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Implementation and Impact Evaluation of the Technology and Human Resources for Industry Programme (THRIP)

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Glossary

AMTS	Advanced Manufacturing Technology Strategy
ARC	Agricultural Research Council
ATP	Advanced Technology Programme
CRD	Collaborative Research Development
CREATE	Collaborative Research and Training Experience
DPME	Department of Performance Monitoring and Evaluation
DST	Department of Science and Technology
EU	European Union
FP	Framework Programme
GDP	Gross Domestic Product
HEI	Higher Education Institution
IP	Intellectual Property
IPR	Intellectual Property Rights
MCDM	Multi-criteria Decision Model
MCEP	Manufacturing Competitiveness Enhancement Programme
MIP	Manufacturing Investment Programme
NACI	National Advisory Council on Innovation
NECSA	Nuclear Energy Corporation of South Africa
NEPF	National Evaluation Policy Framework
NRF	National Research Foundation
NSERC	Natural Sciences and Engineering Research Council
NSI	National System of Innovation
OECD	Organisation for Economic Cooperation and Development
PFMA	Public Finance Management Act
R&D	Research and development
RoI	Return on Investment
Seda	Small Enterprise Development Agency
SETI	Science, Engineering and Technology Institution
SMEs	Small and Medium Enterprises
SMMEs	Small, Medium and Micro Enterprises
the dti	The Department of Trade and Industry
THRIP	Technology and Human Resources for Industry Programme
ToC	Theory of change
ToR	Terms of reference
UK	United Kingdom
USA	United States of America
USPTO	United States Patent and Trademark Office
UWC	University of Western Cape

Policy summary

The Department of Trade and Industry (**the dti**) and the Department of Performance Monitoring and Evaluation (DPME) commissioned Business Enterprises at University of Pretoria (Pty) Ltd in October 2013 to undertake an implementation and impact assessment of the Technology and Human Resources for Industry Programme (THRIP), which is a **dti** research and innovation support programme administered by the National Research Foundation (NRF).

To allow cross validation, a mixed/multi-methods design was used including gathering evidence and statistics from relevant official documents; a literature review; international analyses of overseas programmes; surveys of participating researchers from universities, science councils as well as from industry; personal interviews; and a workshop with representatives of **the dti**, DPME and the NRF.

The three important parameters that guided the compilation of the final reports should be listed at the start. First, the initial *Policy* and *Executive Summaries* are high level summaries of the evaluation and consequently cannot cover detail such as source citations that are discussed in the full report. Secondly, the fieldwork and analyses took place between January and April 2014 and the report consequently does not cover subsequent dynamic changes to relevant strategies. Thirdly, it should be noted that the terms of reference (ToR) of the evaluation project did not include the drafting of plans for implementing the findings and recommendations of the assessment and this was therefore deemed to form part of subsequent departmental implementation plans.

Key findings, recommendations and policy implications

1. It is recommended that THRIP should be continued and be further strengthened.
2. THRIP is an established, valid and important element of the South African government's portfolio of research and innovation support measures. It is efficient (e.g. demonstrating substantially lower overheads than comparable overseas programmes) and offers considerable value for money both in terms of technology development (with an estimated revenue of R24 million five years after conclusion of a project) and in terms of developing human resources with industry related skills (by engaging 1 450 postgraduate students).
3. Its core principles of collaboration between research institutions and industry on the one hand and quality of research and development, on the other, are well aligned to international best practise.
4. The total funding of THRIP should be increased according to industrial absorptive capacity and needs (in real terms it is currently about half of what it was 10 years ago; it could productively absorb more than twice its current allocation).
5. While the Programme is efficient and achieve its objectives (new technologies and knowledge and human resources for industry) it has to satisfy a broader spectrum of needs than its typical counterpart programmes in countries such as Canada, the United States of America (USA) and some European countries. The impact of THRIP can be enhanced by reducing the number of objectives it has to serve.
6. THRIP plays a unique role in the country's system of innovation. However, its domain is designed to support all types of research necessary to resolve the industrial challenge.

Following international best practise it is important for **the dti** and the country to develop additional programmatic instruments supporting industry to commercialise the THRIP produced know-how, including the monitoring and evaluation (tracking) of THRIP project outcomes beyond project conclusion.

7. Stakeholders identified the intellectual property (IP) regime surrounding THRIP as a major challenge for improving the Programme's performance. It is suggested that THRIP's IP regulations should be reconsidered by **the dti** and the Department of Science and Technology (DST).
8. THRIP is one of the oldest dedicated research and innovation support programmes in the country and whilst having retained its core mission of facilitating the training of human resources for industry, it has also adjusted its foci over time to contribute to the needs emerging from the policy eco-system, e.g., attending to the Small, Medium and Micro Enterprise (SMME) sector. Awareness of the national policy context should remain high on the agenda of THRIP in future too, without neglecting its core mission.
9. THRIP contributes to job creation by producing a flow of highly skilled researchers and technology managers for industry and by improving the competitiveness of the participating business organisations. Furthermore, an analysis of THRIP's impact on the economy through the higher education and economic interface shows that, based on 2009 data, the Programme supported 2 290 jobs since inception.

Executive summary

1. Background

The Department of Trade and Industry (**the dti**) and the Department of Performance Monitoring and Evaluation (DPME) commissioned Business Enterprises at University of Pretoria (Pty) Ltd. to undertake *an implementation and impact assessment of the Technology and Human Resources for Industry Programme (THRIP; 2002-2014)*. THRIP is a **dti** research and innovation support programme administered by the National Research Foundation (NRF). THRIP functions on a cost-sharing basis between **the dti** and industry (on a 1:1 basis, except in the case of large organisations (1:2) and Small Medium and Micro Enterprises (SMMEs) (2:1)) and supports science, engineering and technology research collaborations focused on the technology needs of participating firms and encouraging the development of researchers.

To allow cross validation, a mixed/multi-method evaluation design was used. The design included a literature review; relevant official documents (including statistics); international analyses of overseas programmes; surveys of participating researchers from universities and science councils as well as industrial partners; personal interviews; and a workshop with representatives of **the dti**, DPME and the NRF. The fieldwork and analyses took place between January and April 2014 and the report consequently does not cover subsequent dynamic changes to relevant strategies.

2. Key findings

Soon after the initiation of the project the assessment of THRIP's impact was broadened, to also include an evaluation of the implementation of the Programme. The key findings on the implementation commission are first summarised below, followed by the findings on the eight impact questions.

2.1 Implementation findings

The implementation questions focussed on THRIP's relevance, the effects of institutional mechanisms (e.g. structure, administration and processes), cost-effectiveness and benchmarking. The key findings can be summarised as follows.

- 2.1.1 Relevance: Empirical evidence shows that THRIP has retained its unique position in the array of government instruments that support human capacity building and the production of new knowledge in a collaborative way between SETIs and industry.
- 2.1.2 Effects of institutional mechanisms: The analyses showed that THRIP has a commendable structure and it follows best practices in managing, processing and monitoring the funded projects. The selection criteria applied by the Programme enable it to meet broad national needs and help ensure that the benefits of successful awards extend across firms and industries. The relative large number of objectives served by THRIP and the funding ratios were identified as vulnerabilities.

- 2.1.3 Cost-effectiveness: THRIP was shown to have substantially lower overheads than other research funding programmes and compares very favourably to some international programmes.
- 2.1.4 Benchmarking: International comparative analyses showed that THRIP thematically compared very favourably with overseas programmes in this field, that it follows international best practices in the management and evaluation of research proposals, but that it operated with more modest government funding.

2.2 Perceptions of impact findings

The impact questions concerned THRIP's effect on technology development, industrial return on investment (RoI), on SMMEs, skills development, the national return on investment (RoI), commercialisation, possible migration of benefits, and the strengthening of beneficial effects.

