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Appendix A. Research project questionnaires

A.1 First research project questionnaire

STUDY OF THE NANOTECHNOLOGY SYSTEM IN SOUTH AFRICA
by

DERRICK VAN DER MERWE

QUESTIONNAIRE

Part of a research project submitted in partial fulfilment of the requirements for the degree of

MASTER OF TECHNOLOGY MANAGEMENT

in the

FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

UNIVERSITY OF PRETORIA

May 2004

Contact details
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Please fill in the following information

Name of Participant _____

Field of Nanotechnology interest

Employer _____

_____

Introduction

The purpose of the questionnaire is to identify possible opportunities for and threats to South African nanotechnology initiatives, through the identification of future nanotechnology actors, products, services, industries and factors hampering innovation. The aim is to gain information on the South African nanotechnology system and devise a possible innovation strategy for South Africa to consider.

Results from the first questionnaire will be analysed and returned to the panel of experts. Interesting and abnormal answers can then be discussed further (via E-mail or telephone) and elaborated upon in the second (and possible third) iteration. The questionnaire will take a maximum of 15 minutes to complete. Results will be readily available to the panel of experts.

No questions are asked in this questionnaire concerning the current state of nanotechnology in South Africa – this will be the goal of future baseline questionnaires by the South African Nanotechnology Initiative (SANi). Selective information from these questionnaires and other secondary data sources will be used in the Master's research project.

Seven nanotechnology segments and their applications were considered for the questionnaire. These segments were accumulated through a number of literature reviews and by no means incorporate the full breadth of nanotechnology in the future:

1. Tools (microscopy, techniques, tools, techniques, etc.)
2. Raw materials (catalysis, biocompatible materials, coatings and protective creams, etc.)
3. Structures (nanocapsules, nanofilters, quantum dots, branched polymers, etc.)
4. Nanotubes and fullerenes (Buckeyballs)
5. Devices and Systems (bio-sensors, detectors, drug delivery systems, electro-mechanical systems, etc.)
6. Intelligent materials (sense external stimuli and altering properties)
7. Machines (molecular machines, assemblers, nanobots etc.

Please tick the best answer – the grey area may be edited in Microsoft Word

For example – How many segments have been identified?

5	6	7	8
☐	☐	☒	☐

Now try to answer this first question by choosing the best answer

Do you agree with the nanotechnology segments chosen?

Yes	No
☐	☐

Nanotechnology segments

1. How long before these nanotechnology segments start replacing the majority of other technologies in current applications, or create completely new technology applications?

	Now	1-5 years	5-10 years	10-15 years	15-20 years
a. Tools	☐	☐	☐	☐	☐
b. Raw materials	☐	☐	☐	☐	☐
c. Structures	☐	☐	☐	☐	☐
d. Nanotubes and Fullerenes	☐	☐	☐	☐	☐
e. Devices and Systems	☐	☐	☐	☐	☐
f. Intelligent materials	☐	☐	☐	☐	☐
g. Machines	☐	☐	☐	☐	☐
h. Other:	☐	☐	☐	☐	☐

2. What is the market potential during the next 15 years for these nanotechnology segments – in terms of size and timing on return of investment, sustainable market growth, etc.?

	None	Small	Medium	Big	Huge
a. Tools	☐	☐	☐	☐	☐
b. Raw materials	☐	☐	☐	☐	☐
c. Structures	☐	☐	☐	☐	☐
d. Nanotubes and Fullerenes	☐	☐	☐	☐	☐
e. Devices and Systems	☐	☐	☐	☐	☐
f. Intelligent materials	☐	☐	☐	☐	☐
g. Machines	☐	☐	☐	☐	☐
h. Other:	☐	☐	☐	☐	☐

3. How disruptive are these nanotechnology segments the next 15 years to other known and familiar technologies? (What role will nanotechnology assume in relation to the technology it ultimately replaces or complements?)

	No change	Support	Complement	Control	Replace
a. Tools	☐	☐	☐	☐	☐
b. Raw materials	☐	☐	☐	☐	☐
c. Structures	☐	☐	☐	☐	☐
d. Nanotubes and Fullerenes	☐	☐	☐	☐	☐
e. Devices and Systems	☐	☐	☐	☐	☐
f. Intelligent materials	☐	☐	☐	☐	☐
g. Machines	☐	☐	☐	☐	☐
h. Other:	☐	☐	☐	☐	☐

4. How complex are these nanotechnology segments to perform basic and applied research on, design, manufacture and market to a potential market? (Keep in mind the nanotechnology segments in relation to each other in terms of knowledge, time, skills, general public's perceptions, etc. needed)

	Not complex	Not relatively complex	Relatively complex	Complex	Very complex
a. Tools	☐	☐	☐	☐	☐
b. Raw materials	☐	☐	☐	☐	☐
c. Structures	☐	☐	☐	☐	☐
d. Nanotubes and Fullerenes	☐	☐	☐	☐	☐
e. Devices and Systems	☐	☐	☐	☐	☐
f. Intelligent materials	☐	☐	☐	☐	☐
g. Machines	☐	☐	☐	☐	☐
h. Other:	☐	☐	☐	☐	☐

5. Do you have any comments on the above questions?

Innovation hampers

6. How much does each of the following factors hamper nanotechnology innovation in South Africa – by creating for instance uncertainty in investors?

	None	A little	Some	A lot	A great deal
a. Knowledge gap (Lack of information)	☐	☐	☐	☐	☐
b. Technology development (Disruptiveness and unfamiliarity)	☐	☐	☐	☐	☐
c. Lack of tools, equipment and techniques (Microscopes, simulation, etc.)	☐	☐	☐	☐	☐
d. Lack of qualified personnel (Insufficient training)	☐	☐	☐	☐	☐
f. Costs involved (Estimated costs too high)	☐	☐	☐	☐	☐
g. Uncertainty of net economic effect (Breadth, growth and impact of nanotechnology unsure)	☐	☐	☐	☐	☐
h. Insufficient funding (Lack of appropriate government or other external funding)	☐	☐	☐	☐	☐
i. Time to commercialisation (Too long estimated investment return periods)	☐	☐	☐	☐	☐
j. Regulations (Governmental or other legal restrictions)	☐	☐	☐	☐	☐
k. Supplier/Buyer adoption rates (When to switch from known products to new Nanoproducts)	☐	☐	☐	☐	☐
l. Technology replacement (Potential for other newer Nanoproducts to replace existing Nanoproducts)	☐	☐	☐	☐	☐
m. Lack of collaborations (Relationships between innovative organisations and other institutions)	☐	☐	☐	☐	☐
n. Other factors.....	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐

7. Do you have any comments on the above questions?

Nanotechnology actors

In the future, local and international nanotechnology buyers, suppliers, competitors, investors and research partners will emerge.

8. Do you agree that markets in these locations will be important **buyers** of nanotechnology for the next 15 years? (Consider buying power, size of the market, etc.)

	Disagree	Slightly disagree	No opinion	Slightly agree	Agree
a. Local	☐	☐	☐	☐	☐
b. Other African countries	☐	☐	☐	☐	☐
c. Europe	☐	☐	☐	☐	☐
d. North America	☐	☐	☐	☐	☐
e. South America	☐	☐	☐	☐	☐
f. Asia	☐	☐	☐	☐	☐
g. Australia and New Zealand	☐	☐	☐	☐	☐

9. Do you agree that manufacturers in these locations will be important **suppliers** of nanotechnology for the next 15 years? (Consider current national strategies, breadth of potential industries, availability of resources, etc.)

	Disagree	Slightly disagree	No opinion	Slightly agree	Agree
a. Local	☐	☐	☐	☐	☐
b. Other African countries	☐	☐	☐	☐	☐
c. Europe	☐	☐	☐	☐	☐
d. North America	☐	☐	☐	☐	☐
e. South America	☐	☐	☐	☐	☐
f. Asia	☐	☐	☐	☐	☐
g. Australia and New Zealand	☐	☐	☐	☐	☐

10. Do you agree that institutes in these locations will be important **competitors** in the nanotechnology global economy for next 15 years? (Consider the size and amount of potential competitive organisations and industries, etc.)

	Disagree	Slightly disagree	No opinion	Slightly agree	Agree
a. Local	☐	☐	☐	☐	☐
b. Other African countries	☐	☐	☐	☐	☐
c. Europe	☐	☐	☐	☐	☐
d. North America	☐	☐	☐	☐	☐
e. South America	☐	☐	☐	☐	☐
f. Asia	☐	☐	☐	☐	☐
g. Australia and New Zealand	☐	☐	☐	☐	☐

11. Do you agree that South Africa will have strong **relationships** with partners (private or public institutes) located in these areas in the nanotechnology global society for the next 15 years? (Consider countries with similar interests than South Africa or current good bonds with South Africa)

	Disagree	Slightly disagree	No opinion	Slightly agree	Agree
a. Local	☐	☐	☐	☐	☐
b. Other African countries	☐	☐	☐	☐	☐
c. Europe	☐	☐	☐	☐	☐
d. North America	☐	☐	☐	☐	☐
e. South America	☐	☐	☐	☐	☐
f. Asia	☐	☐	☐	☐	☐
g. Australia and New Zealand	☐	☐	☐	☐	☐

12. Do you have any comments concerning any of these relationships – for instance do you feel that the importance of a location could change significantly as time progresses or radically between nanotechnology segments?

