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Assessment of E&P Technology in Nigeria, Detailed technologies ranking

Report RF – 2003/057

Project number:	720. 1922
Project title:	Private sector development in the Nigerian upstream industry
Project Quality Assurance:	
Client(s):	Intsok
Donors:	Norwegian Agency for Development Cooperation (Norad)/ Norwegian Ministry of Petroleum and Energy (OED)
ISBN:	82-490-0235-0
Distribution restriction:	Open

Preface

This report is part of a study addressing technological and institutional aspects of the development and utilisation of offshore petroleum resources in Nigeria. Norway and Nigeria have signed a memorandum of understanding on private sector development in the Nigerian upstream oil and gas industry. One of the objectives of the cooperation is to increase local content in the Nigerian industry. As a first step Norad and the Norwegian Ministry of Petroleum and Energy (OED) has funded an Intsok study on local content and how to improve the capabilities of Nigerian supply and service companies. The study will also assess potential for cooperation between Norwegian and Nigerian enterprises. Intsok/OED has commissioned SNF to undertake the study jointly with Rogaland Research and Kragha and Associates in Nigeria.

Résumé

The report is based on an assessment expert workshop designed for collective handling of complex problems and issues. This part of the overall project had focus upon the prospects of E&P technology and competence requirements related to the Nigerian upstream oil and gas industry, with a view to assess the status of technology and competence requirements applied for E&P operations (exploration, field development, production) and to identify areas with the largest potential for Nigerian local short and mid term contribution.

Different methods such as structured assessment and ranking against multiple criteria were supported by techniques like brainstorming and collective consensus building to arrive at an evaluation of a representative range of E&P technologies.

This report supplements the report 2003/027 "Assessment of E&P Technology in Nigeria" and includes graphs showing the ranking of all specific technologies against the evaluation criteria.

Thanks to contributors.

The project would like to acknowledge the assistance of Mr. Moses Kragha and Associates in the organising of the expert workshop on E&P technology assessment set up in Lagos November 6, 2002. This acknowledgement also extends to all the 15 experts who dedicatedly worked through a series of assignments on various aspects of E&P technologies pertaining to the ambition of increasing local content.

Stavanger, 4 February 2003

Jan Erik Karlsen, project leader

Contents

1 Introduction

1.1 Background of the project

The project was established to address technological and institutional aspects of the development and utilisation of offshore petroleum resources in Nigeria.

Objective:

1. Assess the enabling environment for private sector development in the Nigerian upstream petroleum industry
2. Recommend ways and means of increasing and improving the capabilities of Nigerian supply and service companies
3. Assess areas of co-operation where the Norwegian business community can enhance employment, revenue generation and other development effects

Client: Intsok

Donors: NORAD (Norwegian Agency for Development Cooperation), OED (Norway Ministry of Petroleum and Energy)

Methods:

- Supply and Value Chain analyses
- Technology assessment and foresight analyses
- Policy assessment
- Gap analyses
- Expert assessment
- Comparative case studies

Project organisation: International consortium constituted with Nigerian / Norwegian partnership of SNF, Kragha & Associates and RF.

Time frame: Pilot study (August 2002- February 2003)

1.2 Definition of 'local content'

"The quantum of composite value added to, or created in the Nigerian economy without compromising quality, health, safety and environmental standards"

"Value added": - *Human*; as % of total employment, per skills level
- *Material and services*; stated as % of total price

E.g. 100% value added for:

- All manufacture in Nigeria with Nigerian raw materials
- Consultancies by Nigerians
- Leased equipment from 100% Nigerian companies

E.g. for non-Nigerian goods sold by 100% Nigerian companies, value added =

- finishing in Nigeria or,
- % of amount over and above that paid to the overseas supplier

2 Technology assessment

This part of the overall project had focus upon the present status and future prospects of E&P technology and competence requirements related to the Nigerian upstream oil and gas industry, with a view to:

- Assess the status of technology and educational/competence requirements applied for E&P operations (exploration, field development, production);
- Identify areas with the largest potential for Nigerian local short term contribution;
- Assess trends and forecasts for Nigerian mid term E&P activities.

By *technology* is meant the whole complex of knowledge, skills, routines, competence, equipment and engineering practices which is necessary to design and produce a product, process or service.

The technology assessment was organised prior to the policy gap analysis workshop in order to list and rank E&P technologies conducive to increasing Nigerian local content in the upstream sector.

3 Expert workshop arrangement

3.1 Objective for the Technology assessment workshop

The workshop took place on 6th November 2002 with 15 experts attending (see Appendix A).

The purpose of the technology assessment workshop was to evaluate E&P technologies with respect to

- current level of competence;
- criticality for contribution to new field discoveries and developments;
- potential for impact on local content in the Nigerian E&P industry.

3.2 Scope for the Technology assessment workshop

Prior to the workshop and as basis for the expert assessment, an inventory of proven E&P technologies applicable for the Nigerian context was prepared. The main focus was towards exploitation of the frontier deep sea blocks, as it is believed these will contribute most in the upcoming era of Nigerian E&P development.

The technology inventory was organised along field lifecycle phases (*Exploration*, *Field development* and *Production*) and grouped into 17 major technology areas. The technology areas were further detailed into 117 functionally oriented specific technologies. An overview of the technology inventory is included in appendix A.

In the expert workshop the technology areas and specific technologies would be evaluated and ranked against the following set of criteria:

1. To what extent the technology is critical for improving **discovery** and **cost-effective exploitation** of Nigerian petroleum reserves in the future.
2. To what extent the technology area can contribute to **improved HSE standards** (e.g. personnel safety and external environment protection).
3. Current **competence** in the Nigerian environment (universities, R&D institutions, local industry) relative to leading international competence.
4. To what extent their application can contribute to new **Nigerian employment**, both directly and indirectly
5. Realistic potential for increased share of **locally manufactured equipment** from Nigerian supply and service industry
6. To what extent they offer realistic development potential for **local expertise** (personnel) within Nigerian supply and service industry as well as Operator companies

The score for each technology against each criterion was made on a scale from 1 (low) to 10 (high).

3.3 Working mode

Against the criteria set out above, the expert panel would through a series of steps:

a) set up in pairs, rank all the 17 technology areas against criteria 3-6 and reach consensus;

b) set up in pairs, for each technology area, pick at least 5 critical and prioritised specific technologies, rank those against all 6 criteria and reach consensus;

c) set up in three groups, for each technology area, rank at least 5 critical technologies against all 6 criteria and reach consensus;

d) group presentations of results.

The time available became somewhat limited due to delayed start, thus item c) had to be reduced in scope to ranking by technology area level rather than on specific technologies.

4 Results

The material produced in the expert workshop was analysed with the main findings presented in report RF–2003/027 “Assessment of E&P Technology in Nigeria”.

The main report aggregated information to technology *area* level. This report includes the ranking of each individual technology as it resulted from the pair consensus evaluation of the most dominant technologies within each technology area.

5 Expert assessment of specific technologies

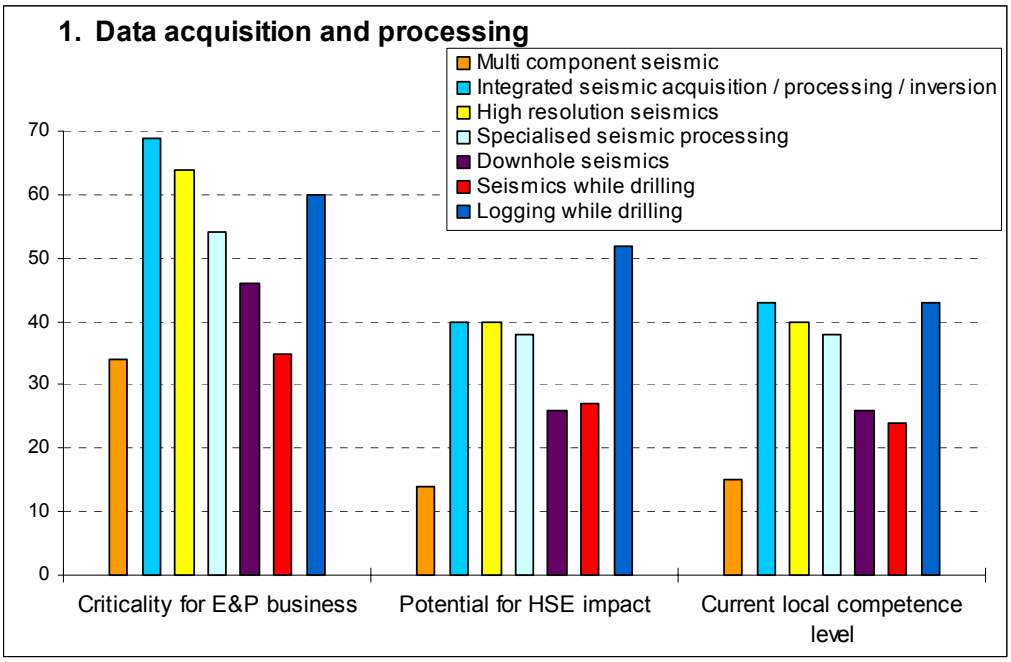
The graphs show the pair wise ranking of all technologies against the evaluation criteria. The participants were asked to apply scores to at least 5 specific technologies within each technology area. With 7 pairs applying a scale from 0 to 10, the maximum score for a specific technology is 70.

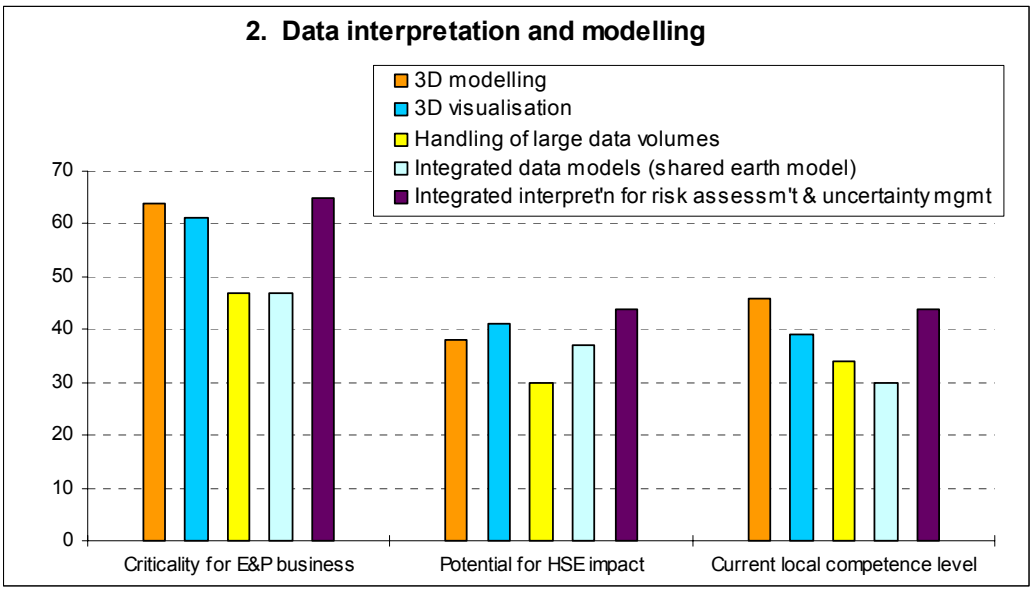
The scoring was distributed amongst the technologies within each technology area. Thus, in areas with many specific technologies listed, the individual technology receives generally lower score levels. The relative ranking within the technology area is here more important than the absolute score for a certain technology.