- 2.2.1 Technology development: The evaluation research justifies the conclusion that THRIP has contributed meaningfully to technology development in terms of, e.g., the production of new applied knowledge in health, mining and the manufacturing industry as well as the stakeholder perceptions of the strategic importance of the projects.
- 2.2.2 Return on Investment by industry: Stakeholders declared that they expected substantial revenues from selling goods or services that incorporate THRIP technology (on average R24 million after five years and R224million 10 years after the completion of the project).
- 2.2.3 Perceived impact on SMMEs: Approximately twice as many SMMEs as large enterprises participate in THRIP and in addition they expect to receive commercial returns above those of the average participating industry.
- 2.2.4 Skills development: THRIP makes a substantial contribution to the development of human resources for industry, if it is considered that approximately 1 400 postgraduate students participate in the THRIP Programme per financial year, and a substantial number of staff members of the participating industries also earn qualifications as a result of those industry participating in the Programme. An international indicator of skills development is graduate studies.
- 2.2.5 National return on investment: The estimated total GDP directly and indirectly generated through THRIP is R508 million; industry provided more than R300 million. Furthermore, it is estimated that the Programme supported 2 290 jobs in the economy (through direct and indirect effects). THRIP clearly makes a meaningful contribution to the national economy.
- 2.2.6 Commercialisation: THRIP does not extend to near-market development of THRIP-supported research outputs and the Programme can consequently not directly contribute to commercialisation and intellectual property. This proved to inhibit the beneficial effects of THRIP.

- 2.2.7 Possible migration of benefits: THRIP's mandate, rules, guidelines and practices since 2002 prevent foreign companies to benefit from THRIP projects during their life time. Furthermore, other research has shown few if any technologies migrating abroad and providing revenue to their owners.
- 2.2.8 Strengthening of beneficial effects: Mechanisms identified in the report include extending the mandate of THRIP to include outcomes; a meaningful increase of its public funding; the improvement of communication and marketing; a review of the intellectual property regime; and the streamlining of selected aspects of its administration.

3. Recommendations

A wide-scoped and mixed/multi-method assessment of a research support programme such as THRIP that was established 12 years ago, can be expected to generate a relative large number of recommendations. In this evaluation study, however, it was decided to formulate only six high-level recommendations and these are presented below with the minimum of elaboration.

3.1 The dti should retain THRIP and enhance the government's financial support. A doubling of the Programme's funding should be the first objective over the intermediate term.

The evidence showed that THRIP is a valid, important and very successful - indeed essential - element of the South African government's portfolio of innovation support measures. It offers considerable value for money and has not yet reached the stage where it is running into diminishing returns. THRIP should consequently be retained and its public funding should be increased according to industrial absorptive capacity and needs.

3.2 The dti (owner) and NRF (manager) should protect and enforce the core principles contributing to THRIP's successes over the past 12 years.

Evidence from benchmarking and surveys of relevant stakeholders' opinions indicate that the future success of THRIP depends on its ability to retain a number of core principles. These are:

- Collaborative research involving at least two partners – one business and one from the research base;
- Quality scientific research;
- Pre-commercial character of research, which can be safeguarded through the participation of more than one firm; and
- The maximum government funding of 1:2 (government: industry) for most research and 1:1 for projects with particular requirements, should be reconsidered to bring the Programme on a par with international standards and to stimulate the increased participation of local industry in the Programme.

3.3 The dti and NRF should act to improve the operational challenges of the Programme, viz. the relatively broad spectrum of objectives; the discouraging effect of partial funding; the promotion of participation by partially owned by Higher Education Institutions (HEIs/Science, Engineering and Technology

Institutions (SETIs); encouragement of participation by universities that were previously unsuccessful in obtaining THRIP funds; and programme evaluation.

Evidence from the process questions and benchmarking reveals that there is a need to continuously review the processes that underpin and support THRIP in order to ensure that users are provided with the most efficient and effective service possible. Areas where refinements are required as a matter of priority are the following:

- THRIP should reduce the number of Programme objectives following international good practice;
- The issue of partial funding of projects should be applied only when the committee has reasons to believe that the relevant costs are inflated;
- The monitoring of the projects should be expanded so that their impacts could be monitored after completion of projects;
- As suggested by stakeholders, THRIP should consider accepting contributions from companies owned wholly or partly by HEIs/SETIs up to a limit of 25% ownership;
- THRIP should consider developing separate approaches linking universities that were previously not succeeding in obtaining THRIP funds with relevant industrial establishments and successful THRIP institutions; and
- Programme evaluations (like this one) should be undertaken every five (5) years. The ten-year horizon is too long a period for evaluation as the majority of the early participants are no longer available to contribute to the evaluation.

3.4 The THRIP management and executive should create links with similar programmes internationally and learn from their experiences.

The review has identified a number of programmes similar to THRIP internationally. THRIP could benefit by establishing active linkages with such programmes and learn from their experiences and approaches.

3.5 The dti should consider the expansion and supplementation of THRIP in support of industry for the uptake and commercialisation of generated knowledge, including the monitoring and evaluation of THRIP project outcomes beyond project conclusion.

As stated earlier in this summary, THRIP plays a unique role in South Africa's system of innovation. Its domain covers all research necessary to resolve the industrial challenges the country faces. Following international good practise and according to evidence from the THRIP theory of change, it is important for **the dti** and the country to develop additional programmes that support industry in commercialising THRIP-produced know-how. Such an approach would have the additional advantage that existing programmes would not have to operate on the basis of "one-size-fits-all".

3.6 The dti should engage with the Department of Science and Technology (DST) in order to resolve the challenge of intellectual property ownership.

THRIP participants identified the intellectual property (IP) regime within which the Programme operates as a weakness and obstacle inhibiting commercialisation. THRIP and **the dti** should engage with the DST to identify ways of simplifying the IP regime for THRIP

projects. The *IP Draft Policy* that is being developed by **the dti** could also provide the relevant recommendations.

4. Conclusions

The THRIP evaluation offers valid evidence in support of retaining and even further strengthening the Programme. It is a valid, important and efficient element of innovation support that offers considerable value for money both in terms of technology development and in terms of developing human resources with industry-related skills. By and large, its core principles of collaboration and quality of research and development are in accordance to international best practise. Its beneficial effects can be reinforced by reducing the number of objectives; streamlining its funding administration to meet stakeholders' requirements; addressing the challenges associated with the IP regime; introducing post-project monitoring/tracking; and assisting non-participating science and technology institutions to participate in the Programme.

5. Report Summary

5.1 Introduction

The Technology and Human Resources for Industry Programme (THRIP) is a research and development programme established during 1992 with the objective of accelerating economic growth, creating wealth on a sustainable basis and improving the quality of life of all South Africans. On a cost-sharing basis with industry, THRIP supports science, engineering and technology research collaborations focused on addressing the technology needs of participating firms and encouraging the development and mobility of research personnel and students among participating organisations. THRIP is funded by the Department of Trade and Industry (**the dti**) and managed by the National Research Foundation (NRF). The Programme aims to improve the competitiveness of South African industry by supporting research and technology development and enhancing the quality and quantity of appropriately skilled people (e.g. NRF, 2012b).

The Programme addresses one of the most critical issues related to this country's international competitiveness – to increase the number and quality of people with appropriate skills in the development and management of technology and innovation for industry. The issue has been important when the Programme was initiated and it still represents the core mission of the Programme in 2014.

As part of its mandate under the National Evaluation Policy Framework (NEPF) and in partnership with the Department of Trade and Industry (**the dti**), the Department of Performance Monitoring and Evaluation (DPME) issued the terms of reference for the evaluation of the *Technology and Human Resources for Industry Programme* (THRIP) in July 2013 (DPME, 2013).