Nanotechnology strengths, weaknesses, opportunities and threats

13. What do you perceive as the most important strengths and weaknesses of South African nanotechnology industries and tertiary institutions focussing on nanotechnology research activities?

a. Strengths

b. Weaknesses

14. What do you perceive as the biggest opportunities and threats for South African nanotechnology industries and tertiary institutions focussing on nanotechnology research activities?

a. Opportunities

b. Threats

15. Please, feel free to comment on this research project (maybe some questions regarding the research objectives or sources) or questionnaire (maybe some questions were not clear)

PLEASE REMEMBER

Please make sure that you **SAVE** the answers you entered and E-mail the Word document to dlvdm@tuks.co.za or print the document and fax it to (012) 362 5307. Address any faxes to Derrick van der Merwe.

If you have you any questions you can contact me via E-mail at dlvdm@tuks.co.za or cell phone at +2782 629 8807

A.2 Second research project questionnaire (feedback form)

STUDY OF THE NANOTECHNOLOGY SYSTEM IN SOUTH AFRICA
by

DERRICK VAN DER MERWE

QUESTIONNAIRE

Part of a research project submitted in partial fulfilment of the requirements for the degree of

MASTER OF TECHNOLOGY MANAGEMENT

in the

FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

UNIVERSITY OF PRETORIA

July 2004

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Mobile number: 082 629 8807
Fax number: (012) 362 5307

Please fill in the following information
Name of Participant _____

Thank you for all your time and effort. Note that all the graphs are based on the averages of the answers provided, and they are by no means faultless...but do provide the general trends and indicate the majority perception of the expert panel. The standard deviation and frequency tables of the data have not been included.

1 Feedback from previous questionnaire

1.1 Nanotechnology segments

As you may remember the time to market (from now = 1 to 20 years = 5), the market potential (from no potential = 1 to huge potential = 5), disruptiveness (from no change = 1 to total replacement = 5) and complexity (from not complex = 1 to very complex = 5) for seven different nanotechnology segment were asked. The graph below illustrates these results.

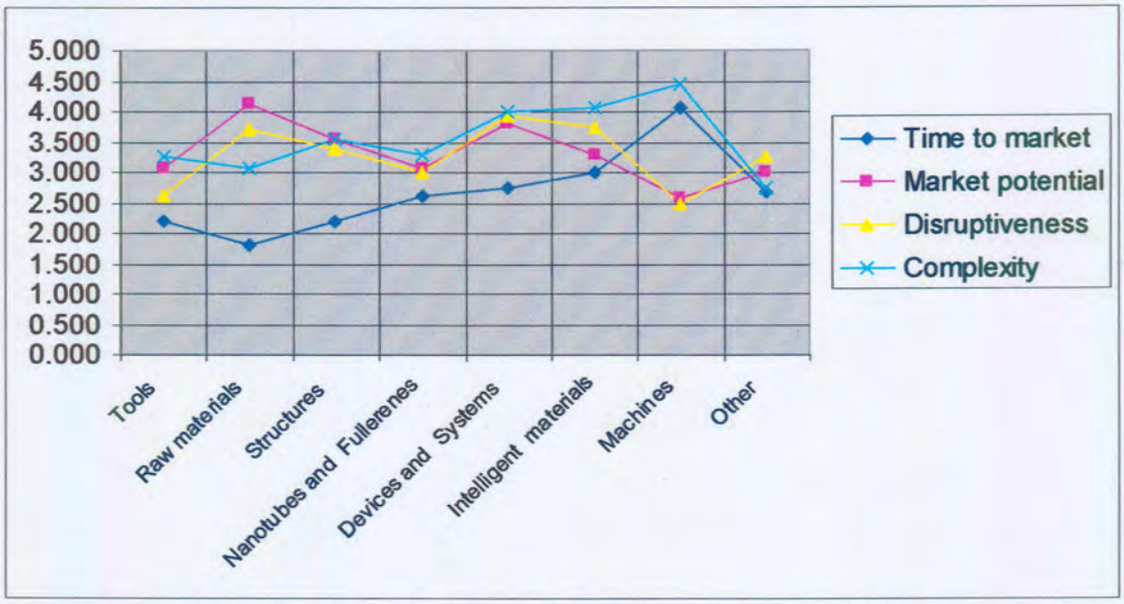

Figure 1-1. The time to market, market potential, disruptiveness and complexity of seven identified nanotechnology segment.

Nanotechnology is extremely diverse with many different definitions, segmentations, groupings and perspectives. The goal is to try and establish some relationship between and estimations of the time to market, market potential, disruptiveness and complexity. Already some evidence suggests that time-to-market and complexity is linearly related. Below are 3 questions, which are optional, but could be helpful to my study.

How much skilled **human** resources are needed to fully research, develop, manufacture, market and sell each of these nanotechnology segments?

	Nothing	Small	Medium	Large	Huge
a. Tools	☐	☐	☐	☐	☐
b. Raw materials	☐	☐	☐	☐	☐
c. Structures	☐	☐	☐	☐	☐
d. Nanotubes and Fullerenes	☐	☐	☐	☐	☐
e. Devices and Systems	☐	☐	☐	☐	☐
f. Intelligent materials	☐	☐	☐	☐	☐
d. Machines	☐	☐	☐	☐	☐
e. Other:	☐	☐	☐	☐	☐

What is the current and future role (influence) of venture capital and government incentives in the research, development, manufacturing, marketing and selling of each of these nanotechnology segments?

Do have any comments on the results of this first section or recommend any grouping, dividing or inclusion of other nanotechnology segments?

1.2 Innovation hampers

The graph below illustrates the innovation hampers standing in the path of nanotechnology development in South Africa (the scale is from none =1 to great deal = 5).

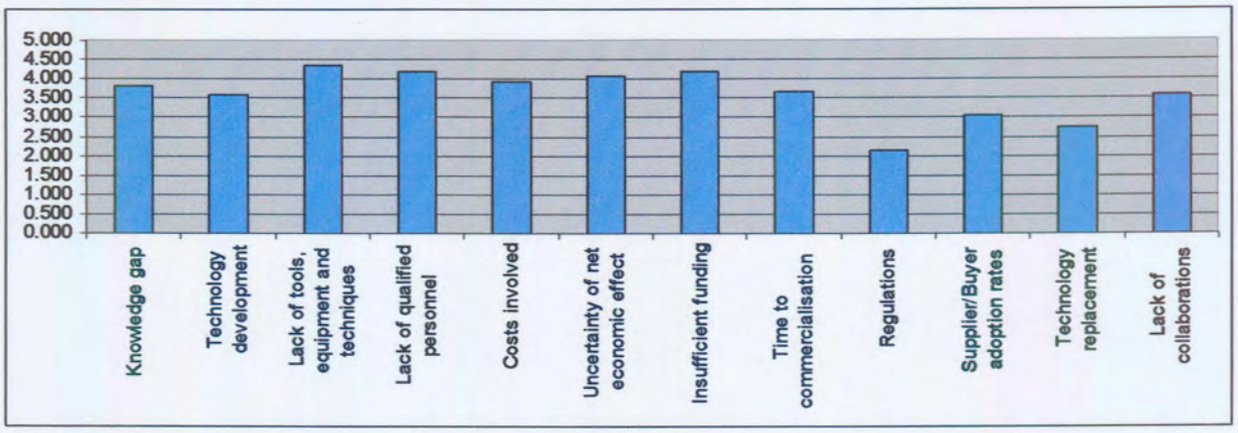

Figure 1-2. The innovation hampers

The lack of equipment, funding and qualified personnel was rated as the top three innovation hampers. Note that the first eight factors together with the lack of collaboration with other institutions was seen hampering nanotechnology innovation in South Africa a lot.