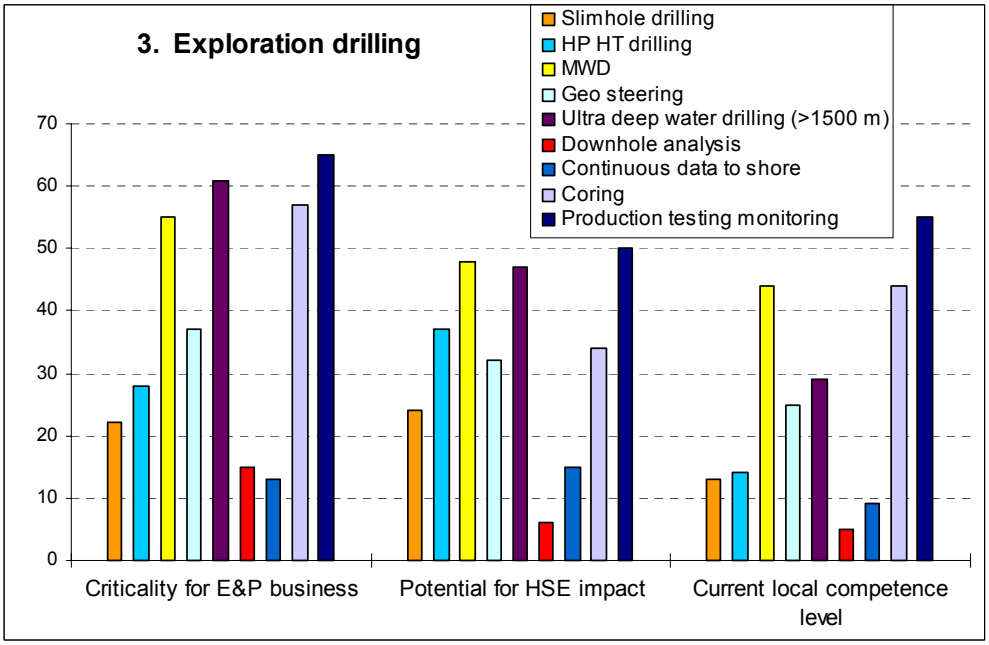
5.1 Ranking on Criticality, HSE and Current Competence criteria

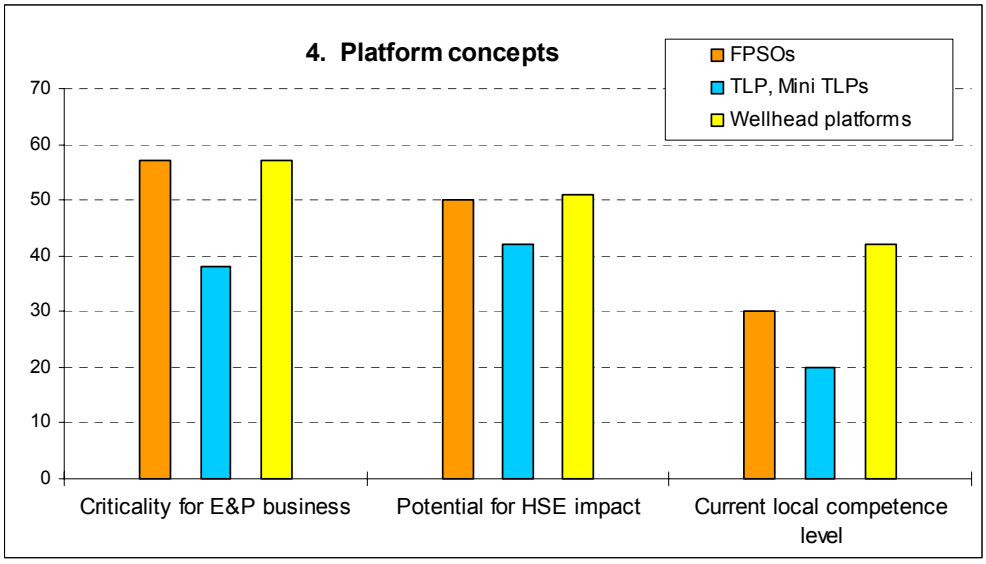
The graphs in this section show the technology's scores against criteria , 2 and 3, i.e. the panel's view on

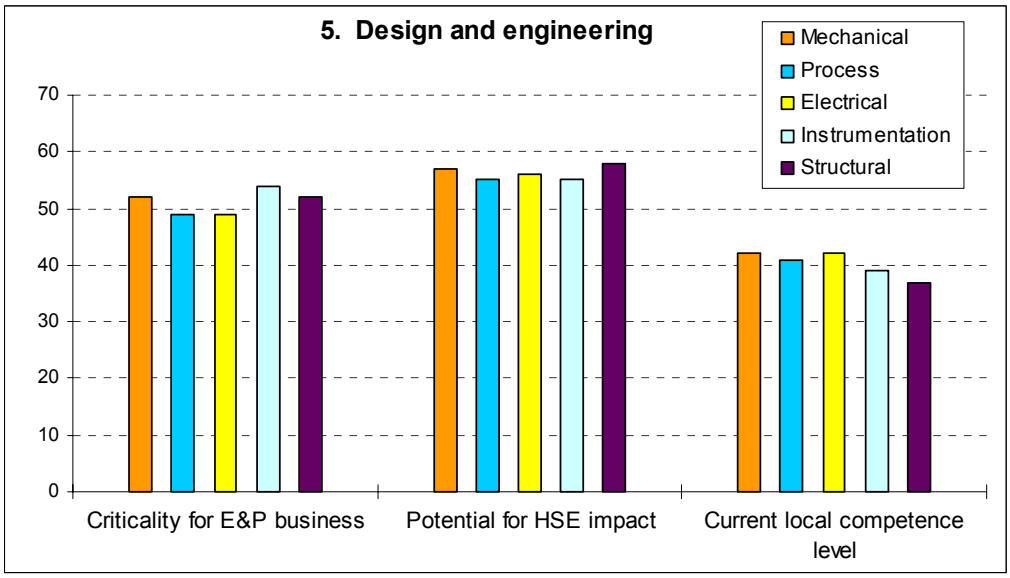
1. To what extent the technology is critical for improving **discovery** and **cost-effective exploitation** of Nigerian petroleum reserves in the future.
2. To what extent the technology area can contribute to **improved HSE standards** (e.g. personnel safety and external environment protection).
3. To what extent the technology area can contribute to **improved HSE standards** (e.g. personnel safety and external environment protection).

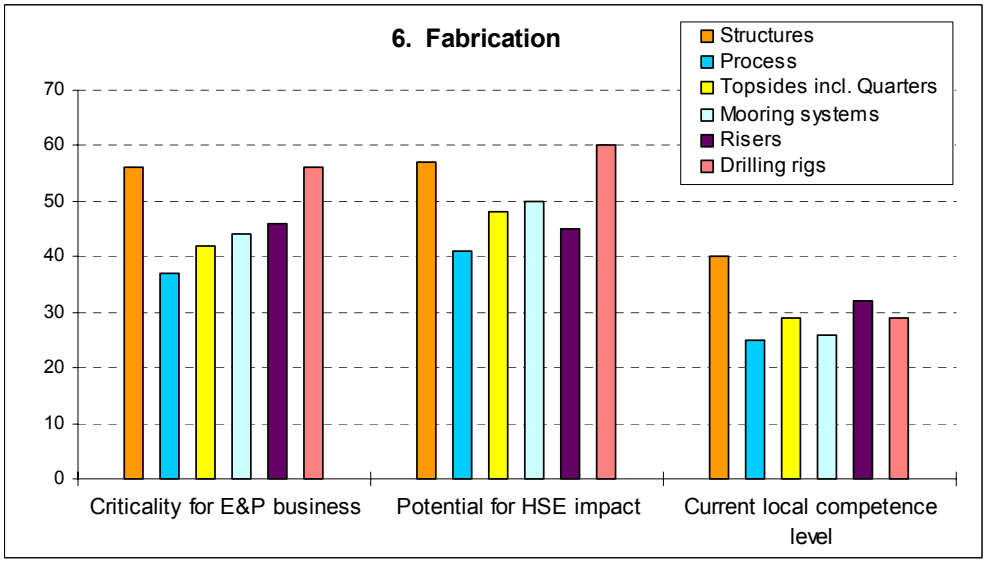


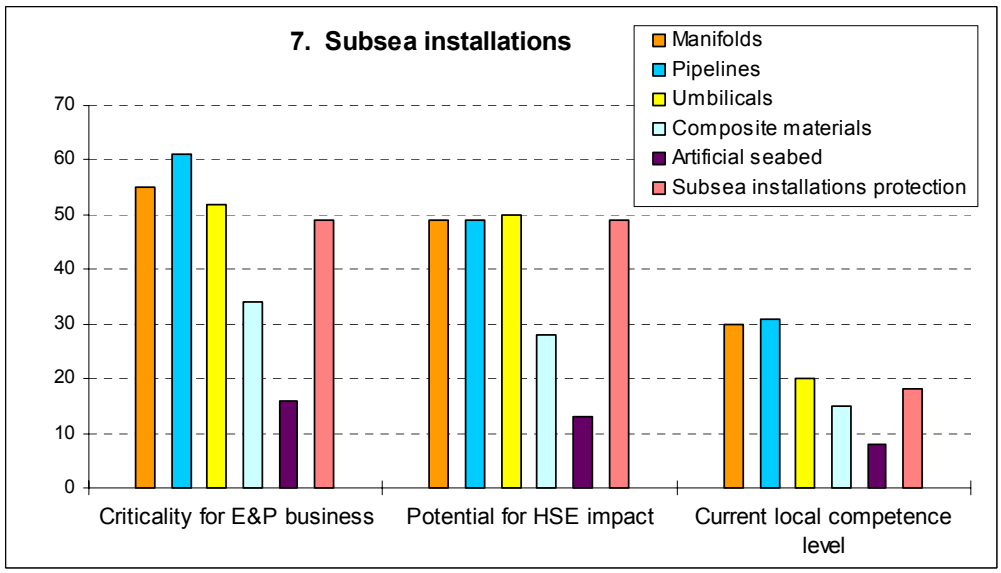

2. Data interpretation and modelling
3D modelling
3D visualisation
Handling of large data volumes
Integrated data models (shared earth model)
Integrated interpret'n for risk assessm't & uncertainty mgmt
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level