Originally, the terms of reference (ToR) specified that the objective of the project was to “assess the impact of THRIP in the context of its objectives and priorities over the period to be reviewed and to determine how the beneficial impacts can be strengthened”. However, after the completion of the literature review, the particular methodological challenges of an impact review in the domain of science, technology and innovation were recognised and the Steering Committee decided that an implementation assessment should rather be emphasised.

This report summary offers an overview of the following components and phases of the report: Aims and objectives of the evaluation; evaluation approach and methodology; overview of the literature review; the THRIP theory of change; key findings; recommendations and conclusions. (The numbers of tables and figures used in the full report appear between brackets in the relevant headings.).

5.2 Aims, objectives and key questions of the evaluation

In its broadest sense, this assessment aimed to identify THRIP's relevance to the country's national system of innovation; the effects of processes (such as structure and administration) on THRIP's performance; as well as the Programme's cost-effectiveness in comparison to other approaches. The assessment also aimed to compare the Programme with similar

initiatives abroad (benchmarking). Similarly, a number of impact issues were investigated – impact on technology development; on small, medium and micro enterprises (SMMEs); skills development; economic development; competitiveness; tax revenue; and intellectual property (IP). More specifically, the questions addressed in this evaluation project were as follows:

5.2.1 Implementation-related questions

- a) **Relevance:** Is THRIP still relevant when considering other instruments in the South African innovation landscape? What factors in the South African context enable or constrain the beneficial impact of THRIP, including the long term sustainability of those impacts?
- b) **Process:** What effects do institutional mechanisms (structure, management, administration, and processes) have on the efficiency and effectiveness of delivering the Programme outcomes?
- c) **Cost-effectiveness:** Is the current model of delivering THRIP cost-effective in comparison to alternative models?
- d) **Benchmarking** How does THRIP's performance compare to similar programmes nationally and internationally?

5.2.2 Perceived impact-related questions

- a) **Technology development:** What impact does THRIP have on technology development?
- b) **Industry's return on investment:** Do industry partners realise a significant return on investment (ROI) from THRIP?
- c) **Impact on SMMEs:** What impact does THRIP have on SMMEs involved in technology development?
- d) **Skills development:** What is the impact of THRIP on skills development in science, engineering and technology?
- e) **National return on investment:** Does South Africa realise a significant ROI from THRIP against the cost of delivering the Programme in terms of:
 - o Economic growth and empowerment
 - o Skills development and job creation (rate)
 - o Taxable revenue
 - o Competitiveness
- f) **IPR:** What happens to the intellectual property (IP) from completed THRIP projects?
- g) **Commercialisation:** To what extent are the outputs of THRIP projects commercialised, and if not, why not?
- h) **National benefit:** To what extent are benefits of THRIP realised in South Africa, if not, why?
- i) **Further reinforcement:** How can the beneficial impacts of THRIP be strengthened?

5.3 Evaluation approach and methodology

To allow cross validation, the evaluation design consisted of a mixed/multi-method approach (Bryman, 2006; Marais, 2012). The methods used in this evaluation study included literature and archive reviews; data collection from the THRIP databases; a survey of university administrators and THRIP grant holders (61 response of a sample of 110); a survey of

industrial participants (45 response of a sample of 187); comparisons of national and international programmes similar to that of THRIP; 21 interviews with key informants/stakeholders (including **the dti** and NRF officials); and a theory of change workshop attended by seven representatives of **the dti** (owner of the Programme), DPME (the commissioning agent for this assessment) and the NRF (the administrator of THRIP). This evaluation design ensured information from different sources that through the process of triangulation normally provides strong and valid evidence.

At least six (6) sets of limitations to the scope and validity of this evaluation should be emphasised, viz. the focus on implementation rather than impact of the programme; the validity of the measurement of stakeholder perceptions; incomplete statistical information; the fluid policy ecology at the time of the evaluation; the time frame of the project; and the absence of strategies for the implementation of the findings and recommendations.

These important limitations can be summarised as follows:

- On advice of the Steering Committee the evaluation focussed on the implementation of the programme rather than its impact, since the latter is normally manifested over a variably long time – requiring long-term monitoring – and allowing many variables to intervene and making the demonstration of causal effects very problematic from a methodological perspective and ideally requires a before-after evaluation design.
- This evaluation relied on qualitative evidence generated by interpretations of documents, survey information and information gathered by means of interviews – none of which could claim absolute validity, i.e., claim that the evaluation tool (e.g. interview or questionnaire) fully measured what it was commissioned to measure. Notwithstanding the fact that the mixed methods design of the evaluation allowed for triangulation of methods, the individual evaluation measures were subject to the vulnerabilities of measures of these types. With regard to external validity, i.e., generalisability of the findings, it should also be noted that the relatively low response rate in the industrial survey calls for caution in generalising the findings beyond the respondents.
- Complete sets of statistical data on THRIP were not always available and a few gaps in the data were encountered. This limitation also relates to the fact that because of time constraints, it was not possible to undertake before-after comparisons, e.g., to test the effect of the introduction of IP legislation on participation rates by businesses.
- Questions about the future ‘bureaucratic home’ of THRIP, more specifically whether the agency function would remain in the NRF or be transferred in all respects to **the dti**, were doing the rounds towards the latter stages of this evaluation. Although the potential effect of such perceptions on the inputs to this evaluation could obviously not be determined with any degree of certainty, it should be marked as a potential confounding variable.
- The fieldwork and analyses took place between January and April 2014 and the report consequently does not cover subsequent dynamic changes to relevant strategies.
- As the terms of reference of the evaluation project did not include the drafting of plans for implementing the findings and recommendations of the assessment this aspect is deemed to form part of subsequent departmental implementation plans.

In summary, whilst this evidence-based evaluation of the implementation of the THRIP

programme was designed to optimise the validity of the findings – and recommendations – it should be acknowledged that the validity of the findings are subject to an unspecified, albeit limited, degree of uncertainty – like most if not all programme evaluations.

5.4 THRIP theory of change and log-frame

A theory of change can be described as a theory of how and why an initiative, such as a policy intervention, programme, or strategic development should be expected to work (cf. Stein and Valters, 2012). Recent years have seen theories of change become necessary elements in virtually all forms of development, support and evaluation projects, including research and innovation support programmes. There was no theory of change posited at the launch of the THRIP programme, since it was a relatively new development in evaluation theory and methodology at the time.

An important priority of the present evaluation of THRIP was consequently to develop a theory of change for THRIP - a map as it were of constituent components and processes required to bring about attaining the long-term goals of THRIP, viz. producing highly skilled researchers and managers in technology and producing new knowledge that could be used by industry.

For this undertaking, the analysis of the mission, objectives, processes and performance of THRIP, presented in parts of Chapters 3 and 5 of the full report, were utilised to develop such a theory of change (ToC). **Figure 1** (p. 13) offers a condensed summary of the process ranging from THRIP inputs to its outputs. The ToC includes outcomes and impact that do not represent part of the THRIP mandate. This theory of change was subjected to a workshop attended by staff of **the dti**, DPME, NRF and various industry representatives and stakeholders.

In narrative form, the THRIP theory of change can be summarised as follows:

- The system of intervention, such as an applied research, technology and innovation programme to facilitate human capacity building and relevant knowledge production, consists of at least five sub-systems, viz. input, activities/actions, outputs, outcomes and impacts.
- THRIP incentives – grants - promote the creation of partnerships among the various stakeholders (firms and universities). THRIP personnel take care of all administrative functions, marketing, processing, assessment, and monitoring of progress. Funds are transferred to universities to support collaborative research and the development of postgraduates.
- The partnerships between firms and universities in turn accelerate Research and Development (R&D) through a number of mechanisms, such as the expansion of the project's R&D scope; lowering financial and technical risk; and creating increase interest.
- Outputs include research publications, patents, models, algorithms and prototypes. THRIP's mandate does not extend beyond the generation of outputs.
- Outputs are followed – not necessarily in a linear relationship - by outcomes such as organisational credibility, availability of additional resources, increased collaborative propensities - even outside the scope of the THRIP-project - in the short term. In the

- intermediate future, commercial benefits such as new products, new processes, productivity gains and relevant licensing emerge. The commercial benefits lead to competitive participants and firm growth and then to competitive industry and economic growth.