Do have any comments on the results of this second section

1.3 Nanotechnology actors

The graph below illustrates the national actors in nanotechnology worldwide (the scale is disagree = 1, slightly disagree = 2, no opinion = 3, slightly agree = 4 and agree = 5)

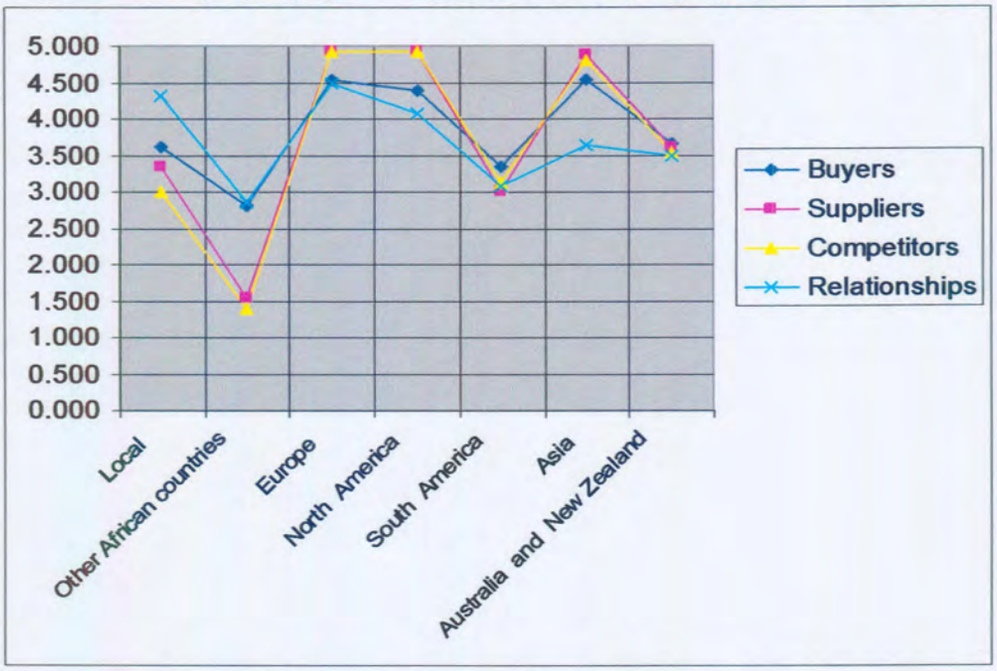

Figure 1-3. Nanotechnology actors in terms of buyers, suppliers, competitors and collaborations.

Europe was rated as the most important geographical area in all the groups and together with North America and Asia rated as the biggest buyers and competitors. Local actors was seen the second most important source of relationships or collaborations, strangely enough Asia was not seen as source of relationships and the greatest uncertainty as buyers existed concerning local, other African countries and South America.

Do have any comments on the results of this third section

Please Remember

Please make sure that you SAVE the answers you entered and E-mail the Word document to dlvdm@tuks.co.za or print the document and fax it to (012) 362 5307. Address any faxes to Derrick van der Merwe.

If you have you any questions you can contact me via E-mail at dlvdm@tuks.co.za or cell phone at +2782 629 8807

Appendix B. CSIR baseline study questionnaire

Baseline Study on Nanotechnology
Activities in South Africa - May/June 2004

Section 1

Date:	
Information collected by:	

Section 2

1	Surname	
2	Name	
3	Title	
4	Position	
5	Organisation	
6	Department	
7	Tel.	
8	e-mail	
9	Fax.	

Section 3

Main focus of your company/group? (Physics, Chemistry, Pharmaceutical, Plastic manuf. etc.)	

Section 4a

Do you know what Nanotechnology/Nanoscience is? Yes ☐ No ☐
If not, please do section 19 and 20 only.

Section 4b
In which broad Nanotechnology / Nanoscience areas is your group active?

Processing/Manufacturing	Characterisation	Modelling	Other

Section 5

Are you involved in Nanotechnology R&D or are you Manufacturing Nanomaterials or devices or use Nanotechnology in a Product or Process?

R&D	Manufacture Nanomaterials or devices	Use Nanotechnology in Process	Use Nanomaterials in a Product	Import and sell Nanomaterials or devices directly	Other

Section 6

What aspect of Nanotechnology are you involved in?
(Mark more than one if required)

Nanomaterials (Particles, Tubes, Composites etc.)	
Nano Biotechnology	
Membranes	
Drug Delivery	
Catalysis	
Nano Devices	
Nano emulsions	
Coatings	
Fundamental Research	
Atomic Modelling	
Characterisation	
Use some of the above in a product or process but buy inn from other source (specify)	
Other	

Please give more details on the involvement and projects of your group. (Max 2 sentence per area)

Section 7

Who is funding your groups Nanotechnology research?

	Estimate amount
Private (Industry)	
Public (NRF, Government etc.)	
Internal (Own funds)	
International	
Science Councils	
Other	

Section 8

In the case of you importing Nanomaterials or Devices

What are you importing	Estimate amount in Rand

Section 9a

In the case of you commercially manufacturing Nanomaterials or Devices

What are you manufacturing?	Estimate amount in Rand

Section 9b

Estimate the % effort (time and cost) spent between R&D and Production?

R&D	Production	
%	%	(Total must be 100%)

Section 10a

If you licence Nanotechnology from overseas, roughly what are the costs of the Licence?

R

Section 10a

Do you have international collaborators in Nanotechnology?
Please name countries and organisations if possible.

Country	Organisation

Section 11

Personnel Information (all questions applicable to Nanotechnology group only)

Total number of Personnel	

Gender	Male	Female

Race	Black	White

People with disability/ies	

Number in Age group	20-30	30-40	40-50	50+

Do you have programmes for staff to further their education?

Section 12 (Academia Only)

At what level is Nanotechnology being taught?

Graduate	Honours	Masters	PhD

Roughly how much financial support for students do you get from Industry? (Bursaries etc.)	kR

Nanotechnology Education Training and Curriculum
(Industry, Funding Agencies and Science Councils – please record your actual students that you support here. Academia, record actual students enlisted in your group)

Total number of students	

Gender	Male	Female

Race	Black	White

Disabled	

Level of education

	Number of students
Honours	
Masters	
PhD	

Post Doctoral Students

Total number of Post Docs	

Gender	Male	Female

Race	Black	White

People with disability/ies	

Section 13 (Academia Only)

From which countries do these students come? (Include all students)

Country	Number of students
South Africa	

Section 14

Technical Outputs of the group

Number of Nanotechnology PATENTS	
Number of Publications in Nanotechnology	
Income from Industry for Nanotechnology R&D. (Total industry support)	
Participation in international projects	
Your thoughts on how you can improve the output?	
Details of Nanotechnology already commercialised by your group to date	

Does your organisation encourage spin-off companies?	Yes		No	
Have there been any Nanotechnology related spin-off companies formed to date?	Yes		No	
Do you have a BEE programme or initiative?	Yes		No	

Section 15

Your major need at the moment

Equipment	
Personnel	
R&D Funding	

Section 16

Networking

Are you aware of, or a member of the South African Nanotechnology initiative (SANi)?	
How many national collaborators do you have? (Groups and persons)	
How many International collaborators do you have? (Groups and People)	
How many of these International Collaborators came about through government arranged international interaction?	
Do you know what the FP6 funding mechanism is and have you been involved in a proposal?	
If there were workshops and educational programmes to learn more about Nanotechnology, would you commit people to attend?	Never / Think not / Possibly / Think so / Definitely
Do you know organisations, companies or groups that should participate in Nanotechnology in SA but are not aware of the activities?	

Section 17

Time frame:

For how long have you been involved in Nanotechnology?	
Where do you see yourselves in future?	
When do you think Nanotechnology will make its impact felt internationally?	

Section 18

General

Where are the opportunities and gaps in Nanotechnology in SA?	
What should be done to address the gap?	
Do you see opportunities or threats for SA from Nanotechnology?	
Do you feel there should be investment in Nanotechnology R&D and on which areas should the focus be?	
What role should government play in the implementation of new sciences and technologies like Nanotechnology?	

Section 19

In the case where you do not know what Nanotechnology is:

Please read the short overview of Nanotechnology and answer the following questions.

Do you feel your group/company should look at the benefits Nanotechnology can offer?

Yes		No	

Does your group/company do research and development?

Yes		No	

Section 20

Do you have any of the following activities in the group/company that might involve Nanotechnology without your knowledge?

Catalysis	
Thin Films	
Macromolecules	
Dendrites	
Protein synthesis	
Fine powder manufacture	
Macromolecules	
Chemistry	
Composites	
Ceramics	

Section 21

Equipment and Facilities

	Equipment/ Facility Description	Condition (1 – Good, 2 – average, 3 – bad)	Compared to state of the art (1 - same, 2- slightly worse, 3- much worse)	Comment on requirements regarding this particular instrument (upgrade required, repairs needed, higher resolution essential etc.)

How are the facilities funded and managed?

Contact details of Facility manager:

Who shares/uses the facilities/equipment with you? (other universities etc.)

Equipment needs?