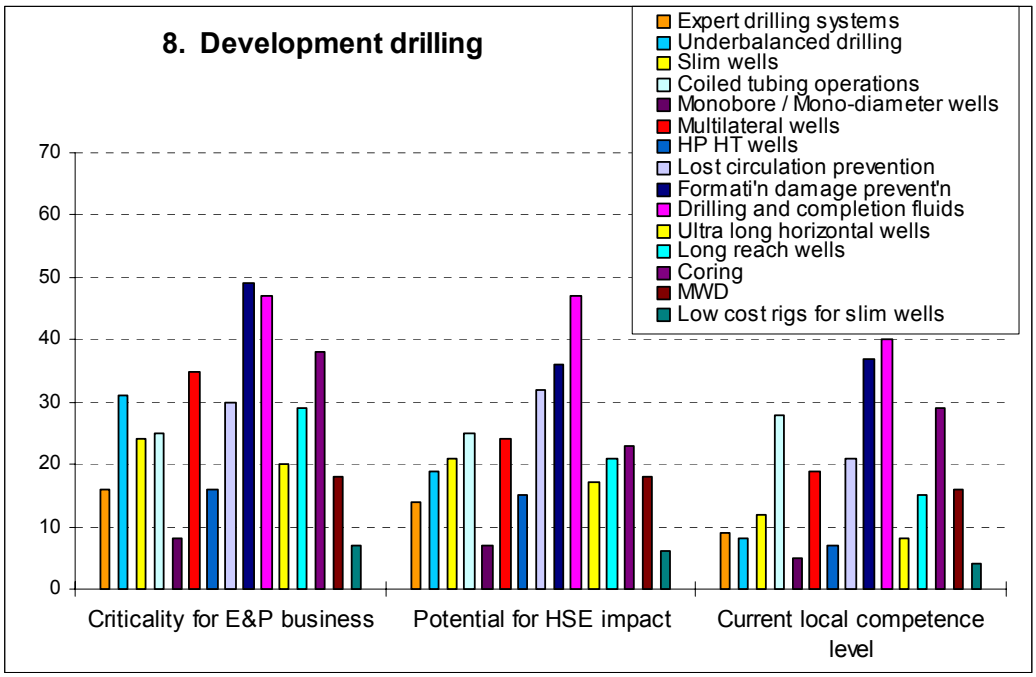

3. Exploration drilling
Slimhole drilling
HP HT drilling
MWD
Geo steering
Ultra deep water drilling (>1500 m)
Downhole analysis
Continuous data to shore
Coring
Production testing monitoring
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level

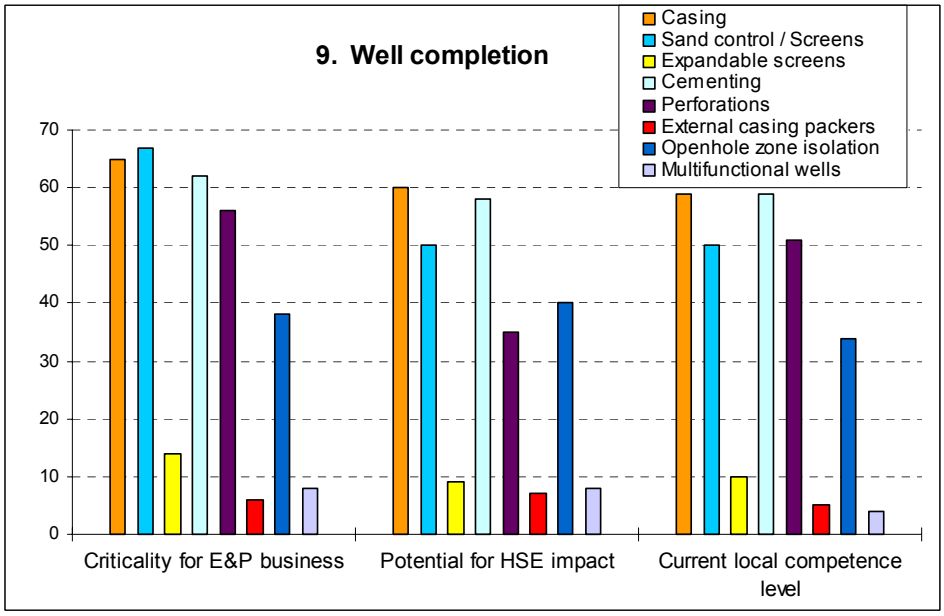

4. Platform concepts
FPSOs
TLP, Mini TLPs
Wellhead platforms
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level

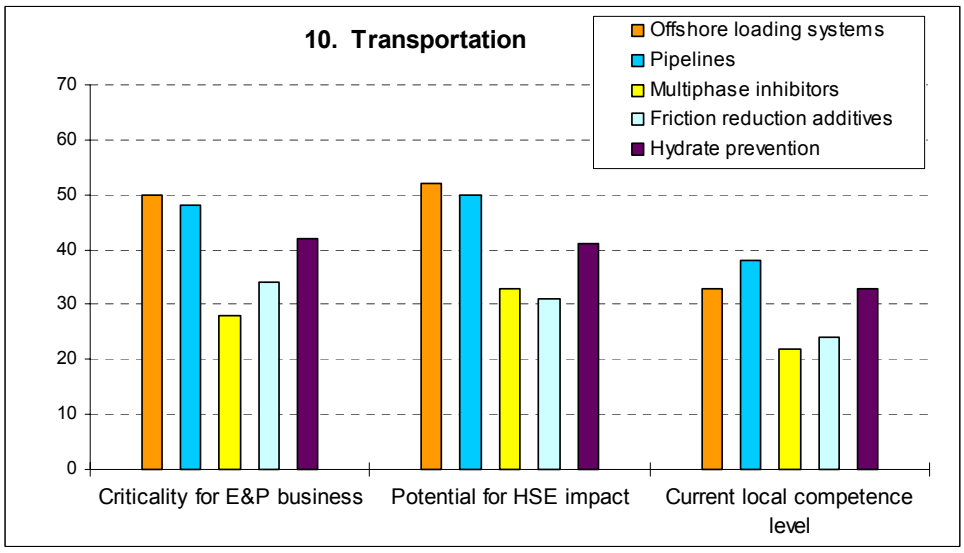

5. Design and engineering
Mechanical
Process
Electrical
Instrumentation
Structural
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level

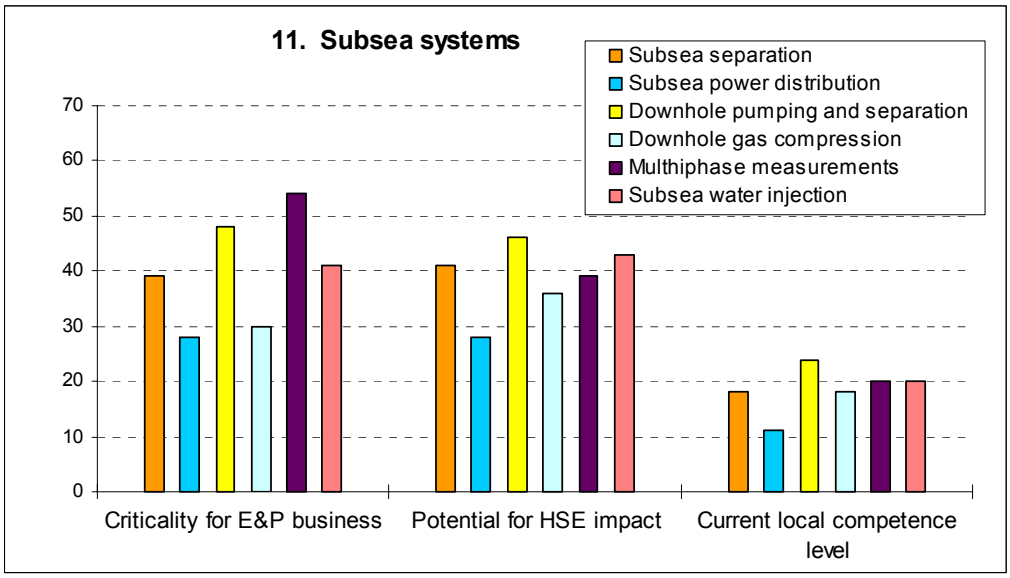

6. Fabrication
Structures
Process
Topsides incl. Quarters
Mooring systems
Risers
Drilling rigs
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level

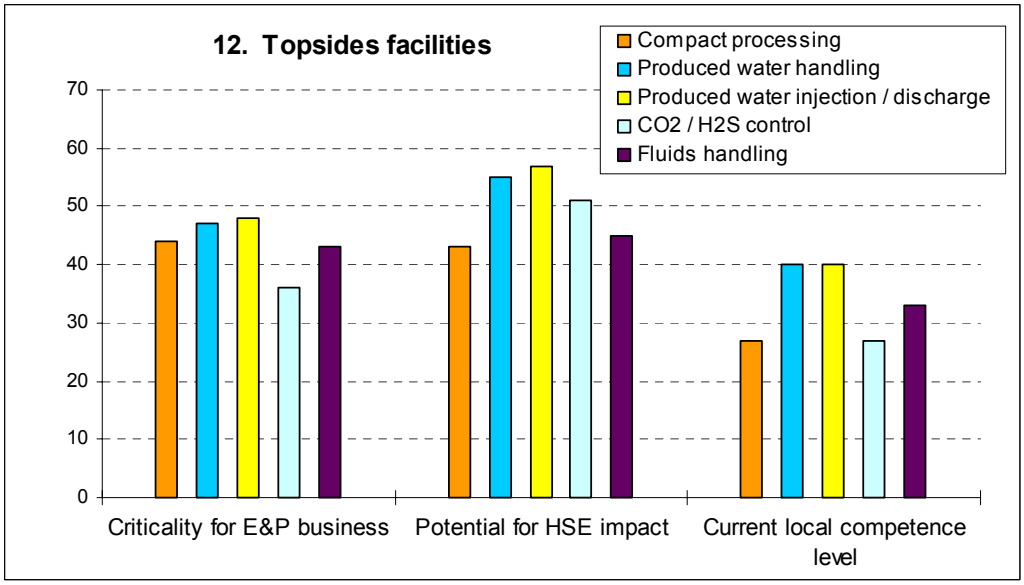

7. Subsea installations
Manifolds
Pipelines
Umbilicals
Composite materials
Artificial seabed
Subsea installations protection
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level