The theory of change underlying THRIP as summarised in **Figure 1** on p. 13 (Figure 4, p. 50 of the full report), indicates that the direct financial support of THRIP is not extended beyond the outputs column (for example, funded projects and postgraduates). This means that THRIP does not control the absorption and transformation of outputs into outcomes.

If industry does not see the benefits of transforming the outputs into outcomes, the process may stop at this stage. In a number of countries, governments offer incentives to facilitate the progression from outputs to outcomes.

5.4.1 Proposed Theory of Change

The amended or proposed theory of change, reflected in **Figure 6** (p. 32 as Annexure B) shows how THRIP can be modified to support the commercialisation of the developed knowledge. THRIP will provide financial support for pilot scale activities, pre-production facilities, technology integration and similar projects, which will create direct long-term outcomes. International practice shows that governments support between 25% and 40% of such activities with the ratio increasing when more than one industrial firm participates in the effort.

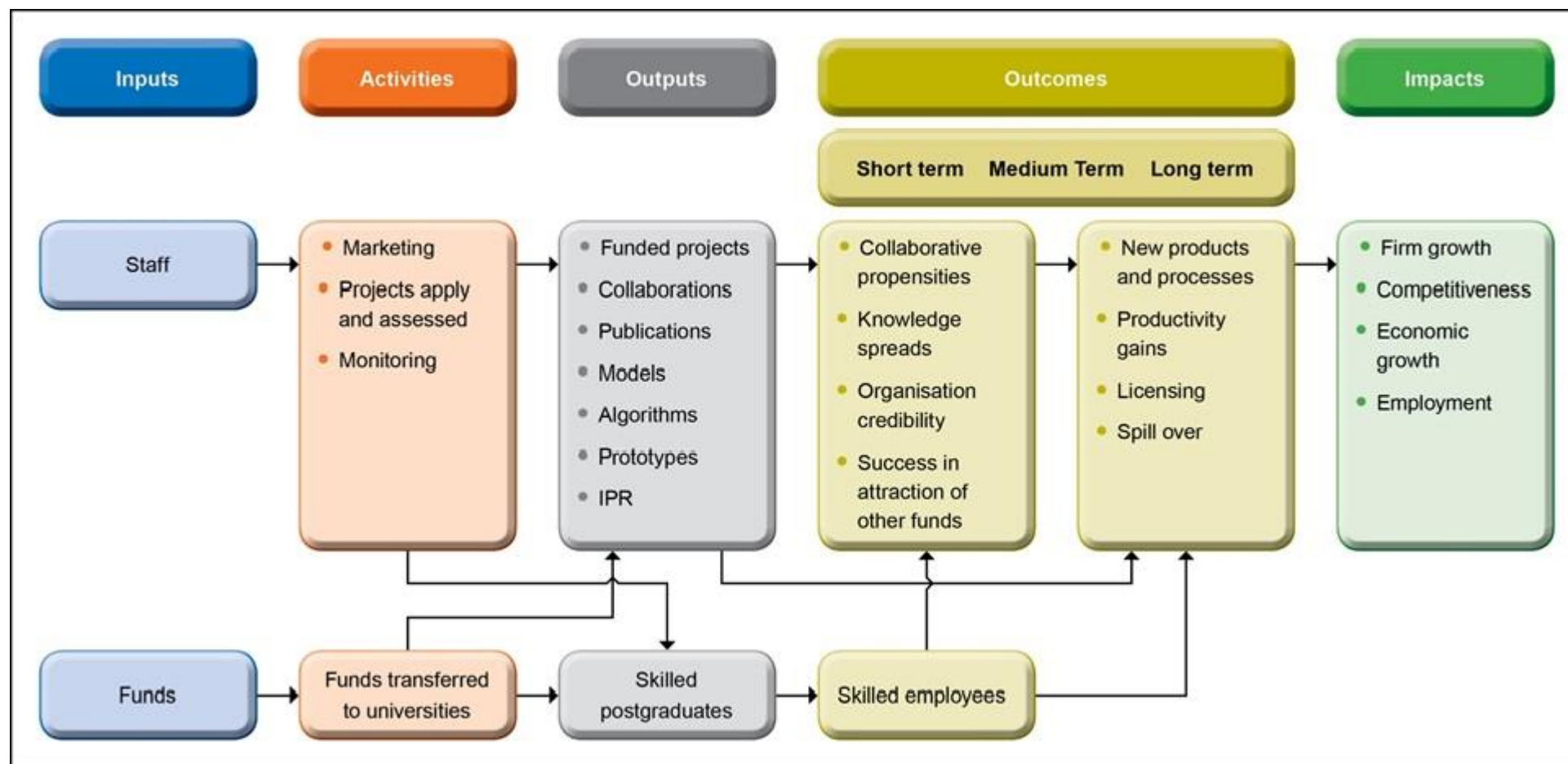


Figure 1: Existing theory of change: pathway of change (Figure 4 on p. 50 of the full report)

The preceding THRIP ToC was converted to a log-frame to guide the evaluation of THRIP as it stood at the time of the present evaluation. The ToC in **Table 1** explicates the intervention logic; indicators of the key variables; verification sources; and the assumptions underpinning variables.

Table 1: Proposed THRIP Log Frame ¹ (Table 7 p. 54 of the full report)

Programme description		Indicators	Verification sources	Assumptions
Overall objective	Competitive industry	Competitive Industrial Performance Index	UNIDO	
Programme purposes	Creation of R&D partnerships through co-funding	Number of partnerships/projects	Programme statistics ²	<ul style="list-style-type: none"> Partnerships are funded appropriately/fully Research efforts are successful
	Development of skilled human resources	Number of postgraduates participating	Programme statistics	<ul style="list-style-type: none"> Availability of appropriate graduates
Outputs 1	Funded projects Collaborations Publications Patents Algorithms Prototypes	Number of artefacts produced	Programme statistics	<ul style="list-style-type: none"> Participation of good researchers
Outputs 2	Skilled postgraduates with industrial exposure	Number of postgraduates participated	Programme statistics	<ul style="list-style-type: none"> Postgraduates are able to complete relevant studies on industrial topics
Outputs 3	Pilot scale equipment Pre-production facilities Technology integration	Numbers of pilots; pre-production facilities and integrated technologies	Programme statistics	<ul style="list-style-type: none"> Research leads to the need for pre-production facilities
Outcomes	New products/processes/ services Productivity gains Firm growth Knowledge spread Spill-over effects Long term collaborations Availability of skilled human resources in industry	Outcomes in participating firms and in firms benefiting from spill-overs	Monitoring statistics and evaluation exercises ³	<ul style="list-style-type: none"> Outputs are diffused in industry. Availability of support in the next level of development (absorption) Skilled human resources find employment in local industry
		Availability of skilled human resources in industry	Survey statistics	
Impacts	Increased GDP Employment gains International competitiveness Improved quality of life	National and international statistics	National and international statistical offices	
Activities	Targeted marketing Application processing Monitoring Funding Linkage with other instruments	Projects supported Funding satisfaction Joint funding Partnership projects	Programme statistics Evaluation exercises	<ul style="list-style-type: none"> Sound relationships and communication between THRIP staff, stakeholders and other instruments

Notes:

¹ The design of the log-frame closely followed the model developed for Business Process Services recommended by DPME

² Statistics supplied by the THRIP office and culled from official documents, such as the guide and other reports.