Appendix C. Data gathered

C.1 Research project questionnaire

C.1.1 Background information

Name	Surname	Title	Field of nanotechnology interest	Employer
Willie	Augustyn	Mr	Application of catalysis	The University of Technology – Dept. of Chemistry and Physics
Martin	Beyers	Mr.	Manufacturing	Groupline Technical Ceramics
Daven	Compton	Dr	Nanotechnology applications using precious metals	Mintek
Humphrey	Dlamini	Dr	Catalysis	SASOL
Marius	Du Plessis	Mr	Polymers, filler, coatings, binding, bio-sensors	Mondi Paper SA
Gerhard	Gericke	Mr	Energy, catalysis and water treatment	ESKOM
Andre	Germishuizen	Mr	The use of self-assembly and bio-molecules (in particular DNA) in the construction of nanoscale devices (molecular electronics MEMS, biosensors, etc)	CSIR
Corinne	Greyling	Ms	Polymeric nanofibres and nanoparticles, for application in catalysis, absorbents, tissue scaffolds and controlled release applications. Fundamental research and industrial product development.	Department of Chemistry and Polymer Science – University of Stellenbosch
Bongani	Nkosi	Dr	Zeolites and Molecular sives. Materials Characterization.	SASOL
Leslie	Petrik	Ms	Advanced Nanomaterials: - composite nanophase electrodes, nanocatalysts and electro catalysts, characterization of nanomaterials, applications of nanomaterials for hydrogen production, fuel cells, environmental cleanup	University of Western Cape
Frans	Prinsloo	Dr	Tools; Raw Materials; Nanotubes	SASOL
Neerish	Revaprasadu	Dr	Synthesis of Nanoparticles	University of Zululand
Manfred	Scriba	Mr	Implementation in SA. International cooperation Network management Synthesis of nanoparticles Nanodevices	CSIR
Eugene	Smit	Mr	Electro spinning as a top-down technique of manufacturing of Polymer and Inorganic nanofibres	University of Stellenbosch – Polymer Science
Kokkie	Swanepoel	Dr	Particles	Thermtron group of Companies
Hannes	Vorster	Mr	Nano particle synthesis - metals and metal oxides Surface modification Cosmetic applications of nano materials Carbon nanotubes	Prime Product Manufacturing (Pty.) Ltd.

Table C-1. Background information on the nanotechnology panel of experts.

C.1.2 Nanotechnology segments

Participant	Comment
Beyers	Although it is good that the questions are application driven, much more should be invested in manufacturing technology. Being able to make useful parts with the materials
Dlamini	The segmentation of nanotechnology that you have chosen is somewhat confusing. Tools such as EM are not a result of development in nanotechnology. These are general tools that are used daily in science and nanotechnology has the potential to benefit from them. An additional segment that I think could be added is nano - synthesis, to support the various segments in the questionnaire.
Du Plessis	Petro-chemicals, Agricultural products, nano-medicine (incl. veterinary), power generation/nuclear safety/efficiency, aircraft/transport performance, certainly must fall into place as well
Gericke	It is assumed that the respondent has a thorough understanding of the economics of technology – makes it difficult to give an accurate answer
Germishuizen	I think "intelligent materials" fit into the "structures" category, because you look to modify macroscopic effects by changing properties at molecular level, such as optical switches etc, metallic/semi conducting behaviour etc. Furthermore, it is not possible to answer in one question the difference between basic and applied research on your 7 nanotech topics: basic research is relatively easy on all but machines, but applied research on all the topics requires huge investment, large research groups (for critical mass) and equipment. Thus, it is ok in US and EU, but very difficult in S.A. Also consider these groups have worked on a topic for 10 years+ (in most cases not even calling their research "nanotechnology"), while here it will take considerable effort to compete with that.
Greyling	Q1 make never an option
Petrik	Your categories don't relate to what is happening or is possible in SA
Scriba	Nanotechnology is very broad in its definition. It is difficult to grasp accurately what we are talking about in each sector indicated
Smit	The fact that I do not agree with the division of nanotechnology in South Africa into these segments makes giving sensible answers rather difficult. The segmentation leads to certain very important fields of study being grouped with other fields that do not necessarily have as much promise. The result is that answers will either be too conservative or too liberal.

Table C-2. Comments from the expert panel to the nanotechnology segments.

Participant	Comment
Petrik	Government has a role to play to provide incentives for the basic, fundamental research needed to bring new materials to a stage where prototyping and commercialization can become feasible at which point venture capital may take the prototype forward to a product
Scriba	Venture capital has a huge role to play in nanotechnology but the sequence has to be well understood: Initially Government will have to play a strong role mainly in establishing the HR component and development of the basic science. Then Industry and Government together must fund and support R&D projects more focussed on delivery of benefits to industry. Now VC can come in with commercialisation support. In SA I believe the sequence above will take 3-6 years

Table C-3. Answers provided on the role of venture capital and government incentives in future nanotechnology research, development, manufacturing, marketing and selling.

C.1.3 Innovation hampers

Surname	Comment
Germishuizen	Be careful in your definition of nanotech: many everyday products aren't classified as nanotech but is, in fact, such as semiconductor devices. These have been around for a few years and we are completely dependent on them. Others are now classified as nanotech (like nanotubes) but have no market.
Greyling	Mismanagement of funding or corruption
Petrik	Stakeholder initiatives NB and are needing urgent support by government to prevent SA from being left behind. We are currently losing any market niche opportunity unless we support what is already taking place in SA
Vorster	I think South Africa needs to train more scientists and engineers in the nanotechnology field. We also need to invest in good research infrastructure and equipment to facilitate nanotechnology development.

Table C-4. Comments from the expert panel to the innovation hampers.

C.1.4 Nanotechnology actors

Surname	Comments
Beyers	Whether Asia is going to be a buyer or competitor is going to depend on how much they spend on developing nanotechnology themselves. That they are going to be one of the biggest USERS of nano-technology, is beyond any doubt
Du Plessis	It is probably now the time to make our intentions known with respects to the technology so that we can associate ourselves with the best nanotechnology partners elsewhere in the world. I will look at Europe first then Asia then N-America but not Southern Hemisphere. South Africa needs a STRONG alliance with a known/peer reviewed partner and not a mate of the state.
Germishuizen	I think the world leaders (US, EU and Japan) will keep their ranking because of the long delay of other, like Africa and South America, to start fundamental work. This gap will ultimately not be bridged.
Petrik	Yes the location could change but once a market is established it is very difficult to break in. SA has an opportunity in certain niche areas of nanotechnology and these should immediately be strengthened
Scriba	There is a strong link with the European FE6 system. SA Government has Agreements are in place with Japan, Brazil, Russia, India and Iran. These could become strong nanotechnology partners.
Smit	Many of the European countries and the USA have very strict regulations in terms of health and environmental safety; schooled labour and research are typically more expensive that in South Africa and other developing countries. There is also a higher degree of resistance towards disruptive technologies in the public opinion of first world countries, which is not as strong in South Africa. The importance of location becomes apparent when, as an example, American companies start using South African research groups for developing products that require animal testing and/or other controversial methods, or if the development can be done at a significantly lower price by local 'cheaper' research groups.
Vorster	I think as more countries becomes involved in nanotechnology the will be a definite shift and some regions of the world might develop a more advanced or niche in a specific field in nanotechnology.

Table C-5. Comments from the expert panel to the nanotechnology actors.

C.1.5 Strength, weaknesses, opportunities and threats

Surname	Strengths	Weaknesses
Augustyn	Talent and interest (S8)	No strategy (focus areas) (W6) Funds (W2) Equipment (W3) Qualified researchers (W1)
Beyers	Sufficient academic support for the second tier level of research (S1) Good manufacturing and logistics infrastructure (S14) Relatively well positioned currency both for buying in Materials and selling value added products (NOT USED)	Lack of cooperation between different academic institutions and industry. (W5) Focus too much on primary development of nano-technology. We should stay out of expensive primary research, get raw materials supplied and invest in making value added products. The development required to successfully manufacture these materials is more important that duplicating technology that is being done world-wide. (We will be re-inventing the wheel) (W8)
Compton	Geographical isolation forces innovation (S4) Can follow prior research - follower status rather than leading, can choose best practices immediately (USED IN O6) SA researchers are more innovative than international researchers (what we can do on such limited budgets.) (S2)	Funding (W2) Equipment (funding) (W3) Limited knowledge in some fields - too expensive to attend workshops overseas (funding) (W4) Fragmentation of nanotechnology community - no critical mass in some areas (W5)
Dlamini	What are the nanotechnology industries in South Africa? The strength of our industries in general is cheap labour (S2), natural resources (S9), and good positioning in Africa (S10)	Lack of suitable infrastructure to perform nanotechnology research. (W1,2,3) Poorly structured education system that does not result in the development of entrepreneurs. (W9) Strong reliance on North America and Europe for good technical skills. (W4)
Du Plessis	Ground principles seems to have been agreed on CSIR footprints in SA and abroad is recognised (S5)	Application value largely unclear At the very small scale it is impossible to visualise - nothing as exciting as the Big5. (USED IN T8)
Gericke	Raw material readily available (USED IN O1) Research relatively cheap (S2)	Perception from industry that local institutions cannot compete with overseas counterparts (W10) Lack of research funding (W2) Lack of teaching programmes in this technology (W4) Lack of skilled manpower to "kick start" industries (W1) Lack of government incentives (W11)

Table C-6. Strengths and weaknesses provided by the panel of experts (Part A).