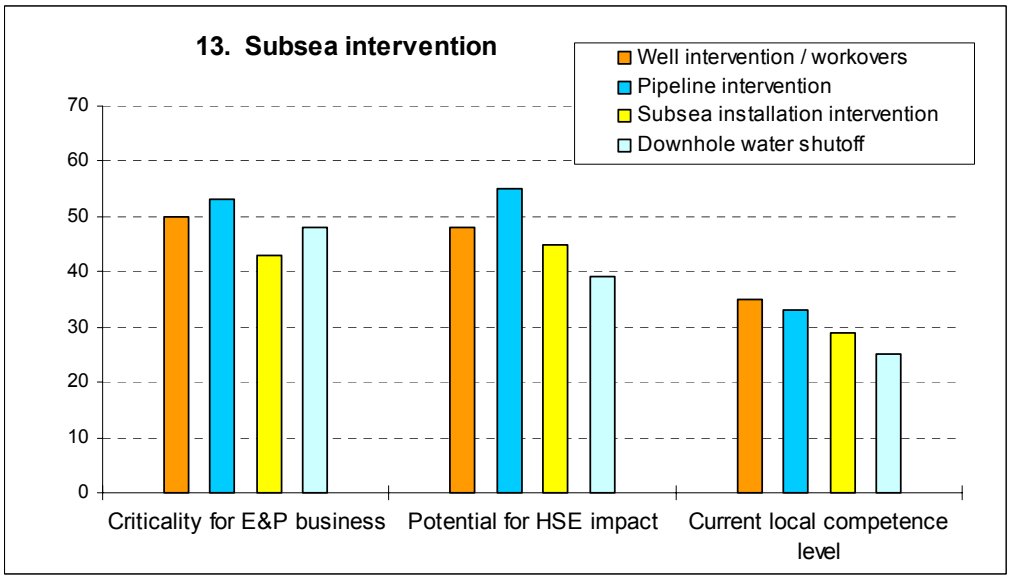

8. Development drilling
Expert drilling systems
Underbalanced drilling
Slim wells
Coiled tubing operations
Monobore / Mono-diameter wells
Multilateral wells
HP HT wells
Lost circulation prevention
Formati'n damage prevent'n
Drilling and completion fluids
Ultra long horizontal wells
Long reach wells
Coring
MWD
Low cost rigs for slim wells
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level

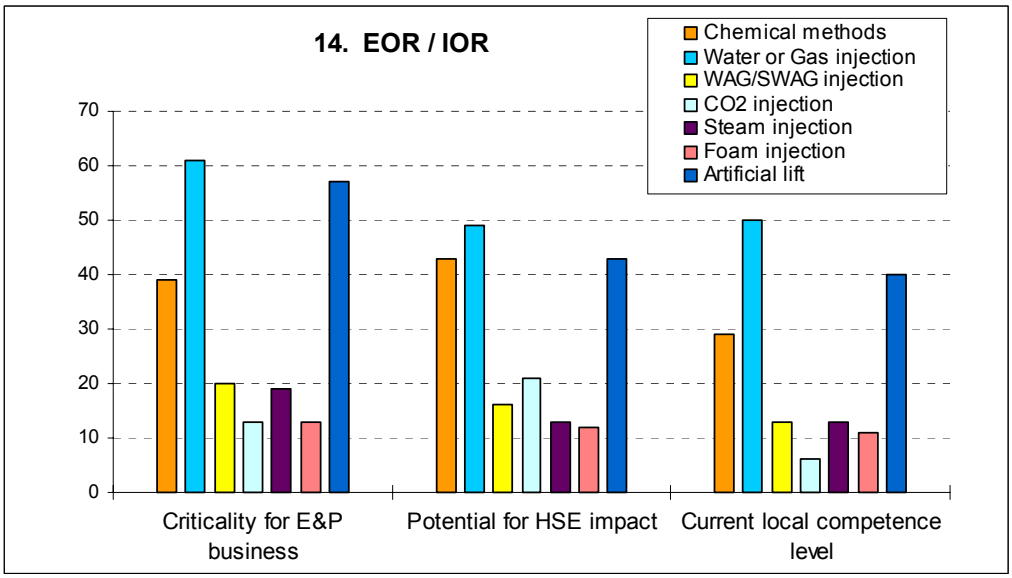

9. Well completion
Casing
Sand control / Screens
Expandable screens
Cementing
Perforations
External casing packers
Openhole zone isolation
Multifunctional wells
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level

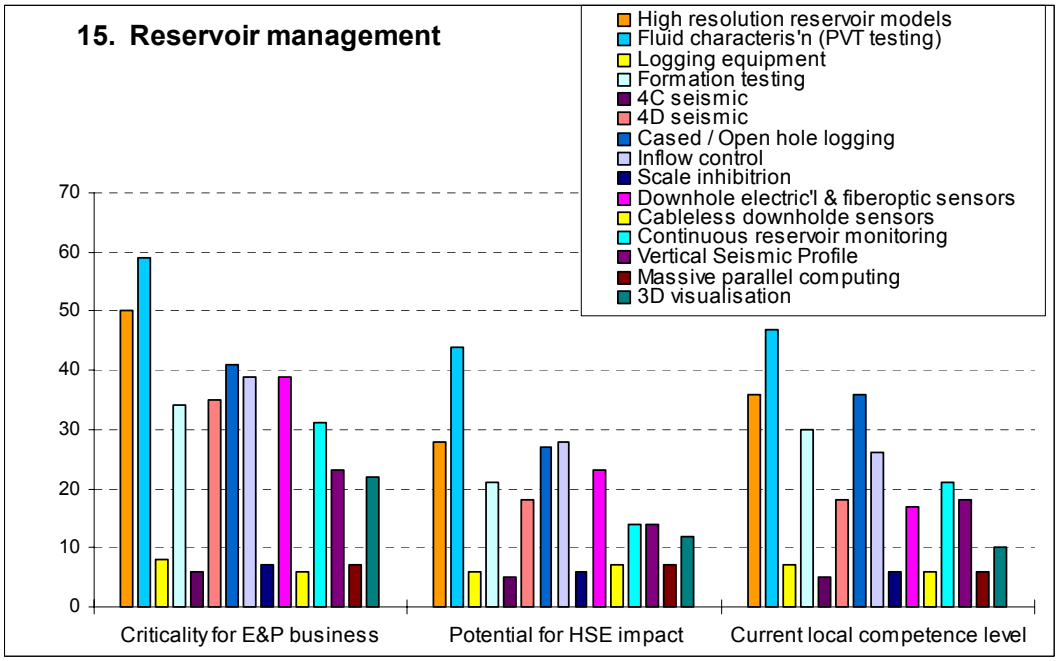

10. Transportation
Offshore loading systems
Pipelines
Multiphase inhibitors
Friction reduction additives
Hydrate prevention
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level

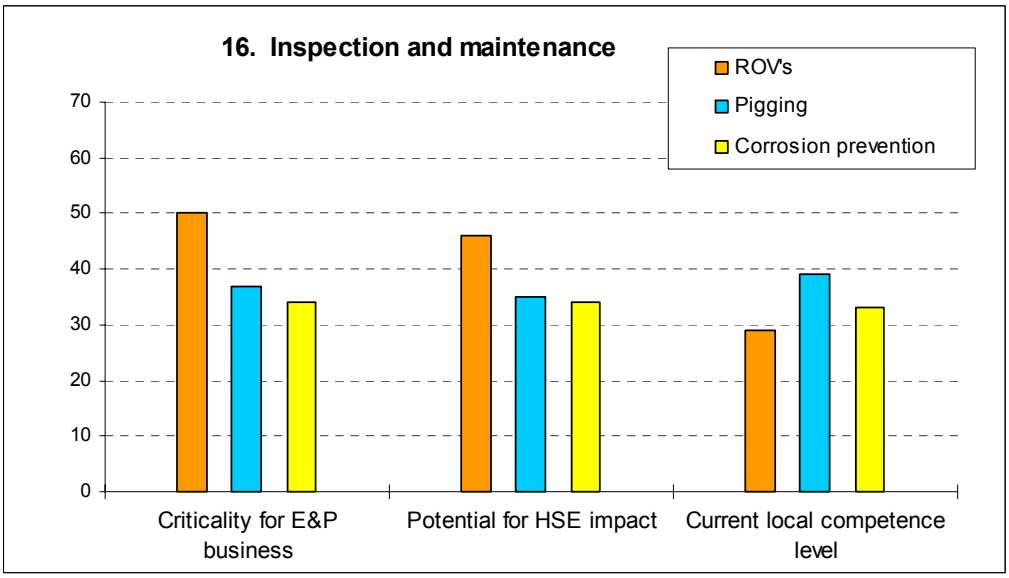

11. Subsea systems
Subsea separation
Subsea power distribution
Downhole pumping and separation
Downhole gas compression
Multiphase measurements
Subsea water injection
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level