³ Higher education and industrial partners' surveys

5.5. Key findings

The analyses show that THRIP's design is based on the second-generation innovation policy (chain-linked model of innovation). THRIP's design allows collaboration that enables partners to share research and development (R&D) costs, pool risks and enjoy access to institution-specific know-how and commercialisation resources. Collaboration, furthermore, guarantees that support is going to industry-wide projects. This collaboration is characterised by high social rates of return – the basic tenet of government interference in the market. Collaboration prevents a situation where the proprietary advantages of projects could be conferred to individual firms – which would constitute a failure of the government intervention.

The key findings of the implementation and impact evaluation are presented below as responses to the key questions presented in Section 2 (page 9).

5.5.1 Implementation-related findings

5.5.1.1 Relevance

Is THRIP still relevant when considering other funding instruments in the innovation landscape? What factors in the South African context enable or constrain THRIP's positive impact, including the long term sustainability of those impacts?

The positioning of THRIP within the NSI identified it as a unique instrument in the National System of Innovation (NSI). Its unique characteristics include the following:

- It provides incentives for technology development locally;
- It promotes collaboration among the various stakeholders of the innovation system;
- It provides a prioritisation mechanism for the higher education sector based on industrial needs;
- It is versatile and can support different size challenges (small or big grants) and companies, ranging from large enterprises to SMMEs;
- Its priorities are industry-based (contribution to economic clusters in 2011/12: Manufacturing: 30%; Agriculture: 14.3%; ICT and Mining each 12.2%);
- It is open to all qualifying organisations (a number of incentives are structured to benefit particular institutions and technologies); and
- It promotes increases in the country's R&D expenditure – a priority of government.

It should be mentioned that, while **the dti** has a number of instruments promoting the acquisition of technology embodied in equipment and facilities technology, (e.g., the Manufacturing Competitiveness Enhancement Programme (MCEP), the Manufacturing Investment Programme (MIP) and others, cf. **the dti**, 2012a). THRIP is unique in promoting technology development locally.

Similarly, the international benchmarking and the theory of change identified that the Programme is operated in accordance with international best practice and it follows a sound approach. Almost all countries in the world develop programmes that promote the utilisation of scientific research and support collaborative efforts.

The number of applications for THRIP grants over the past six years have averaged 294 of which 246 were successful annually, giving a success rate of nearly 84% - high in comparison to other public funded R&D support schemes. The fact that the number of applications and funded projects have remained fairly stable over time could be interpreted as pointing to the relevance of the Programme.

The stakeholders identified that the “pre-established relationship of the universities with the industrial partners” and “relevance of university research to industry” strongly facilitate the beneficial effects of THRIP. The very high ratings by university participants in the Programme (**Table 2**) bear testimony to the success of THRIP. “Geographic location”, “requirement to find industrial partners willing to make a cash contribution” and “IP agreement/management issues” are relative inhibiting factors. Similarly, the stakeholders (both from the science base and the industrial sector) declared the Intellectual Property Rights from Publicly Financed Research and Development Act, Act No. 51 of 2008 as an inhibiting factor.

The theory of change analysis found that the Programme is not designed to promote commercialisation of the knowledge produced beyond the applied stages of research. Additional incentives across the innovation chain can enhance THRIP’s long-term impact and can further its relevance sustainability.

Table 2: THRIP effects (Table 13 on p. 64 of the full report)

How do you rate THRIP’s effect on the following (high – 5, average – 3, low – 1)?			
	Mean	St Dev	Median
Technology transfer from university to industry	4.02	0.83	4
Supporting students to complete their studies	4.32	1.06	5
Linking industry and academia/councils	4.37	0.88	5
Support students from previously disadvantaged backgrounds to complete studies	4.05	1.09	4
Making the university responsive to industry’s priorities	4.19	1.08	4
Making the university responsive to government’s priorities	3.80	1.14	4
Produce graduates with skills demanded by industry	4.47	0.62	5

5.5.1.2 Process

What effect do institutional mechanisms (structure, management, administration, and processes) have on the efficiency and effectiveness of delivering the Programme outcomes?

The analyses showed that THRIP has a commendable structure (including a representative Advisory Board) and it follows good practices in managing, processing and monitoring the projects. The selection criteria applied by the Programme enable it to meet broad national needs and help ensure that the benefits of successful awards extend across firms and industries.

The Programme produces guides/manuals for its processes, has effective digital archives and receives unqualified reports by the Auditor-General, including Public Finance Management Act (PFMA) compliance. **Table 3** (p. 17) shows that universities and science

councils gave THRIP's administration an above-average rating across ten issues (effectiveness of application process, effectiveness of disbursing funds, etc.).

How do you rate THRIP's administration (high – 5, average – 3, low – 1)?			
	Mean	Std Dev	Median
Effectiveness of application process	3.73	0.97	4
Effectiveness of application requirements	3.58	1.19	4
Appropriateness of evaluation criteria	3.74	1.09	4
Effectiveness of monitoring procedures	3.71	0.99	4
Effectiveness of marketing of Programme	3.50	1.23	4
Appropriateness of resources available	3.28	1.21	3
Accessibility of management team	3.81	1.16	4
Effectiveness of disbursing funds	3.41	1.24	4
Efficiency of funds auditing system	3.94	0.97	4
Cost-effectiveness of Programme	3.87	1.10	4

Table 3: Performance rating of THRIP by SETIs (Table 14 p. 65 of the full report)

The THRIP approach also contributes to the development of scientific and technological infrastructure. On the question: “Has THRIP created long-term collaborative activities of your university with industry?” participants were positive. Examples of responses include: “Much of the advanced genetics and genomics work at the ARC (and at UWC previously) has been funded by THRIP as industries have not been willing to fund these areas directly. The impact is therefore on allowing the implementation of cutting-edge technology for industry without their initial commitment to the direct investment. As it becomes an effective tool, then the direct funding becomes attractive”. Another response stated: “Through the combined effort of our main industry partners (Anglo American Operations, Anglo American Kumba Iron Ore and Glencore), supported by THRIP, we could establish a Centre for Pyrometallurgy in 2009, followed by the establishment of a new field of research within our centre, that of pyrometallurgical modelling in 2013.”

The stakeholders identified weaknesses in the Programme's funding ratios (industry to government; e.g. approximately 2.2:1.5 in 2012/13) and on the partial funding of projects. The partial funding of projects forces the universities to renegotiate projects with industrial stakeholders and revisit the scope and objectives of projects. This creates additional costs to universities, science councils and industrial partners. **Figure 2** (p. 18) shows the comparative contribution by government, industry and government to THRIP projects.

The international benchmarking analyses showed that THRIP has a large number of criteria or objectives in comparison to other internationally relevant programmes. In South Africa, the monitoring of the outcomes and impact of projects stops when the project no longer receives funding from the Programme, while abroad monitoring of the project continues for a number of years after completion.

Finally, in the process of the current evaluation, it was concluded that the 10-year horizon for evaluating the performance of THRIP is not feasible. One institution that was asked to mobilise its researchers to participate in the THRIP evaluation informed us that “about 44%

of the 2002 project leaders have left the University (mostly retired, left for Australia, one person died)” – a reliability detractor. Similarly, the international comparisons show that programmes similar to THRIP are assessed every five years.