Surname	Strengths	Weaknesses
Germishuizen	Strong collaboration between institutions can result in multidisciplinary research groups, essential for nanotech research. (S6) The identification of focus areas, like energy, water health, etc, can help channel funding into a flagship type project. (S5)	Lack of funding and critical mass and skilled people. (W1,2) Another major weakness is the reluctance to work on "blue sky" research. (W7) Nanotechnology will yield products only a few years down the line, while most people expect returns much sooner, therefore a whole attitude change or paradigm shift is required.
Greyling	RSA has good education standard and good scientists (S3)(S1) People tend to be innovative (S4) People have confidence in Manfred Scriba (S11)	Funding (W2) Too few young scientists (W1) Ageing publishing population Affirmative action (W12) Insufficient industrial training (scientists become managers too fast) (NOT USED) Lack of a firm direction for RSA to compete in Nanotech internationally (W6)
Nkosi	Labour costs for researchers lower than in the developed economies. (S2) As a follower able to spend less money on R&D costs. (S12)	There are not researchers in this area, critical mass. Also the R&D funding is low. (W1,2)
Petrik	Small but Sophisticated R&D at some universities (S1)	Industry lack of knowledge of threat to their products and processes (W4) Far too few resources allocated to developing our own skills and capabilities (W1,2,3)
Prinsloo	Natural resources (USED IN O1)	Follower approach usually adopted by SA (W13) Limited resources (W1,2,3) Too distant from leading innovators (W5) Not enough R&D on nanotechnology (W7) SA is already lacking on the field of nanotechnology (W14) In a 3rd world Country like SA it will take a long time to convert to opportunities offered by nanotechnology SA already lacks on all fronts of nanotechnology (R&D, technology, commercialisation, etc) Restrictions on import tariffs
Revaprasadu	We have dedicated researchers who are motivated to achieve results with low funding. (S2) There is now sufficient networking in this area to work on bigger projects. (S6)	There is a lack on adequate equipment such as microscopes. (W3) The level of funding from Govt and industry is inadequate. (W2)

Table C- 7. Strengths and weaknesses provided by the panel of experts (Part B).

Surname	Strengths	Weaknesses
Scriba	Have natural resources here. (USED IN O1) Good expertise in certain fields, including mineral extraction and catalysis. (S1) SA has been multidisciplinary for years - we could thus pick up on some nanotechnology aspect quickly. (S1)	Lack of equipment, expertise and funding. (W1,2,3) The science base in SA is far from what it should be. (NOT USED) This will take time to correct. The SA industry in general is not high tech and there is in general very little R&D at these companies. (W7)
Smit	High degree of competence in some fields. (S1)	By not giving a clear definition of what 'Nanotech' really is, we are allowing every researcher with his eyes on the money to describe his/her work as 'Nano'. This will lead to a dilution of the available funds for nanotech, with 'nano' money being spent on non-nano research. (W4) A lack of a co-ordinated focus locally could also lead to research funding being diluted among too many fields leading to unfocused, sub-relevant local expertise. (W6)
Swanepoel	High technology knowledge in Nuclear, Space, Lasers, Plasma, minerals beneficiation, mining, design and engineering, Petrochemical, biological sciences, medical research (S1) Good banking system (S13) Good scientists and technologists (S3)	Fragmented research, no collaborations (W5) Not market driven (W8) Old generation of scientists (W1)
Vorster	I think we have the tenacity as South Africans to tackle quite difficult high tech problems and follow it through until we have success. (NOT USED) We have a pool of people from many different backgrounds with diverse abilities and talents that can generate a critical mass of people in nanotechnology. (S7)	We are not very well equipped, far from the major research centres such as Europe, USA and Asia. (W3) We are lacking in technicians and technical people and need to train much more scientists and engineers. (W1)

Table C- 8. Strengths and weaknesses provided by the panel of experts (Part C).

Name	Opportunities	Threats
Augustyn	Same as for the rest of the world - innumerable (NOT USED)	Because of lack of personnel, funds, strategy, etc. we may fall behind in R&D and applications (industry) (T3)
Beyers	Become manufacturing partners to developed countries, who will take on them the role of marketing, positioning and do the primary technology research. (O6)	Over investment on research not leading to the ability to manufacture value added products (T6)
Compton	Critical mass of research focussed on SA natural resources (O1) Initiatives for HR capital development - strong government support (O7) Can learn from other countries (best practices) without making their mistakes and re-inventing the wheel. (O6)	Expensive and difficult to control intellectual property, lack of knowledge on IP issues (T7) Uncoordinated actions in some areas (NOT USED) International researchers are better resourced in equipment and HR capital (T3)
Dlamini	As a third world country there are a number of opportunities to provide solutions to a number of social problems i.e. water purification etc. (O2)	Unemployment, social instability, strong competition from the Europe, East and West (T4,7)
Du Plessis	New, basically unknown technology to majority of industries in South Africa (O4) SA developing more and more into a recognised producing country than an exploiting country and should use the image to enhance/sell the concepts (O9)	Barrier to entry, affordability? (T4) Poor contribution record from government, commitment doubtful. (T6)
Gericke	Beneficiation of local raw materials - add value (O1) Development of high quality/high value products for niche applications (O4,5) To develop centres of excellence (O3) To be a leader instead of a follower (O10)	Good researchers might be lost to overseas industries/institutions due to the lack of incentives (T5) SA to become dumping ground for technology from overseas competitiveness (T2,4)
Germishuizen	Health is a good one. Bionanotechnology is relatively not too difficult to get into, and can yield biosensors and nano-scale drug delivery systems etc. much sooner. (O2)	Biggest threat is of course EU/US. (T4) Products , devices, techniques (according to your idea of nanotech, like carbon nanotubes) will become much cheaper as time/research progress overseas, that we will spend money on buying the products rather than doing our won research. (T2) Once again the threat from uninformed people in government (and local researchers) that don't understand the significance of nanotech research will hamper progress significantly (T8)

Table C-9. Opportunities and threats provided by the panel of experts (Part A).

Name	Opportunities	Threats
Greyling	None	None
Nkosi	No huge investments as the country is a follower in this area. (O6)	May lag and never be able to catch up. (T1)
Petrik	Catalysis, electro catalysis, renewable energy, clean water, health (O2)	Huge budgets and significant leads in R&D in other countries (T3)
Prinsloo	Weak Rand (NOT USED) Natural resources (O1) Capitalisation on human potential, with centres of nanotechnology (O3) Fuel cell vehicles (should we manufacture methanol). Paint industry, now is the time to take up the opportunities. Energy industry (O2,4,5)	Crime (T9) HIV/AIDS (T5) Collapsing of US stock market (NOT USED)
Revaprasadu	There are areas of research which SA has distinct expertise e.g. catalysis. (O3) There are niche areas which also could be exploited. (O4,5)	If SA does not act quickly we could be very far behind the developing countries in this field. (T1) We would lose momentum in research and active researchers would be forced to look elsewhere. (T5)
Scriba	We must focus on local needs: nanotechnology for health, energy and water. These areas are not always international priority. (O2) Our wealth in minerals and PGM materials is a great opportunity and we are also leaders in diamond synthesis. (O1)	Falling into the old trap of importing technology and developing our selves. (T2) Not reaching fast enough with adequate funding. Having started to late in the first place (T1) Brain drain. (T5)
Smit	Local legislation and lower cost of research could be seen by first-world companies as an incentive to utilise local expertise for development, but only if expertise and infrastructure are in place. (O8)	South Africa started late in the nano race and it might already be too late to catch up with the first world countries in many fields of research. (T1) One of the biggest threats we face is being the runner-up in the development of many crytical technologies and being forced, through patents and other IP protecting structures, to licence or buy essential technologies from the first world countries like we currently do with many pre-nano technologies. (T2)

Table C- 10. Opportunities and threats provided by the panel of experts (Part B).

Name	Opportunities	Threats
Swanepoel	One focussed body to lead group (NOT USED) Cheaper labour than USA and Europe (O8)	Dumping of old nanotechnology products on local market (T2) Start to late with focussed program (T1)
Vorster	Biggest opportunities we have is the support of the SA Government in the DST and DTI. (O7) We have a wealth of experience in other high tech fields e.g. Nuclear technology and armaments industries that can be pooled and redirected into nanotechnology. (O3) We have a wealth of raw materials and base metals that is the basis of nanotechnology. (O1)	If we don't start actively pursuing nanotechnology as a national priority we can completely miss the nanotechnology wave and be pushed to the backwaters of nanotechnology in the 21st Century. (T1) We don't have sufficient funding to really stimulate these industries. (T3)

Table C- 11. Opportunities and threats provided by the panel of experts (Part C).