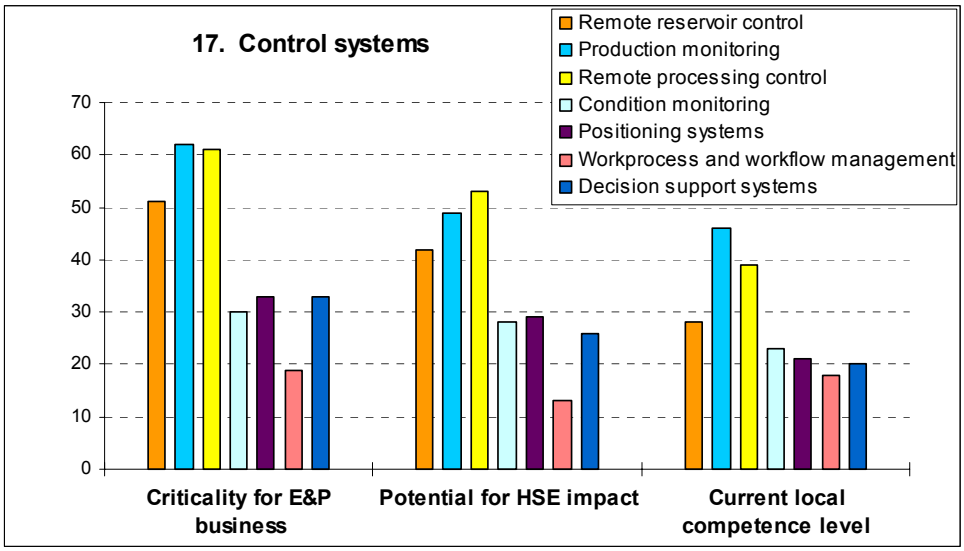

12. Topsides facilities
Compact processing
Produced water handling
Produced water injection / discharge
CO2 / H2S control
Fluids handling
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level


13. Subsea intervention
Well intervention / workovers
Pipeline intervention
Subsea installation intervention
Downhole water shutoff
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level


14. EOR / IOR
Chemical methods
Water or Gas injection
WAG/SWAG injection
CO2 injection
Steam injection
Foam injection
Artificial lift
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level


15. Reservoir management
High resolution reservoir models
Fluid characteris'n (PVT testing)
Logging equipment
Formation testing
4C seismic
4D seismic
Cased / Open hole logging
Inflow control
Scale inhibitrion
Downhole electric'l & fiberoptic sensors
Cableless downholde sensors
Continuous reservoir monitoring
Vertical Seismic Profile
Massive parallel computing
3D visualisation
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level

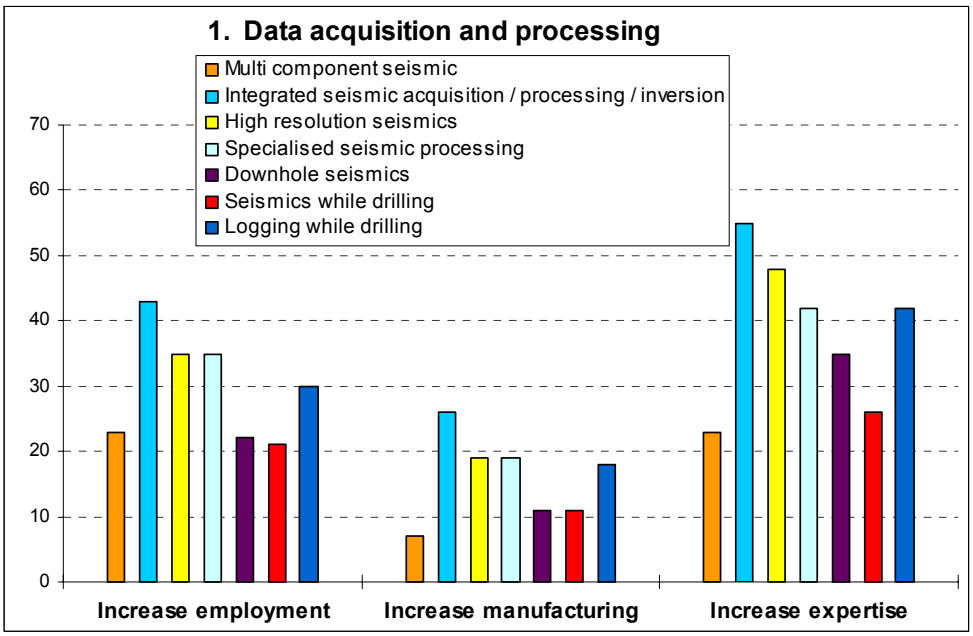

16. Inspection and maintenance
ROV's
Pigging
Corrosion prevention
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level

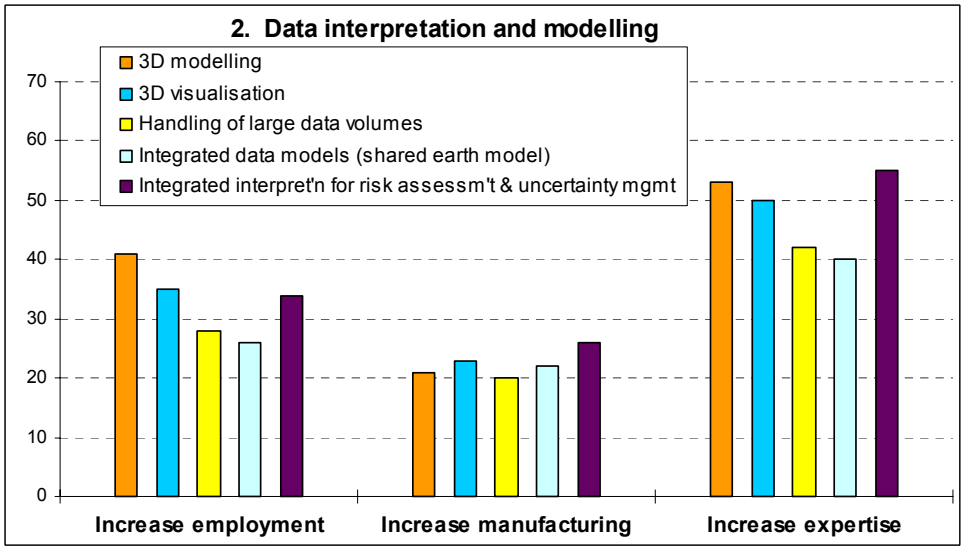

17. Control systems
Remote reservoir control
Production monitoring
Remote processing control
Condition monitoring
Positioning systems
Workprocess and workflow management
Decision support systems
70
60
50
40
30
20
10
0
Criticality for E&P business
Potential for HSE impact
Current local competence level

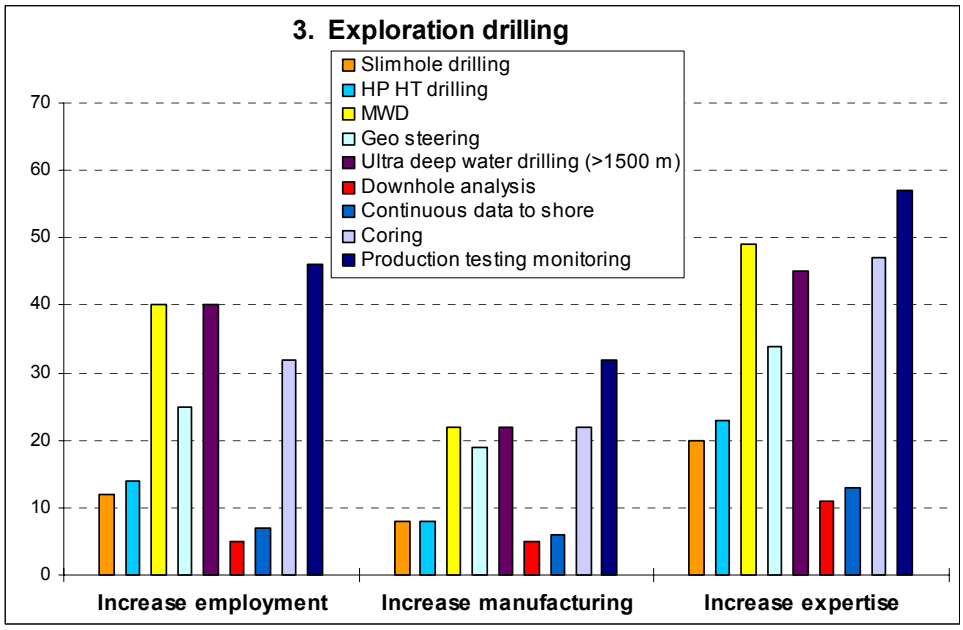
5.2 Ranking on Local Content criteria

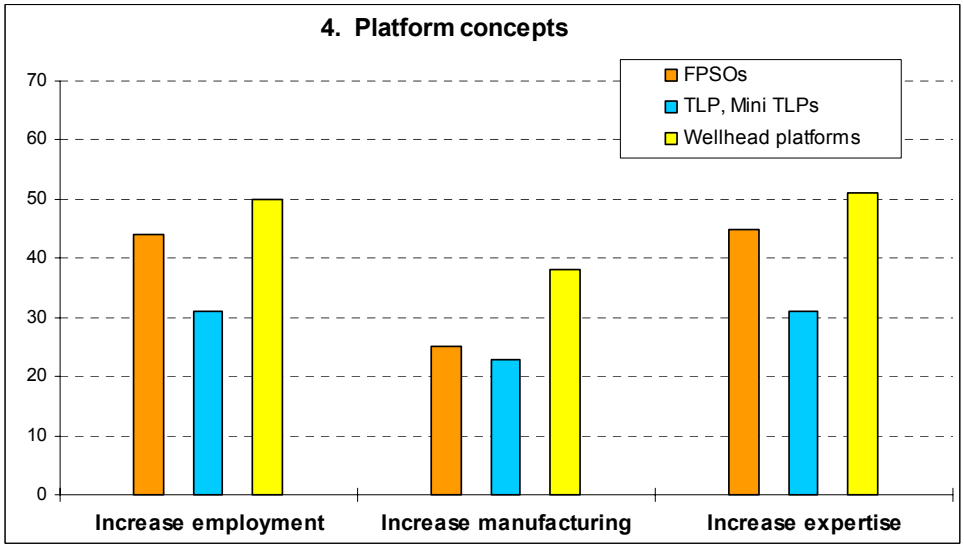
The graphs in this section show the technology's scores against criteria 4, 5 and 6, i.e. the panel's view on