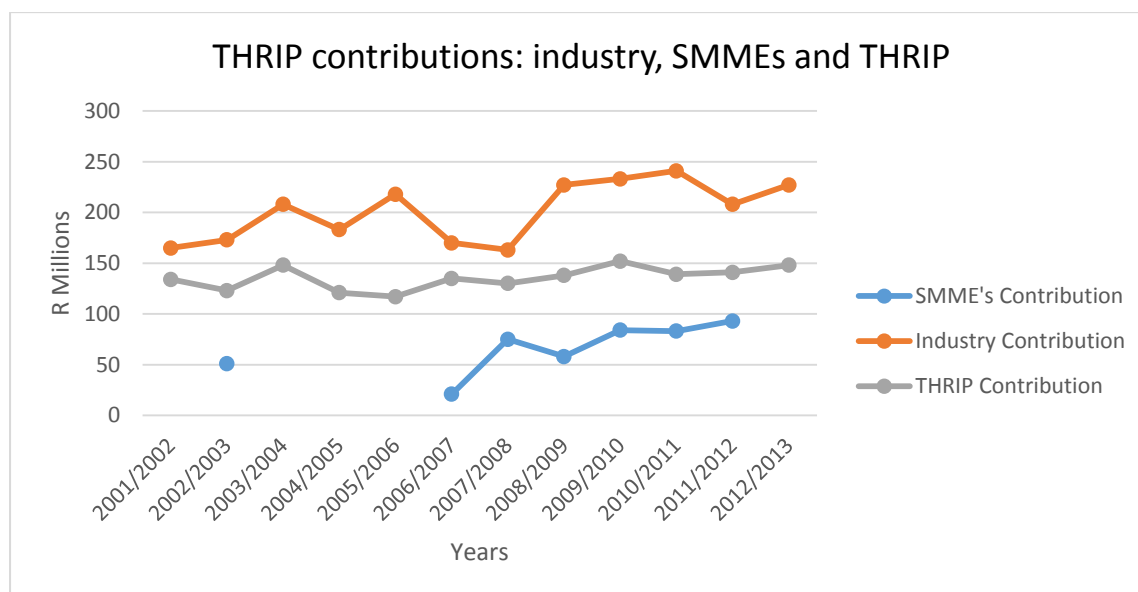


Figure 2: THRIP contributions: Industry, SMMEs and government via THRIP (Figure 7 p. 58 in the full report)

5.5.1.3 Cost-effectiveness

Is the current model of delivering THRIP cost-effective in comparison to alternative models?

THRIP operations are embedded in the NRF infrastructure, which makes the Programme efficient. The estimated operating expenses, i.e. overheads, as a percentage of the Programme's contributions to the projects have been between 6% and 7% during the recent years. As the Programme leverages additional resources from the industrial partners as well, the operating expenses, as a percentage of the total funds mobilised, is approximately 3%.

In comparison to other local programmes, THRIP has substantially smaller overheads. THRIP overheads are comparable with international programmes (such as the Canadian programmes), even though the programmes abroad handle substantially more resources.

5.5.1.4 Benchmarking

How does THRIP's performance compare to similar programmes nationally and internationally?

A comparison with 12 other South African programmes of **the dti** and DST showed that THRIP is unique in the country in its effort to support locally developed technologies through collaboration with the industry and scientific institutions such as universities and science councils. This collaboration facilitates growth in the number of people with appropriate industry-related skills and stimulates industry and government to increase their investment in R&D, innovation and technology diffusion.

Internationally, most countries provide incentives to their industries that are similar to THRIP's incentives. An international comparison of THRIP on seven dimensions/criteria, such as mission, technical scope and selection process, with programmes in the Canada, China, Europe, Finland, the United Kingdom (UK), and the United States of America (USA) showed that THRIP largely overlaps with those programmes. Examples of the programmes included the Advanced Technology Programme (ATP) in the USA, the industry-driven

The Collaborative Research Development (CRD) Programme in Canada, the Framework Programmes in the European Union and the Chinese National Key Technologies R&D Programme.

An important difference that the comparative study identified was that abroad, different programmes/approaches are followed for different objectives, while THRIP attempts to accommodate a wide range of objectives. For example, in Canada, the Natural Sciences and Engineering Research Council (NSERC) Engage grants are intended to foster the development of new research partnerships between academic researchers and companies that have never collaborated before, by supporting short-term research and developing projects aimed at addressing a company-specific problem. The Interaction grants are intended to financially support researchers from Canadian universities to meet with Canadian-based companies with the objective of identifying a company-specific problem that they could solve by collaborating in a subsequent, newly established research partnership. The Collaborative Research and Training Experience (CREATE) Programme is designed to improve the mentoring and training environment for the Canadian researchers of tomorrow by improving areas such as communication, collaboration and professional skills, as well as providing them with experience relevant to both academic and non-academic research environments.

It is noted that the ultimate objectives of Canada's programmes are separated into discrete grants, while the approach in South Africa appears to be "one size fits all".

THRIP is following international best practice by using review committees for the assessment of the projects and producing guides/manuals to guide its officials in their tasks.

Apart from THRIP's wide scope of objectives, other differences with programmes from abroad include the low budget of THRIP in general and the relatively small contribution of government in comparison to the contribution of the industrial partners in particular (e.g. in 2012/13 it was 1.5:2.2). **Figure 2** (on p. 18 in the previous section 6.1) shows the disparities between industry and public funding of THRIP since its establishment in 2001/02).

These findings are particularly important to the competitiveness of the country's industry (both big and small enterprises). It was found that the THRIP budget has remained at around R150 million for the last ten years. This means that, in real terms, government's contribution is almost half of what it was ten years ago.

NRF officials mentioned that THRIP could absorb twice to three times its current budget. This issue is confirmed by the fact that THRIP is currently funding the successful projects only partially and a number of qualifying project proposals are not funded at all (the success rates in 2011/12 and 2012/13 were 77 and 79%, respectively). A doubling of the

Programme's funding would bring it in its initial levels in terms of purchasing power parity (value of money over time).

5.5.2 Perceived impact of THRIP

5.5.2.1 Technology development

What impact does THRIP have on technology development?

In the surveys conducted for this evaluation, the industrial stakeholders declared that the THRIP projects are strategically important to their organisations. **Figure 3** summarises the main reasons why participating industries participate in THRIP.

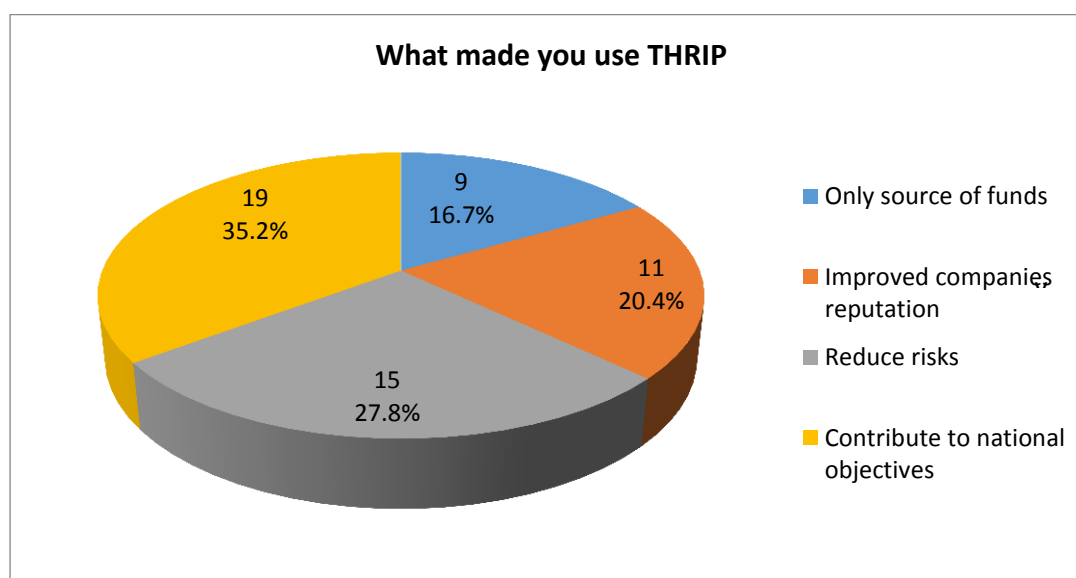


Figure 3: Main reasons for using THRIP (Figure 11 p. 70 of the full report)

The industrial respondent mentioned that the Programme's cost-shared, industry-driven approach has shown considerable success in advancing technologies that can contribute to important national objectives and societal goals, such as improved health (for example, controlling air pollution from domestic fires with the *Basa Magogo* project), developing tools to add value in the country's mining resources (for example, gold-based catalysts), and improving the efficiency and competitiveness of the South African manufacturing industry. Furthermore, they emphasised that technology fields like big data and predictive analytics, breast imaging system development, metal matrix composite, grid/cloud-based mobile computing and Internet of Things for smart cities would not have been available in South Africa without THRIP.