C.1.6 General comments

Surname	Comment
Du Plessis	Thanks for the opportunity.
Gericke	I am not sure as to how far this questionnaire will go to assist in establishing a nanotechnology strategy for South Africa. I abuse my comment on the type of questions being asked. Questions such as niche market/products applications in developing countries, incentives requirements, priorities etc. are lacking.
Germishuizen	Define nanotechnology carefully. As I say many products around us have existed even before the phrase "nanotechnology" was coined. They completely took over our world (semiconductor devices, polymers, etc) and have nanometre dimensions, but are often not classified into "nanotech". This often leads to a lot of confusion because nanotech as you use it here has yielded very view marketable products (last year a BBC editor said that the only people who make money out of nanotechnology is conference organisers). So these two are fundamentally different, and by defining it well you can make your work much easier.
Petrik	Not clear what this info is for and how it relates to SANi and baseline study. You ask questions that have already been addressed in the SANi strategy document to government i.e. SWOT analysis
Scriba	Good structure of questions Some are difficult to judge.
Vorster	I think it is a great idea to do research on the whole status of nanotechnology in South Africa. We need urgently to benchmark our present position in the world and see how we can find niches and international collaboration to develop and stay in the development of nanotechnology.

Table C-12. General comments from the panel of experts to the research project questionnaire.

C.2 CSIR baseline study questionnaire

C.2.1 Nanotechnology awareness, involvement and focus areas

	R&D	Manufacture	Process development	Product development	Import and sell	Other category
Universities	12	8	3	3	4	0
Industry	7	4	2	4	2	2
Science councils	3	2	1	2	0	1
Total number of participants	22	14	6	9	6	3

Table C-13. Statistics of nanotechnology life-cycle involvement per institution.

Nanotechnology focus area	Number of participants
Nanomaterials	21
Nanobiotechnology	3
Membranes	5
Drug delivery	4
Catalysis	11
Nano Devices	5
Nano emulsions	4
Coatings	7
Fundamental Research	17
Atomic modelling	7
Characterisation	18
Implemented some above technologies, outsourced others	7
Other	4

Table C-14. Statistics of nanotechnology areas South African participants are involved in.

C.2.2 Nanotechnology funding

	Private Funding	Public Funding	Internal	International	Science Council	Other group
Universities	9	13	10	3	5	1
Industry	6	2	5	1	2	0
Science councils	2	2	2	0	2	0
Total	17	17	17	4	9	1

Table C-15. Statistics of South African nanotechnology funding sources per institution.

C.2.3 Nanotechnology personnel

	Total	Male	Female	Black	White	Other race	Disabled
Personnel	151	110	37	65	76	2	0

Table C-16. Statistics of the South African nanotechnology personnel demographics per institution.

Personnel	20-30	30-40	40-50	50+
Universities	39	17	16	13
Industry	6	9	8	1
Science councils	8	11	7	4
Total	53	37	31	18

Table C-17. Statistics of South African nanotechnology personnel employed per institution per age.

C.2.4 Nanotechnology education

	Total	Male	Female	Black	White	Other race	Disabled
Students	160	100	57	122	34	1	1
Post doctoral	23	17	6	10	9	1	0
Total	183	117	63	132	43	2	1

Table C-18. Statistics of South African nanotechnology students.

C.2.5 Nanotechnology networking and collaborations

Country	Number of collaborations
Local	74
Europe	49
North America	8
Australia and New Zealand	5
Asia	2
South America	1
Other African countries	0
Total	139

Table C-19. Statistics of the number of South African nanotechnology collaborations.

	Aware of SANi	National Collaborators	International Collaborators	Government arranged collaborations	International projects
Universities	13	13	12	4	7
Industry	9	10	5	0	1
Science councils	3	3	3	0	1
Total	25	26	20	4	9

Table C-20. Statistics of South African nanotechnology relations and networking.

C.2.6 Nanotechnology equipment information

	Condition of the equipment	Compared to the state of the art equipment
1 (Good or the same)	44	26
2 (Average or slightly worse)	31	36
3 (Bad or much worse)	11	23

Table C-21. Statistics of South African nanotechnology equipment.

Appendix D. Data analysis

D.1 Research project questionnaire

D.1.1 Nanotechnology segments

	Tools	Raw materials	Structures	Nanotubes and fullerenes	Devices and systems	Intelligent materials	Machines	Other
Valid	16	16	16	16	16	16	16	3
Missing	0	0	0	0	0	0	0	13
Mean	2.12500	1.87500	2.31250	2.62500	2.75000	3.12500	4.12500	2.66667
Std. Error of Mean	.221265	.179699	.236621	.271953	.232737	.271953	.221265	.333333
Median	2.00000	2.00000	2.00000	2.50000	3.00000	3.00000	4.00000	3.00000
Mode	3.000	2.000	2.000	2.000	2.000	3.000	4.000	3.000
Std. Deviation	.885061	.718795	.946485	1.087811	.930949	1.087811	.885061	.577350
Variance	.783333	.516667	.895833	1.183333	.866667	1.183333	.783333	.333333
Skewness	-.268	.192	.352	.522	.000	.078	-.927	-1.732
Std. Error of Skewness	.564	.564	.564	.564	.564	.564	.564	1.225
Range	2.000	2.000	3.000	4.000	3.000	4.000	3.000	1.000
Minimum	1.000	1.000	1.000	1.000	1.000	1.000	2.000	2.000
Maximum	3.000	3.000	4.000	5.000	4.000	5.000	5.000	3.000
Sum	34.000	30.000	37.000	42.000	44.000	50.000	66.000	8.000

Table D-1. Statistics of the nanotechnology segments' time to market.

	Tools	Raw materials	Structures	Nanotubes and fullerenes	Devices and systems	Intelligent materials	Machines	Other
Valid	16	16	16	16	16	15	15	5
Missing	0	0	0	0	0	1	1	11
Mean	3.06250	4.12500	3.43750	3.12500	3.87500	3.40000	2.73333	3.00000
Std. Error of Mean	.265656	.125000	.240983	.221265	.271953	.235028	.283963	.547723
Median	3.00000	4.00000	3.50000	3.00000	4.00000	3.00000	3.00000	3.00000
Mode	3.000	4.000	4.000	3.000	5.000	3.000	3.000	2.000
Std. Deviation	1.062623	.500000	.963933	.885061	1.087811	.910259	1.099784	1.224745
Variance	1.129167	.250000	.929167	.783333	1.183333	.828571	1.209524	1.500000
Skewness	.243	.343	-.054	.392	-.433	.341	.237	1.361
Std. Error of Skewness	.564	.564	.564	.564	.564	.580	.580	.913
Range	4.000	2.000	3.000	3.000	3.000	3.000	4.000	3.000
Minimum	1.000	3.000	2.000	2.000	2.000	2.000	1.000	2.000
Maximum	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
Sum	49.000	66.000	55.000	50.000	62.000	51.000	41.000	15.000

Table D-2. Statistics of the nanotechnology segments' market potential.

	Tools	Raw materials	Structures	Nanotubes and fullerenes	Devices and systems	Intelligent materials	Machines	Other
Valid	16	15	16	16	16	16	15	4
Missing	0	1	0	0	0	0	1	12
Mean	1.75000	2.93333	2.56250	2.43750	3.68750	3.50000	2.93333	1.75000
Std. Error of Mean	.232737	.462567	.376040	.386962	.384261	.387298	.371184	.750000
Median	1.50000	2.00000	2.00000	2.00000	4.00000	4.00000	3.00000	1.00000
Mode	1.000	1.000	1.000	1.000	5.000	5.000	2.000	1.000
Std. Deviation	.930949	1.791514	1.504161	1.547848	1.537043	1.549193	1.437591	1.500000
Variance	.866667	3.209524	2.262500	2.395833	2.362500	2.400000	2.066667	2.250000
Skewness	1.133	.115	.199	.750	-.782	-.492	.466	2.000
Std. Error of Skewness	.564	.580	.564	.564	.564	.564	.580	1.014
Range	3.000	4.000	4.000	4.000	4.000	4.000	4.000	3.000
Minimum	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Maximum	4.000	5.000	5.000	5.000	5.000	5.000	5.000	4.000
Sum	28.000	44.000	41.000	39.000	59.000	56.000	44.000	7.000

Table D-3. Statistics of the nanotechnology segments' disruptiveness.

