<p>commercial approach in universities nor how academics understand commerciality.</p> <ul style="list-style-type: none">• The above hinders entrepreneurial growth in an increasingly competitive landscape.	

Supplementary Table 4: Study Participant Profile

Academic Position	School / Department	Academic Discipline	Age Range	Sex	Journal Articles - Dec 2021	Attended Workshop
Professor	Department of Molecular Medicine and Haematology	Pathology	50 - 59	M	> 200	
Professor	School of Clinical Medicine	Paediatrics and Child Health	50 - 59	M	100 - 200	
Professor	School of Public Health	Health Economics	60 - 69	F	50 - 99	
Professor	Wits Research Institute for Malaria	Malaria Vector Biology	50 - 59	F	100 - 200	Yes
Professor	School of Clinical Medicine	Infectious Diseases	50 - 59	M	> 200	Yes
Reader	Wits Reproductive Health and HIV Institute	Clinical Trials	40 - 49	F	100 - 200	
Associate Professor	Department of Family Medicine and Primary Care	Family Medicine	50 - 59	M	< 50	
Professor	Department of Paediatrics and Child Health	Noncommunicable Diseases	50 - 59	F	100 - 200	Yes
Professor	School of Public Health	Public Health	60 - 69	M	> 200	Yes
Professor	Department of Paediatrics and Child Health	Paediatrics and Child Health	50 - 59	F	100 - 200	
Associate Professor	Department of Paediatrics and Child Health	Medicine	40 - 49	M	50 - 99	Yes
Professor	Department of Obstetrics	Infectious Diseases	70 - 79	F	100 - 200	Yes

Academic Position	School / Department	Academic Discipline	Age Range	Sex	Journal Articles - Dec 2021	Attended Workshop
	and Gynaecology					
Scientific Coordinator	Wits-African Leadership in Vaccinology Expertise Consortium	Vaccinology	50 - 59	F	100 - 200	Yes
Professor	School of Public Health	Public Health	60 - 69	F	> 200	Yes
Medical Doctor	School of Clinical Medicine	Clinical Governance	60 - 69	M	< 50	Yes
Director	Office of the Deputy Vice Chancellor: Research and Innovation	Research Development	60 - 69	M	< 50	Yes
Professor	Department of Surgery	Surgery	60 - 69	M	50 - 99	Yes
Professor	School of Physiology	Endocrinology	60 - 69	M	< 50	Yes
Professor	Department of Internal Medicine	Oncology	60 - 69	M	100 - 200	
Professor	Centre of Excellence for Biomedical TB Research	Microbiology	40 - 49	M	50 - 99	
Professor	Department of Paediatrics and Child Health	Medicine	50 - 59	M	100 - 200	Yes
Professor and Assistant Dean	Faculty of Health Sciences	Molecular Research	50 - 59	F	> 200	Yes
Medical Doctor	School of Public Health	Health Economics, Policy & Systems	40 - 49	M	< 50	Yes

Academic Position	School / Department	Academic Discipline	Age Range	Sex	Journal Articles - Dec 2021	Attended Workshop
Medical Doctor	Department of Paediatrics and Child Health	Public Health and Psychology	40 - 49	F	< 50	
Senior Lecturer	Health Economics and Epidemiology Research Office	Health Economics	50 - 59	F	< 50	Yes
Professor	Department of Obstetrics and Gynaecology	Obstetrics and Gynaecology	60 - 69	F	100 - 200	Yes
Professor	Department of Internal Medicine	Endocrinology and Metabolism	60 - 69	M	> 200	
Senior Researcher	Faculty of Health Sciences	Health Economics	50 - 59	M	< 50	Yes
Emeritus Professor	School of Therapeutic Sciences	Therapeutic Sciences	70 - 79	M	100 - 200	
Medical Doctor	School of Public health	Noncommunicable Diseases	50 - 59	F	50 - 99	Yes
Associate Professor	School of Public Health	Biostatistics and Epidemiology	50 - 59	M	50 - 99	