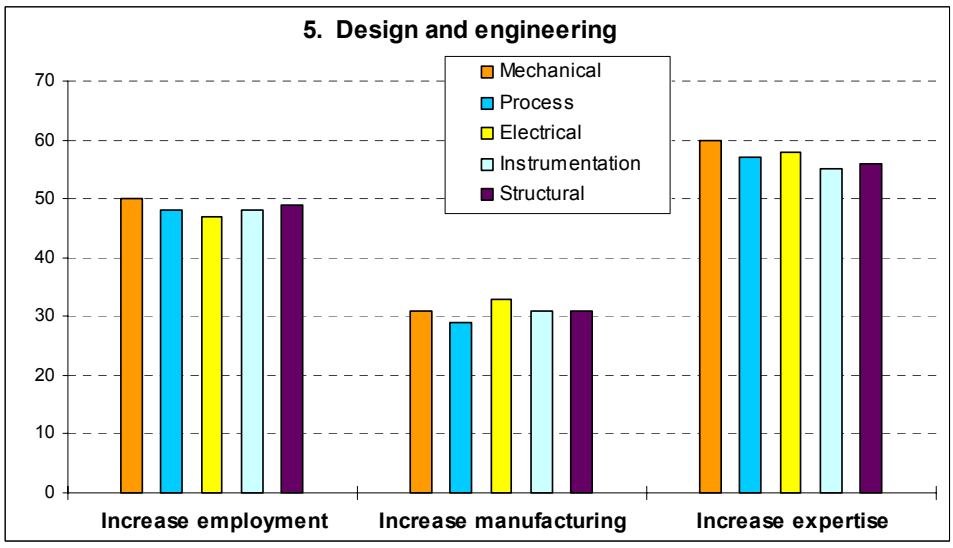
4. To what extent their application can contribute to new **Nigerian employment**, both directly and indirectly
5. Realistic potential for increased share of **locally manufactured equipment** from Nigerian supply and service industry
6. To what extent they offer realistic development potential for **local expertise** (personnel) within Nigerian supply and service industry as well as Operator companies

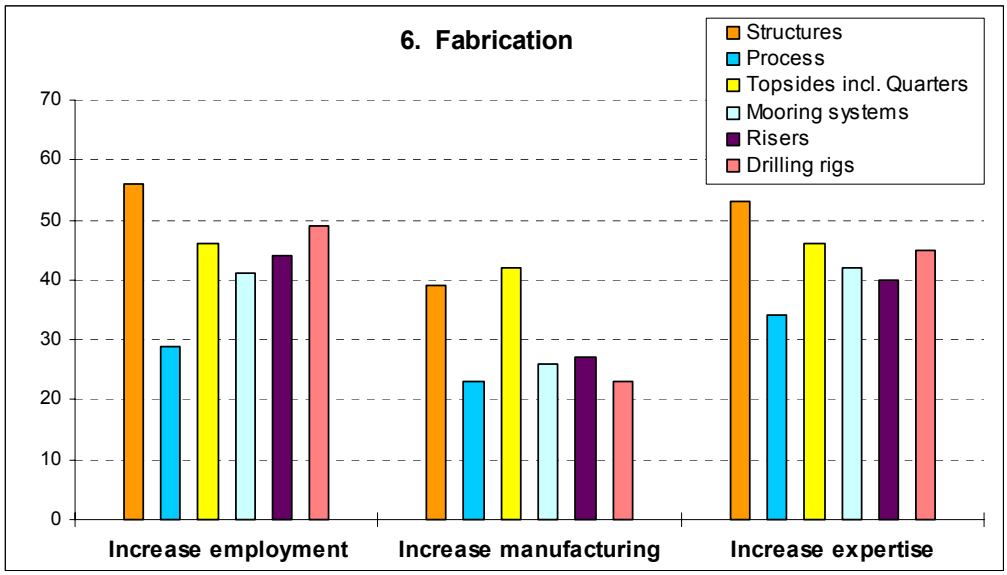


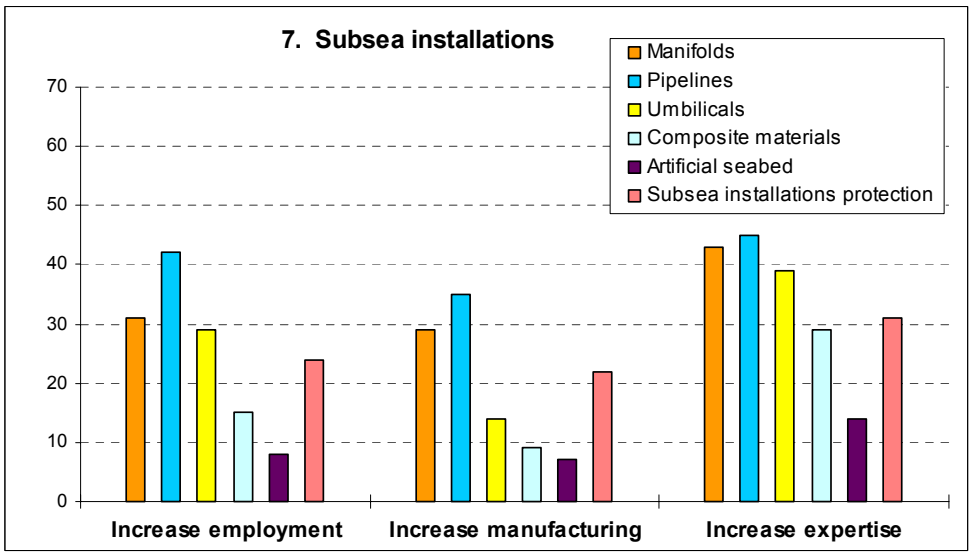


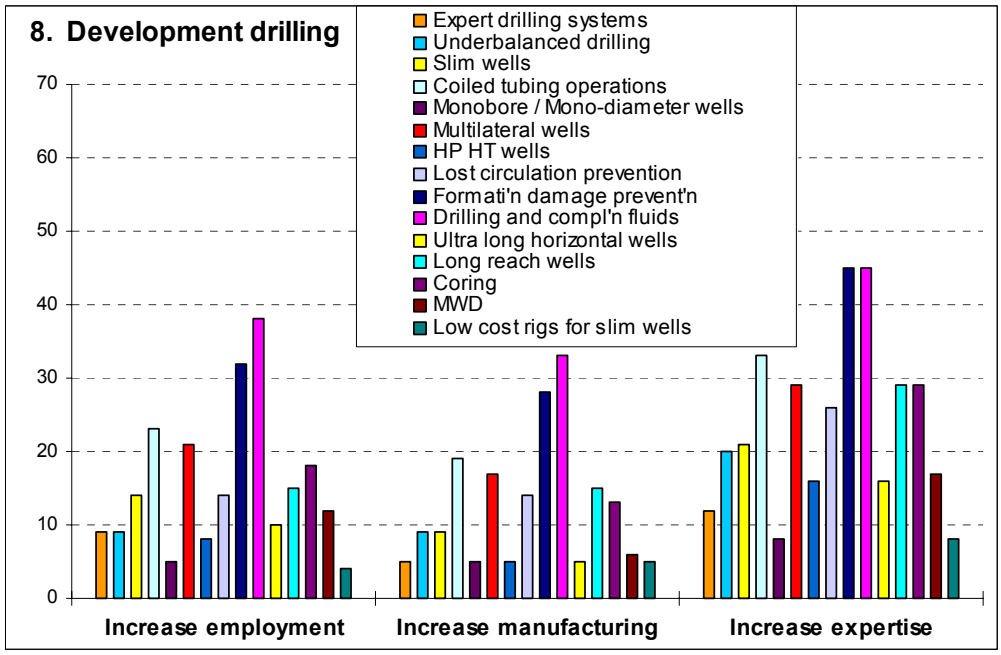

3. Exploration drilling
Slimhole drilling
HP HT drilling
MWD
Geo steering
Ultra deep water drilling (>1500 m)
Downhole analysis
Continuous data to shore
Coring
Production testing monitoring
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise


4. Platform concepts
FPSOs
TLP, Mini TLPs
Wellhead platforms
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise


5. Design and engineering
Mechanical
Process
Electrical
Instrumentation
Structural
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise


6. Fabrication
Structures
Process
Topsides incl. Quarters
Mooring systems
Risers
Drilling rigs
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise


7. Subsea installations
Manifolds
Pipelines
Umbilicals
Composite materials
Artificial seabed
Subsea installations protection
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise


8. Development drilling
Expert drilling systems
Underbalanced drilling
Slim wells
Coiled tubing operations
Monobore / Mono-diameter wells
Multilateral wells
HP HT wells
Lost circulation prevention
Formati'n damage prevent'n
Drilling and compl'n fluids
Ultra long horizontal wells
Long reach wells
Coring
MWD
Low cost rigs for slim wells
70
60
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30
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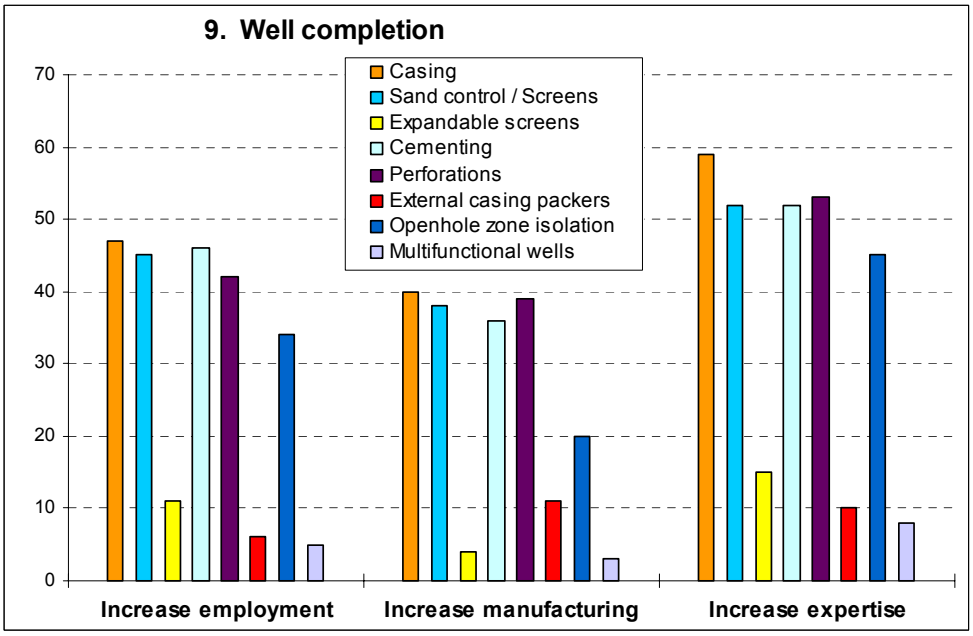
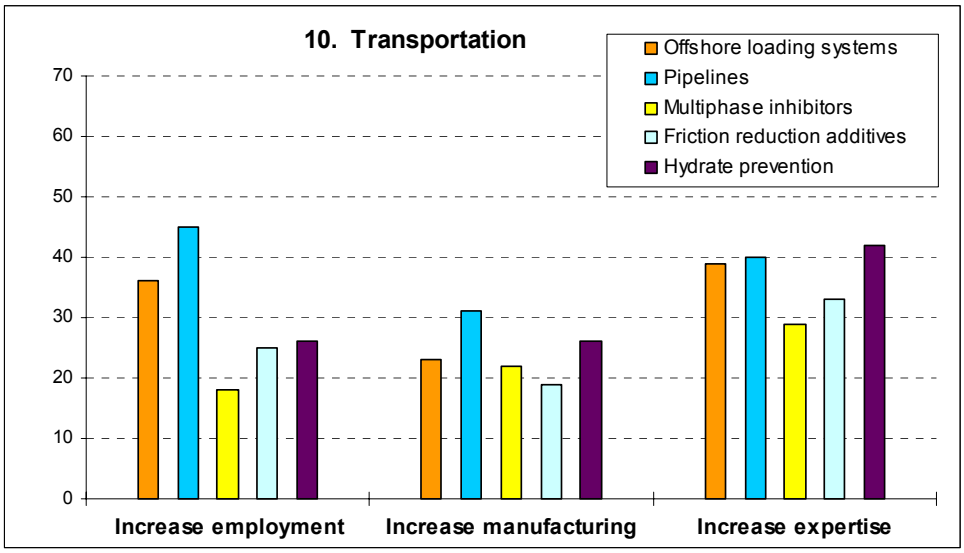
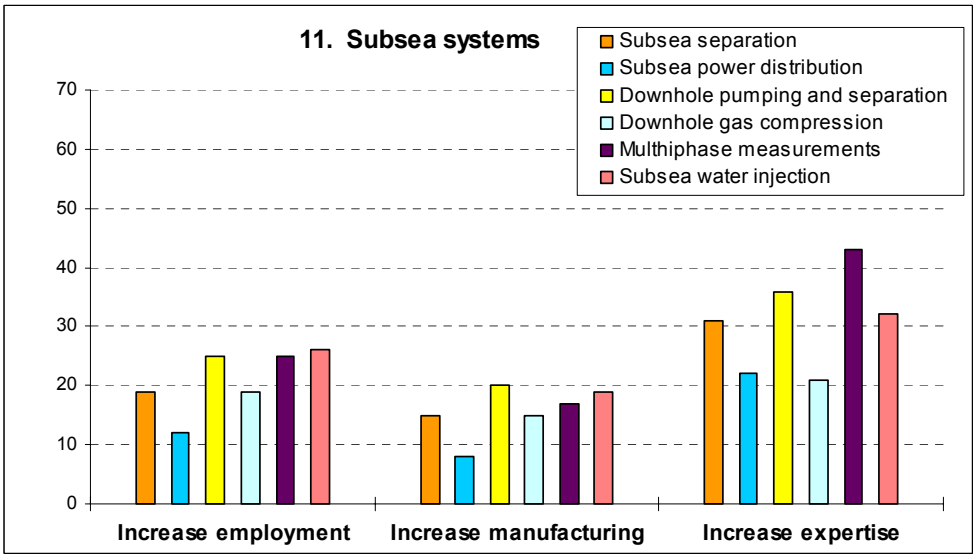
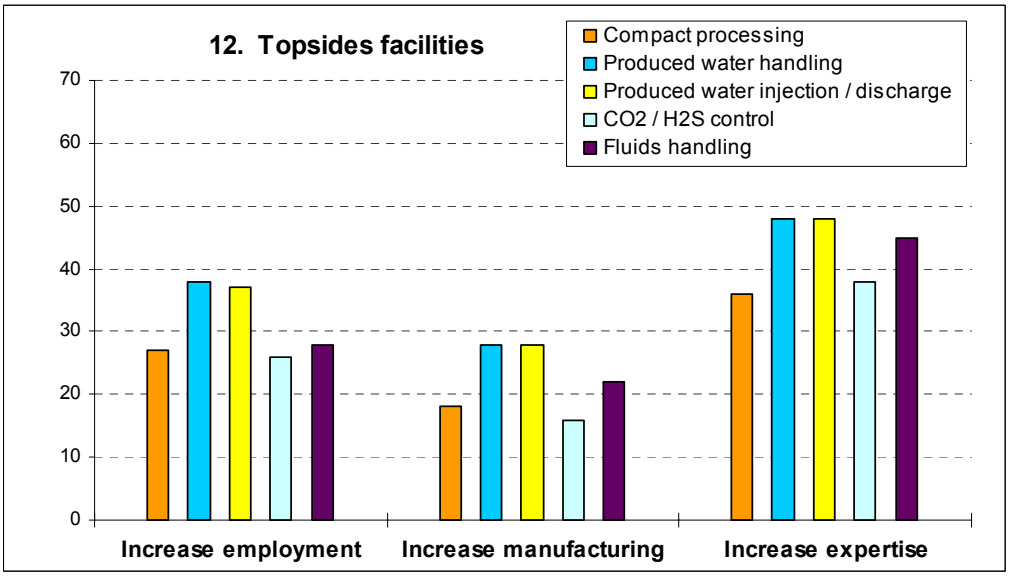
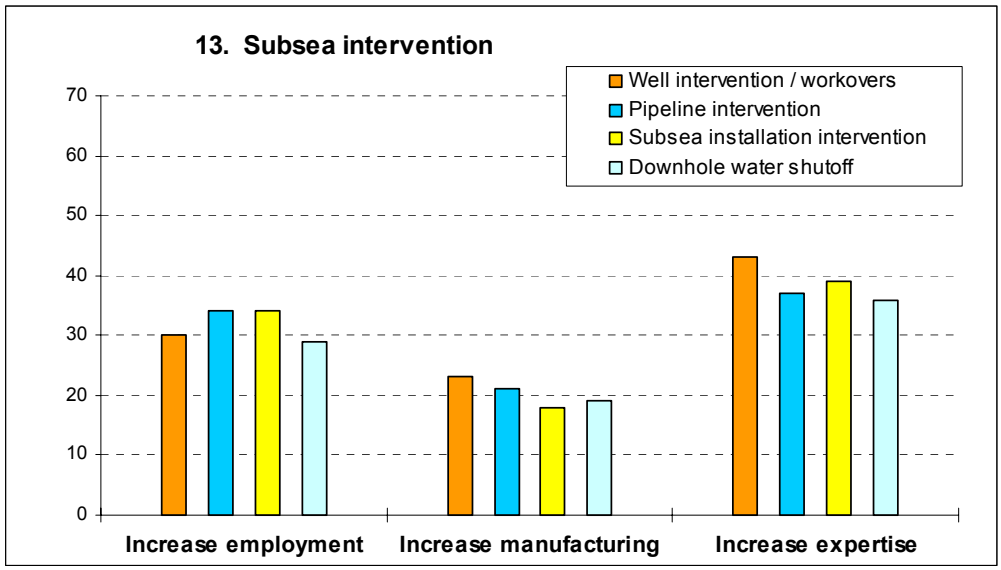
Increase employment
Increase manufacturing
Increase expertise

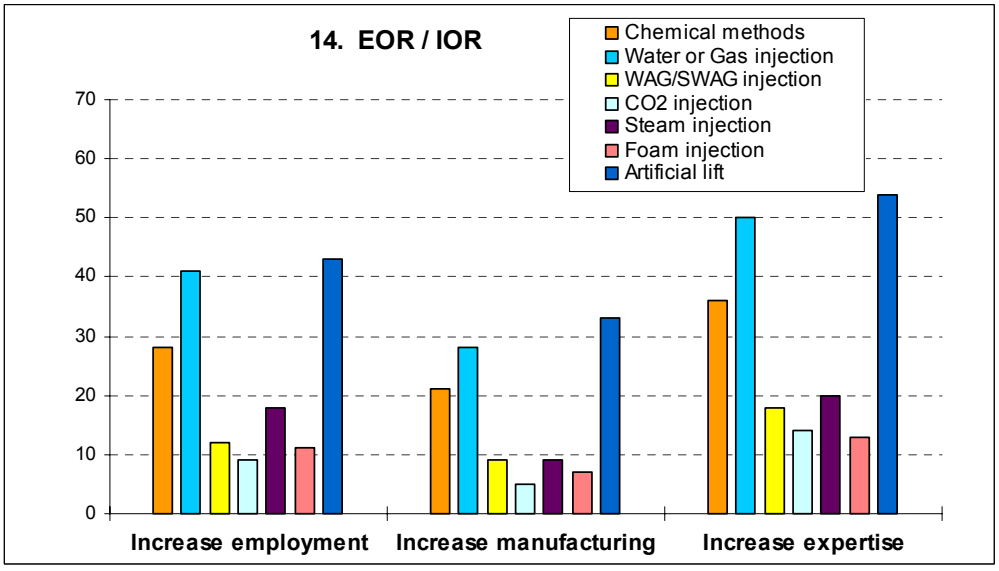

9. Well completion
Casing
Sand control / Screens
Expandable screens
Cementing
Perforations
External casing packers
Openhole zone isolation
Multifunctional wells
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise

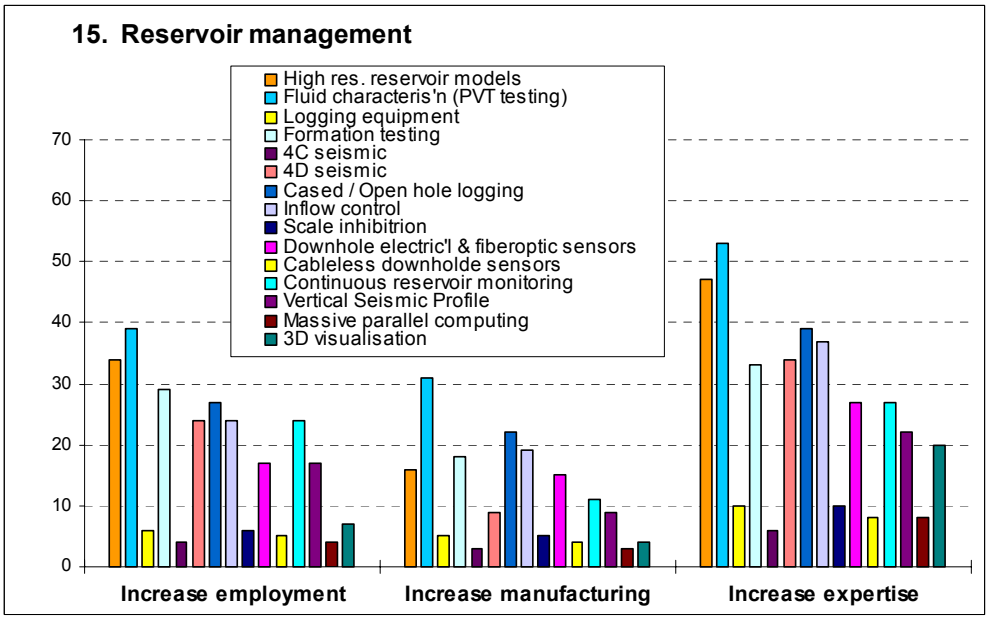

10. Transportation
Offshore loading systems
Pipelines
Multiphase inhibitors
Friction reduction additives
Hydrate prevention
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise

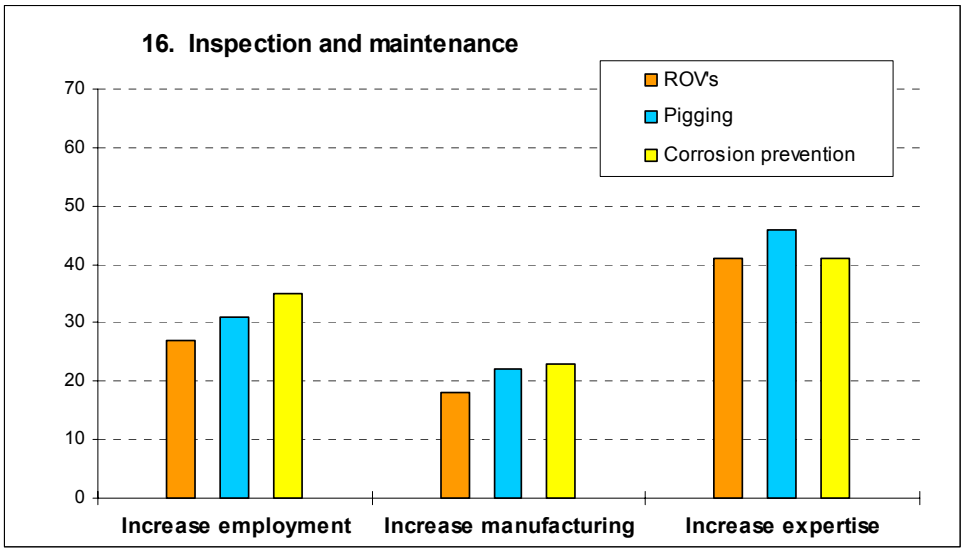

11. Subsea systems
Subsea separation
Subsea power distribution
Downhole pumping and separation
Downhole gas compression
Multiphase measurements
Subsea water injection
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise

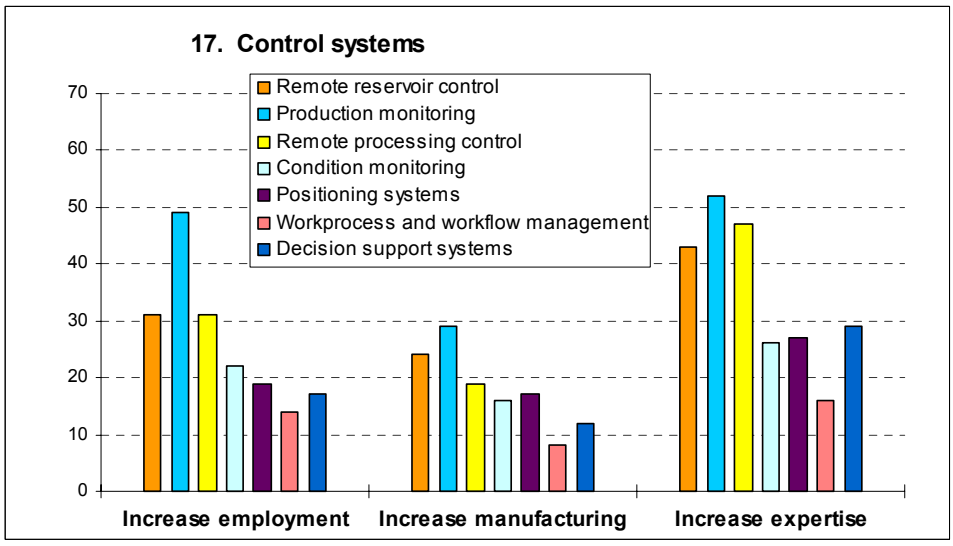

12. Topsides facilities
Compact processing
Produced water handling
Produced water injection / discharge
CO2 / H2S control
Fluids handling
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise


13. Subsea intervention
Well intervention / workovers
Pipeline intervention
Subsea installation intervention
Downhole water shutoff
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise


14. EOR / IOR
Chemical methods
Water or Gas injection
WAG/SWAG injection
CO2 injection
Steam injection
Foam injection
Artificial lift
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise


15. Reservoir management
High res. reservoir models
Fluid characteris'n (PVT testing)
Logging equipment
Formation testing
4C seismic
4D seismic
Cased / Open hole logging
Inflow control
Scale inhibitrion
Downhole electric'l & fiberoptic sensors
Cableless downholde sensors
Continuous reservoir monitoring
Vertical Seismic Profile
Massive parallel computing
3D visualisation
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise


16. Inspection and maintenance
ROV's
Pigging
Corrosion prevention
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise


17. Control systems
Remote reservoir control
Production monitoring
Remote processing control
Condition monitoring
Positioning systems
Workprocess and workflow management
Decision support systems
70
60
50
40
30
20
10
0
Increase employment
Increase manufacturing
Increase expertise

Appendix A – List of participants (Expert panel)

Dr. G.S. Ihetu	GSI consulting
Chief C.J. Ikelionwu	Tinomek consulting
Axel Destremau	Schlumberger
W.A. Akinsipe	DPR
M.J Orife	Versa-Tech
O.M. Otabor	SPE
D. Osinusi	Mansfield/Reslink
Prof. J.C. Igbeka	University of Ibadan
Prof. G.K. Falade	University of Ibadan
T.M Gbugu	NAPIMS
Sola Oyinola	Schlumberger
Engi.U.J Otokpa	NAPIMS
A Shehu	NAPIMS
Dr. O.A.Lalude	Omega Petroleum
O. Olaosebikan	NAPIMS

Appendix B – Technology inventory

17 TECHNOLOGY AREAS:

Exploration and Appraisal

1. *Data acquisition and processing*
2. *Data interpretation and modelling*
3. *Exploration drilling*

Field Development

4. *Platform concepts*
5. *Design and engineering*
6. *Fabrication*
7. *Subsea*
8. *Development drilling*
9. *Well completion*

Production

10. *Transportation*
11. *Subsea systems*
12. *Topsides facilities*
13. *Subsea intervention*
14. *EOR / IOR*
15. *Reservoir management*
16. *Inspection and maintenance*
17. *Control systems*

117 SPECIFIC TECHNOLOGIES:

Exploration and Appraisal

1. *Data acquisition and processing*
   - Multi component seismic
   - Integrated seismic acquisition / processing / inversion
   - High resolution seismics
   - Specialised seismic processing
   - Downhole seismics
   - Seismics while drilling
   - Logging while drilling

2. *Data interpretation and modelling*
   - 3D modelling
   - 3D visualisation
   - Handling of large data volumes
   - Integrated data models (shared earth model)
   - "Integrated interpretation for risk assessment and uncertainty management"

3. *Exploration drilling*
   - Slimhole drilling
   - HP HT drilling
   - MWD
   - Geo steering
   - Ultra deep water drilling (>1500 m)
   - Downhole analysis
   - Continuous data to shore
   - Coring
   - Production testing monitoring

Field Development

4. *Platform concepts*
   - FPSOs
   - TLP, Mini TLPs
   - Wellhead platforms

5. *Design and engineering*
   - Mechanical
   - Process
   - Electrical
   - Instrumentation
   - Structural

6. *Fabrication*
   - Structures
   - Process
   - Topsides incl. Quarters
   - Mooring systems
   - Risers
   - Drilling rigs

7. *Subsea installations*
   - Manifolds
   - Pipelines
   - Umbilicals
   - Composite materials
   - Artificial seabed
   - Subsea installations protection

8. *Development drilling*
   - Expert drilling systems
   - Underbalanced drilling
   - Slim wells
   - Coiled tubing operations
   - Monobore / Monodiameter wells
   - Multilateral wells
   - HP HT wells
   - Lost circulation prevention
   - Formation damage prevention
   - Drilling & completion fluids
   - Ultra long horizontal wells
   - Long reach wells
   - Coring
   - MWD
   - Low cost rigs for slim wells

9. *Well completion*
   - Casing
   - Sand control / Screens
   - Expandable screens
   - Cementing
   - Perforations
   - External casing packers
   - Openhole zone isolation
   - Multifunctional wells

Production

10. Transportation

- Offshore loading systems
- Pipelines
- Multiphase inhibitors
- Friction reduction additives
- Hydrate prevention

11. Subsea systems

- Subsea separation
- Subsea power distribution
- Downhole pumping and separation
- Downhole gas compression
- Multiphase measurements
- Subsea water injection

12. Topsides facilities

- Compact processing
- Produced water handling
- Produced water injection / discharge
- CO_2 / H_2S control
- Fluids handling

13. Subsea intervention

- Well intervention / workovers
- Pipeline intervention
- Subsea installation intervention
- Downhole water shutoff

14. EOR / IOR

- Chemical methods
- Water or Gas injection
- WAG/SWAG injection
- CO_2 injection
- Steam injection
- Foam injection
- Artificial lift

15. Reservoir management

- High resolution reservoir models
- Fluid characterisation (PVT testing)
- Logging equipment
- Formation testing
- 4C seismic
- 4D seismic
- Cased / Open hole logging
- Inflow control
- Scale inhibitrion
- Downhole electrical and fiberoptic sensors
- Cableless downhole sensors
- Continuous reservoir monitoring
- Vertical Seismic Profile
- Massive parallel computing
- 3D visualisation

16. Inspection and maintenance

- ROV's
- Pigging
- Corrosion prevention

17. Control systems

- Remote reservoir control
- Production monitoring
- Remote processing control
- Condition monitoring
- Positioning systems
- Workprocess and workflow management
- Decision support systems