THRIP creates "additionality". More than a quarter of the business stakeholders declared that the project would not have been undertaken in South Africa without THRIP support and the rest declared that the project would have suffered from reduced objectives, longer time scales and a lack of partners.

5.5.2.2 Return on Investment

Do industry partners realise a significant return on investment?

The industrial stakeholders declared that they expect substantial revenues from selling

goods or services that incorporate THRIP technology. The expected average revenue is R24 million after five years from the completion of the project and R224million 10 years after the completion of the project.

5.5.2.3 SMMEs

What impact does THRIP have on SMMEs?

THRIP pays particular attention to SMMEs and, during the recent years, there were twice as many participating SMMEs than large corporations. **Figure 4** shows the number of large enterprises relative to SMMEs that participated in THRIP since the Programme's launch and it can be clearly seen that the differences increased markedly in 2007/08, stabilised again later at two SMMEs for each large enterprise.

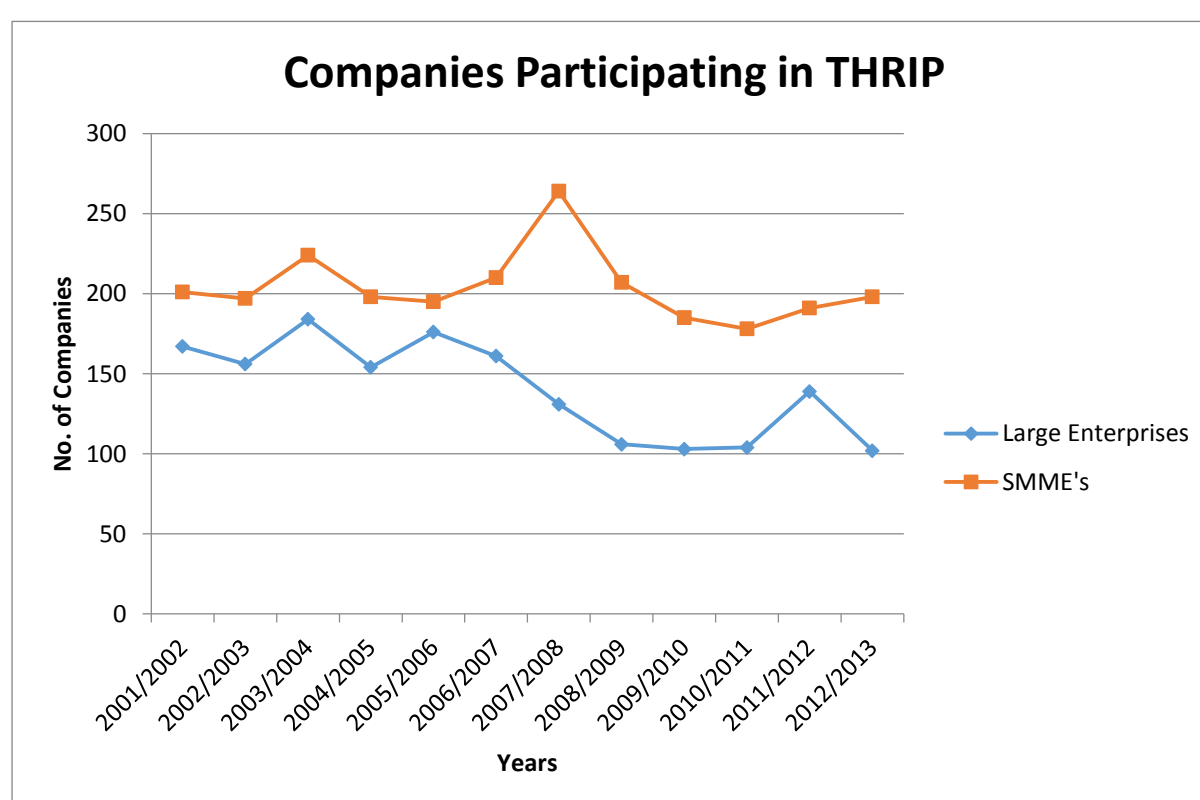


Figure 4: Companies participating in THRIP (Figure 6 p. 57 of the full report)

There are not only about twice as many SMMEs as large organisations participating in THRIP (see **Figure 4**), but they also declare that high benefits arise from their participation. Comparisons of the SMME responses with those across all industries in **Table 4** show that SMMEs reported currently and expecting in future to receive commercial returns and economic impacts above those in the average participating industry. Inspection of the information in **Table 4** shows, first, that the actual impacts hovered around the middle between 'minor' and 'major', secondly that future returns were expected slightly higher, and thirdly that the SMME respondents scored higher on all the options. Finally, "Improved financial viability" and "increased competitiveness" received the highest ratings on both actual impacts and expected returns – also in the case of the SMME subsample.

Table 4: Actual and expected economic impacts (all and SMMEs separate) (Table 20 p. 73 of the full report)

Economic impacts (minor – 1 to major – 5)						
	Actual impacts			Expected returns		
	Mean		Median	Mean	Median	
	All	SMME	All	All	SMME	All
Increased turnover	2.56	3.25	2	3.04	4.11	3
Increased profits	2.63	3.43	2	3.10	3.80	3
Greater savings	2.84	3.13	3	3.31	3.67	4
Improved financial viability	3.36	4.00	4	3.72	4.50	4
Expanded share of existing markets	2.64	3.67	2	2.85	4.00	3
Creation of entirely new markets	2.44	3.63	2	2.38	3.89	2
Entry: new markets for your organisation	2.79	3.25	3	2.93	3.60	3
Entry: new geographical markets for organisation	2.68	3.38	3	3.64	3.78	4
Increased productivity	3.23	3.89	3	3.69	4.36	4
Increased competitiveness	3.48	4.38	3	3.85	4.45	4

Public/private partnership arrangements targeting Small and Medium Enterprises (SMEs) are an international phenomenon. There are two reasons for this. The first is that successful innovation in firms will increase the number of competitors, leading to improved performance in product markets and consequently generating job creation. The second is that there is a general perception that SMEs face higher risk and uncertainty in technological innovation because of their more limited R&D portfolios and lack of resources, such as information, human and financial capital. Market failures may also arise in product markets when the dominant position of large firms or the oligopolistic structure of a given market impedes innovations by SMEs.

However, the above does not mean that large corporations do not need innovation support. Asia's emergence was based to a large extent on the ability of large corporations to enter international export markets. For example, the government of General Park Chung Hee (1962–1979) came to the conclusion quite early on that Korea needed big companies if it was to compete in the international markets. To achieve that goal, they promoted a series of national champions called *chaebols*. (Yergin & Stanislaw, 1998). These firms were nurtured with low-interest government loans, tax advantages and other incentives to enable them to become large and strong industrial groups. Thus were born companies whose names are now globally known, such as Hyundai, Samsung and Daewoo. Similarly, the Organisation for Economic Cooperation and Development (OECD) suggests that “blindly promoting partnerships between SMEs and universities could divert resources away from projects with larger firms that may have potentially higher social and private returns” (OECD, 1998).

5.5.2.4 Skills Development

What is the impact of THRIP on skills development?