	Tools	Raw materials	Structures	Nanotubes and fullerenes	Devices and systems	Intelligent materials	Machines	Other
Valid	16	16	16	15	16	16	16	4
Missing	0	0	0	1	0	0	0	12
Mean	3.31250	3.06250	3.56250	3.33333	4.06250	4.12500	4.50000	2.75000
Std. Error of Mean	.269548	.249479	.223024	.287297	.213478	.154785	.223607	.250000
Median	3.00000	3.00000	4.00000	4.00000	4.00000	4.00000	5.00000	3.00000
Mode	3.000	3.000	4.000	4.000	5.000	4.000	5.000	3.000
Std. Deviation	1.078193	.997914	.892095	1.112697	.853913	.619139	.894427	.500000
Variance	1.162500	.995833	.795833	1.238095	.729167	.383333	.800000	.250000
Skewness	-.355	-.138	-1.502	-.771	-.129	-.060	-1.917	-2.000
Std. Error of Skewness	.564	.564	.564	.580	.564	.564	.564	1.014
Range	4.000	4.000	4.000	4.000	2.000	2.000	3.000	1.000
Minimum	1.000	1.000	1.000	1.000	3.000	3.000	2.000	2.000
Maximum	5.000	5.000	5.000	5.000	5.000	5.000	5.000	3.000
Sum	53.000	49.000	57.000	50.000	65.000	66.000	72.000	11.000

Table D-4. Statistics of the nanotechnology segments' complexity.

D.1.2 Grouped nanotechnology segment according to CSIR baseline study

	Tools	Nanomaterials	Nanostructures	Nanodevices and systems	Nanomachines	NanoBiotechnology
Valid	16	32	32	16	16	112
Missing	96	80	80	96	96	0
Mean	2.12500	2.25000	2.71875	2.75000	4.12500	2.70536
Std. Error of Mean	.221265	.173902	.191736	.232737	.221265	.108842
Median	2.00000	2.00000	3.00000	3.00000	4.00000	3.00000
Mode	3.000	2.000	3.000	2.000	4.000	2.000
Std. Deviation	.885061	.983739	1.084625	.930949	.885061	1.151876
Variance	.783333	.967742	1.176411	.866667	.783333	1.326818
Skewness	-.268	.759	.283	.000	-.927	.312
Std. Error of Skewness	.564	.414	.414	.564	.564	.228
Range	2.000	4.000	4.000	3.000	3.000	4.000
Minimum	1.000	1.000	1.000	1.000	2.000	1.000
Maximum	3.000	5.000	5.000	4.000	5.000	5.000
Sum	34.000	72.000	87.000	44.000	66.000	303.000

Table D-5. Statistics of the grouped nanotechnology segments' time to market.

	Tools	Nanomaterials	Nanostructures	Nanodevices and systems	Nanomachines	NanoBiotechnology
Valid	16	32	31	16	15	110
Missing	96	80	81	96	97	2
Mean	3.06250	3.62500	3.41935	3.87500	2.73333	3.40000
Std. Error of Mean	.265656	.153914	.165745	.271953	.283963	.097679
Median	3.00000	4.00000	3.00000	4.00000	3.00000	3.00000
Mode	3.000	4.000	3.000	5.000	3.000	3.000
Std. Deviation	1.062623	.870669	.922829	1.087811	1.099784	1.024471
Variance	1.129167	.758065	.851613	1.183333	1.209524	1.049541
Skewness	.243	-.411	.117	-.433	.237	-.142
Std. Error of Skewness	.564	.414	.421	.564	.580	.230
Range	4.000	3.000	3.000	3.000	4.000	4.000
Minimum	1.000	2.000	2.000	2.000	1.000	1.000
Maximum	5.000	5.000	5.000	5.000	5.000	5.000
Sum	49.000	116.000	106.000	62.000	41.000	374.000

Table D-6. Statistics of the grouped nanotechnology segments' market potential.

	Tools	Nanomaterials	Nanostructures	Nanodevices and systems	Nanomachines	NanoBiotechnology
Valid	16	31	32	16	15	110
Missing	96	81	80	96	97	2
Mean	1.75000	2.67742	3.03125	3.68750	2.93333	2.82727
Std. Error of Mean	.232737	.298336	.278549	.384261	.371184	.149984
Median	1.50000	2.00000	4.00000	4.00000	3.00000	2.00000
Mode	1.000	1.000	4.000	5.000	2.000	1.000
Std. Deviation	.930949	1.661066	1.575710	1.537043	1.437591	1.573048
Variance	.866667	2.759140	2.482863	2.362500	2.066667	2.474479
Skewness	1.133	.413	-.107	-.782	.466	.219
Std. Error of Skewness	.564	.421	.414	.564	.580	.230
Range	3.000	4.000	4.000	4.000	4.000	4.000
Minimum	1.000	1.000	1.000	1.000	1.000	1.000
Maximum	4.000	5.000	5.000	5.000	5.000	5.000
Sum	28.000	83.000	97.000	59.000	44.000	311.000

Table D-7. Statistics of the grouped nanotechnology segments' disruptiveness.

	Tools	Nanomaterials	Nanostructures	Nanodevices and systems	Nanomachines	NanoBiotechnology
Valid	16	31	32	16	16	111
Missing	96	81	80	96	96	1
Mean	3.31250	3.19355	3.84375	4.06250	4.50000	3.71171
Std. Error of Mean	.269548	.187911	.142765	.213478	.223607	.097795
Median	3.00000	3.00000	4.00000	4.00000	5.00000	4.00000
Mode	3.000	4.000	4.000	5.000	5.000	4.000
Std. Deviation	1.078193	1.046243	.807600	.853913	.894427	1.030334
Variance	1.162500	1.094624	.652218	.729167	.800000	1.061589
Skewness	-.355	-.414	-1.267	-.129	-1.917	-.663
Std. Error of Skewness	.564	.421	.414	.564	.564	.229
Range	4.000	4.000	4.000	2.000	3.000	4.000
Minimum	1.000	1.000	1.000	3.000	2.000	1.000
Maximum	5.000	5.000	5.000	5.000	5.000	5.000
Sum	53.000	99.000	123.000	65.000	72.000	412.000

Table D-8. Statistics of the grouped nanotechnology segments' complexity.

D.1.3 Innovation hampers

	Knowledge gap	Technology development	Lack of tools, equipment and techniques	Lack of qualified personnel	Costs involved	Uncertainty of net economic effect
Valid	16	16	16	16	16	16
Missing	0	0	0	0	0	0
Mean	3.87500	3.62500	4.37500	4.25000	4.00000	4.06250
Std. Error of Mean	.239357	.271953	.221265	.170783	.241523	.192976
Median	4.00000	4.00000	5.00000	4.00000	4.00000	4.00000
Mode	4.000	4.000	5.000	4.000	4.000	4.000
Std. Deviation	.957427	1.087811	.885061	.683130	.966092	.771902
Variance	.916667	1.183333	.783333	.466667	.933333	.595833
Skewness	-.765	-.189	-1.545	-.358	-1.014	-.113
Std. Error of Skewness	.564	.564	.564	.564	.564	.564
Range	3.000	3.000	3.000	2.000	3.000	2.000
Minimum	2.000	2.000	2.000	3.000	2.000	3.000
Maximum	5.000	5.000	5.000	5.000	5.000	5.000
Sum	62.000	58.000	70.000	68.000	64.000	65.000

Table D-9. Statistics of the nanotechnology innovation hampers (part 1).

	Insufficient funding	Time to commercialisation	Regulations	Supplier/Buyer adoption rates	Technology replacement	Lack of collaborations
Valid	15	16	16	16	16	16
Missing	1	0	0	0	0	0
Mean	4.26667	3.75000	2.12500	3.12500	2.62500	3.62500
Std. Error of Mean	.248168	.281366	.179699	.221265	.286865	.179699
Median	5.00000	3.50000	2.00000	3.00000	2.00000	4.00000
Mode	5.000	3.000	2.000	3.000	2.000	4.000
Std. Deviation	.961150	1.125463	.718795	.885061	1.147461	.718795
Variance	.923810	1.266667	.516667	.783333	1.316667	.516667
Skewness	-1.172	-.080	-.192	.392	.558	-.500
Std. Error of Skewness	.580	.564	.564	.564	.564	.564
Range	3.000	3.000	2.000	3.000	4.000	3.000
Minimum	2.000	2.000	1.000	2.000	1.000	2.000
Maximum	5.000	5.000	3.000	5.000	5.000	5.000
Sum	64.000	60.000	34.000	50.000	42.000	58.000

Table D- 10. Statistics of the nanotechnology innovation hampers (part 2).

D.1.4 Nanotechnology actors

	Local	Other African countries	Europe	North America	South America	Asia	Australia and New Zealand
Valid	16	16	16	16	16	16	16
Missing	0	0	0	0	0	0	0
Mean	3.50000	2.68750	4.56250	4.43750	3.37500	4.50000	3.68750
Std. Error of Mean	.353553	.384261	.257694	.257694	.286865	.158114	.284587
Median	4.00000	3.00000	5.00000	5.00000	4.00000	5.00000	4.00000
Mode	4.000	1.000	5.000	5.000	4.000	5.000	4.000
Std. Deviation	1.414214	1.537043	1.030776	1.030776	1.147461	.632456	1.138347
Variance	2.000000	2.362500	1.062500	1.062500	1.316667	.400000	1.295833
Skewness	-.727	.099	-2.278	-1.896	-.558	-.904	-1.151
Std. Error of Skewness	.564	.564	.564	.564	.564	.564	.564
Range	4.000	4.000	3.000	3.000	4.000	2.000	4.000
Minimum	1.000	1.000	2.000	2.000	1.000	3.000	1.000
Maximum	5.000	5.000	5.000	5.000	5.000	5.000	5.000
Sum	56.000	43.000	73.000	71.000	54.000	72.000	59.000

Table D-11. Statistics of the nanotechnology buyers.

	Local	Other African countries	Europe	North America	South America	Asia	Australia and New Zealand
Valid	16	16	16	16	16	16	16
Missing	0	0	0	0	0	0	0
Mean	3.18750	1.50000	4.93750	4.93750	3.06250	4.81250	3.62500
Std. Error of Mean	.367636	.204124	.062500	.062500	.280903	.100778	.271953
Median	4.00000	1.00000	5.00000	5.00000	3.00000	5.00000	4.00000
Mode	4.000	1.000	5.000	5.000	3.000	5.000	4.000
Std. Deviation	1.470544	.816497	.250000	.250000	1.123610	.403113	1.087811
Variance	2.162500	.666667	.062500	.062500	1.262500	.162500	1.183333
Skewness	-.368	1.260	-4.000	-4.000	-.459	-1.772	-.899
Std. Error of Skewness	.564	.564	.564	.564	.564	.564	.564
Range	4.000	2.000	1.000	1.000	4.000	1.000	4.000
Minimum	1.000	1.000	4.000	4.000	1.000	4.000	1.000
Maximum	5.000	3.000	5.000	5.000	5.000	5.000	5.000
Sum	51.000	24.000	79.000	79.000	49.000	77.000	58.000

Table D-12. Statistics of the nanotechnology suppliers.

	Local	Other African countries	Europe	North America	South America	Asia	Australia and New Zealand
Valid	16	16	16	16	16	16	16
Missing	0	0	0	0	0	0	0
Mean	2.87500	1.37500	4.93750	4.93750	3.18750	4.75000	3.56250
Std. Error of Mean	.286865	.154785	.062500	.062500	.305761	.193649	.273385
Median	3.00000	1.00000	5.00000	5.00000	3.00000	5.00000	4.00000
Mode	4.000	1.000	5.000	5.000	3.000	5.000	4.000
Std. Deviation	1.147461	.619139	.250000	.250000	1.223043	.774597	1.093542
Variance	1.316667	.383333	.062500	.062500	1.495833	.600000	1.195833
Skewness	-.331	1.505	-4.000	-4.000	-.405	-3.443	-1.056
Std. Error of Skewness	.564	.564	.564	.564	.564	.564	.564
Range	3.000	2.000	1.000	1.000	4.000	3.000	4.000
Minimum	1.000	1.000	4.000	4.000	1.000	2.000	1.000
Maximum	4.000	3.000	5.000	5.000	5.000	5.000	5.000
Sum	46.000	22.000	79.000	79.000	51.000	76.000	57.000

Table D-13. Statistics of the nanotechnology competitors.

	Local	Other African countries	Europe	North America	South America	Asia	Australia and New Zealand
Valid	14	15	15	15	15	15	15
Missing	2	1	1	1	1	1	1
Mean	4.28571	2.93333	4.46667	4.06667	3.06667	3.60000	3.46667
Std. Error of Mean	.244243	.315725	.133333	.266667	.300264	.289499	.236375
Median	4.50000	3.00000	4.00000	4.00000	3.00000	4.00000	4.00000
Mode	5.000	2.000	4.000	4.000	3.000	4.000	4.000
Std. Deviation	.913874	1.222799	.516398	1.032796	1.162919	1.121224	.915475
Variance	.835165	1.495238	.266667	1.066667	1.352381	1.257143	.838095
Skewness	-1.368	.414	.149	-1.944	-.461	-.814	-1.821
Std. Error of Skewness	.597	.580	.580	.580	.580	.580	.580
Range	3.000	4.000	1.000	4.000	4.000	4.000	3.000
Minimum	2.000	1.000	4.000	1.000	1.000	1.000	1.000
Maximum	5.000	5.000	5.000	5.000	5.000	5.000	4.000
Sum	60.000	44.000	67.000	61.000	46.000	54.000	52.000

Table D-14. Statistics of the nanotechnology relationships.

D.2 CSIR baseline study questionnaire

D.2.1 Original nanotechnology segments

Nanotechnology involvement area						
Product life cycle	Nano materials	Nano biotechnology	Membranes	Drug delivery	Catalysis	Nano Devices
Research						
Count	8	2	3	3	4	3
% of column	16.67%	22.22%	23.08%	23.08%	18.18%	20.00%
Technology development						
Count	14	3	3	4	7	3
% of column	29.17%	33.33%	23.08%	30.77%	31.82%	20.00%
Product and process development						
Count	10	2	4	3	4	4
% of column	20.83%	22.22%	30.77%	23.08%	18.18%	26.67%
Product and process improvement						
Count	1	0	0	0	0	0
% of column	2.08%	0.00%	0.00%	0.00%	0.00%	0.00%
Manufacture						
Count	9	2	2	2	5	3
% of column	18.75%	22.22%	15.38%	15.38%	22.73%	20.00%
Import and selling						
Count	4	0	1	0	1	2
% of column	8.33%	0.00%	7.69%	0.00%	4.55%	13.33%
Other						
Count	2	0	0	1	1	0
% of column	4.17%	0.00%	0.00%	7.69%	4.55%	0.00%
Total						
Count	48	9	13	13	22	15
% of column	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table D-15. Frequency table of the cross tabulation of the Nanotechnology product life cycle and involvement areas (Part A).

Nanotechnology involvement area						
Product life cycle	Nano emulsions	Coatings	Atomic modelling	Characterisation	Other	Total
Research						
Count	3	3	4	9	2	44
% of column	23.08%	15.79%	22.22%	21.43%	16.67%	19.64%
Technology development						
Count	3	4	6	13	2	62
% of column	23.08%	21.05%	33.33%	30.95%	16.67%	27.68%
Product and process development						
Count	3	6	4	7	3	50
% of column	23.08%	31.58%	22.22%	16.67%	25.00%	22.32%
Product and process improvement						
Count	0	0	0	0	0	1
% of column	0.00%	0.00%	0.00%	0.00%	0.00%	0.45%
Manufacture						
Count	3	4	3	10	2	45
% of column	23.08%	21.05%	16.67%	23.81%	16.67%	20.09%
Import and selling						
Count	1	2	1	3	1	16
% of column	7.69%	10.53%	5.56%	7.14%	8.33%	7.14%
Other						
Count	0	0	0	0	2	6
% of column	0.00%	0.00%	0.00%	0.00%	16.67%	2.68%
Total						
Count	13	19	18	42	12	224
% of column	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table D-16. Frequency table of the cross tabulation of the Nanotechnology product life cycle and involvement areas (Part B).

D.2.2 New nanotechnology segment groupings

	Tools	Nano materials	Nano structures	Nano devices and Nano systems	Nano machines	Nano Biotech	Other	Total
Research								
Count	13	18	3	6	0	2	2	44
% of col.	21.67%	17.48%	21.43%	21.43%	0.00%	22.22%	16.67%	19.47%
Technology development								
Count	19	28	3	7	0	3	2	62
% of col.	31.67%	27.18%	21.43%	25.00%	0.00%	33.33%	16.67%	27.43%
Product and process development								
Count	11	23	4	7	0	2	3	50
% of col.	18.33%	22.55%	28.57%	25.00%	0.00%	22.22%	25.00%	22.32%
Product and process improvement								
Count	0	1	0	0	0	0	0	1
% of col.	0.00%	0.98%	7.14%	0.00%	0.00%	0.00%	0.00%	1.77%
Manufacture								
Count	13	21	2	5	0	2	2	45
% of col.	21.67%	20.39%	14.29%	17.86%	0.00%	22.22%	16.67%	19.91%
Import and selling								
Count	4	8	1	2	0	0	1	16
% of col.	6.67%	7.77%	7.14%	7.14%	0.00%	0.00%	8.33%	7.08%
Other								
Count	0	3	0	1	0	0	2	6
% of col.	0.00%	2.91%	0.00%	3.57%	0.00%	0.00%	16.67%	2.65%
Total								
Count	60	102	14	28	0	9	12	224
% of col.	100%	100%	100%	100%	0%	100%	100%	100%

Table D-17. Frequency table of the cross tabulation of the nanotechnology product life cycle and involvement areas.