THRIP's mission states that the Programme aims to “produce a flow of highly skilled researchers and technology managers for industry”. The investigation identified that the Programme engages just under 300 honours graduates, more than 750 master's students and over 400 PhD candidates per financial year. Apart from the number of graduates

participating in the Programme, what is of critical importance is the fact that those postgraduates are involved in research topics chosen by and relevant to industrial partners. In addition, the industrial partners declared that part of the benefits of the THRIP project in their organisation were “qualifications earned by their staff”. The average organisation declared that, during the period of the THRIP project, eight (8) members of staff earned additional qualifications, and during the three (3) years following the end of the project, ten (10) members of staff earned additional qualifications. Taking into account that approximately 300 projects are initiated annually, the number of staff members earning qualifications after the end of the project becomes substantial.

A type of outcome emanating from the number of projects and postgraduate students is the number of research articles. In the three-year period 2010/11 to 2012/13 the annual mean number of articles was slightly more than 1 000. The Department of Higher Education and Training funds universities, among others, according to the number of articles they produce. The current (2014) subsidy is R120 000 per article. Hence, the THRIP production of 1 000 articles can be valued at R120 million, and compares very favourably to the approximately R150 millions of total annual government support to THRIP.

The preceding findings justify the conclusion that THRIP makes a substantial contribution to the development of human resources for industry – one its core objectives.

5.5.2.5 National return on investment (Rol)

Does South Africa realise a significant return on investment?

THRIP supports economic growth through a variety of channels. Elsewhere THRIP’s contribution through universities to the economy’s growth has been referred to. The HEIs in the country produce, except for knowledge and skilled graduates, their own economic output. They also employ numerous employees of different professions and at various qualification and skills levels. In addition to their own output and employment, universities generate additional output and employment in other economic sectors through secondary or “knock-on” multiplier effects.

It is estimated that the total Gross Domestic Product (GDP) generated from THRIP (through that interface) is R508 million. The importance of the figure becomes profound when one takes into account that government contributes approximately only R150 million to the Programme. Furthermore, it is estimated that the Programme supported 2 290 jobs in the economy (through direct and indirect effects). It should be emphasised that the above figures do not take into account economic growth and employment effects that can be attributed to the development of new knowledge and skills; industrial competitiveness; etc.

The industrial stakeholders were asked to rate from 1 to 10 the contributions that THRIP makes in a number of policy objectives. In the rating, the objectives “improved economic development and growth”; “improved employment situation”; “improved preservation of the environment”; “improved standards of living in rural and semi-rural communities”; and “improved competitiveness” had a median of 8. This means that at least 50% of the respondents rated the objective at 8 or higher.

The industrial stakeholders were asked to provide estimates of the expected revenue from the THRIP project and from the relevant tax rate. Estimates of the expected taxable revenue

created by each THRIP project show that from the 5th to the 10th year after completion, each project is expected to generate R7.2 million, and after the 10th year, the tax revenues are forecast to increase substantially. These amounts are considerable, taking into account that THRIP contributes less than R1 million to the average project. THRIP not only provides a substantive return to the industrial participants, but it also provides a return to the country.

Industrial stakeholders ranked THRIP's impact on competitiveness highly. They were asked to rank the ways in which THRIP enhances competitiveness in industry. The indicators of or routes to industrial competitiveness that were rated highest included "higher quality goods, services, etc."; "expanded reputation for THRIP and leading-edge technology"; and "improved innovation performance". The long-term expected impacts are regarded as more important than the impacts realised during the undertaking of the project.

THRIP-supported research has produced over 600 local and international patents in the period 2000/01 to 2012/13 giving a mean of 50 per year (however, the annual mean for the past three years from 2010/11 to 2012/13 was 26.6). To this contribution should be added copyrights, trademarks and designs. The stakeholders mentioned that a number of technologies are commercialised, even though the Programme does not provide incentives for the post-prototype stage. In the question: "Since the end of THRIP project funding, how much has your company spent on continued R&D and commercialisation of your THRIP project?" the average respondent mentioned that they had collectively spent R3.84 million. It is apparent that THRIP projects are supported by the industrial partners after Programme funding for the relevant project had ceased.

5.5.2.6 Intellectual property and commercialisation

What happens to the IP - Is it commercialised?

The stakeholders (both from the science base and the industrial sector) declared that the Intellectual Property Rights from Publicly Financed Research and Development Act, Act No. 51 of 2008, is a challenge. It is emphasised that this is not an implementation challenge, but an inhibiting environmental factor.

The issue of IP is an interesting one in the THRIP context. Patents serve as a performance indicator reported by the National Advisory Council on Innovation (NACI) to the DST. However, the country's innovation system produces a limited number of international patents. It can be argued that this is the result of the structure of the economy (lack of high-technology industries and large multinationals) and probably a lack of appropriate government support.

THRIP statistics show that since 2001/02 the Programme produced just over 50 patents per year (locally and abroad). As there is no detailed information available, it is difficult to judge the quality of these patents. For example, local patents are not examined for novelty, usefulness, etc. (Pouris and Pouris, 2011). On the other hand, South Africa produces less than 120 patents in the United States Patent and Trademark Office (USPTO) per annum. Hence, if THRIP patents are granted by the USPTO, the Programme makes a substantial contribution in the field.

It should be emphasised, as shown in the overview of THRIP guidelines and the THRIP theory of change, that THRIP does not support near-market development. Hence, from an

incentive structure perspective, the Programme cannot directly influence the progress of IP to commercialisation. However, the industrial partners declared “licenses issued” among the outputs produced (1.6 during the period that the Programme was running and just over three (3) during the three (3) years after completion of the project).

On the question: “What changes in the IP regulations can improve chances of commercialisation of the THRIP projects?” the majority of respondents mentioned the adverse effects of the Publicly Financed Research Act on THRIP.

5.5.2.7 Benefits for South Africa

To what extent are benefits of THRIP realised in South Africa?

This overview of the findings has so far shown that THRIP had indeed, since its inception, contributed to technology development, return on investment for industry, capacity building (both skills development and empowering small and medium sized enterprises) and national return on investment. The successes are especially notable if the relatively modest size of the THRIP budget is considered.

THRIP’s rules and guidelines in various ways prevent foreign companies to benefit. In this regard it is also important to quote a report by **the dti** (2008: 10) on the ‘migration’ of technologies funded by government that states: “In-depth analysis, however, indicates that if there are technologies that have been “lost” abroad during the period under examination – in the sense that they have been successfully commercialised and provide an income to their current owners (without benefit to original inventors) – they are not profound. The case studies that were investigated in that study did not identify any technologies that have been transferred abroad (to the detriment of the inventors), are successfully commercialised or provide an income to their current owners.” THRIP creates benefits for the South African national system of innovation and its benefits are not lost to countries abroad.

5.5.2.8 Further reinforcement

How can the beneficial impacts of THRIP be strengthened?

There are two sides to this final implementation question, namely the need to identify inhibiting factors on the one hand and recommending ways of addressing potentially inhibiting factors, on the other. Grant holders at universities and science councils rated pre-established relationships with industrial partners as being by far the most important facilitator of the beneficial effects of THRIP; relevance of the research was rated as the second most important. The two most inhibiting factors turned out to be finding an industrial partner willing to make a cash commitment to the project and the IP issue referred to earlier.

The industrial partners that participated in this part of the evaluation rated as strengths the collaboration between universities and industry and the production of relevant human resources skills for industry. One stakeholder stated: “THRIP is one of the best initiatives of government. The Programme provides the necessary infrastructure and know-how to enable job creation in a scarce skills environment and to improve the quality of industry-directed research through enabling fundamental directed research.” The weaknesses that were reported by more than 70% of the respondents were funding and certain administrative matters, especially the time required for the evaluation of applications; and releasing the

funds after approval of applications. **Figure 5** (p.26) gives an overview of the percentage of respondents from industry who listed specific categories of strengths and weaknesses,

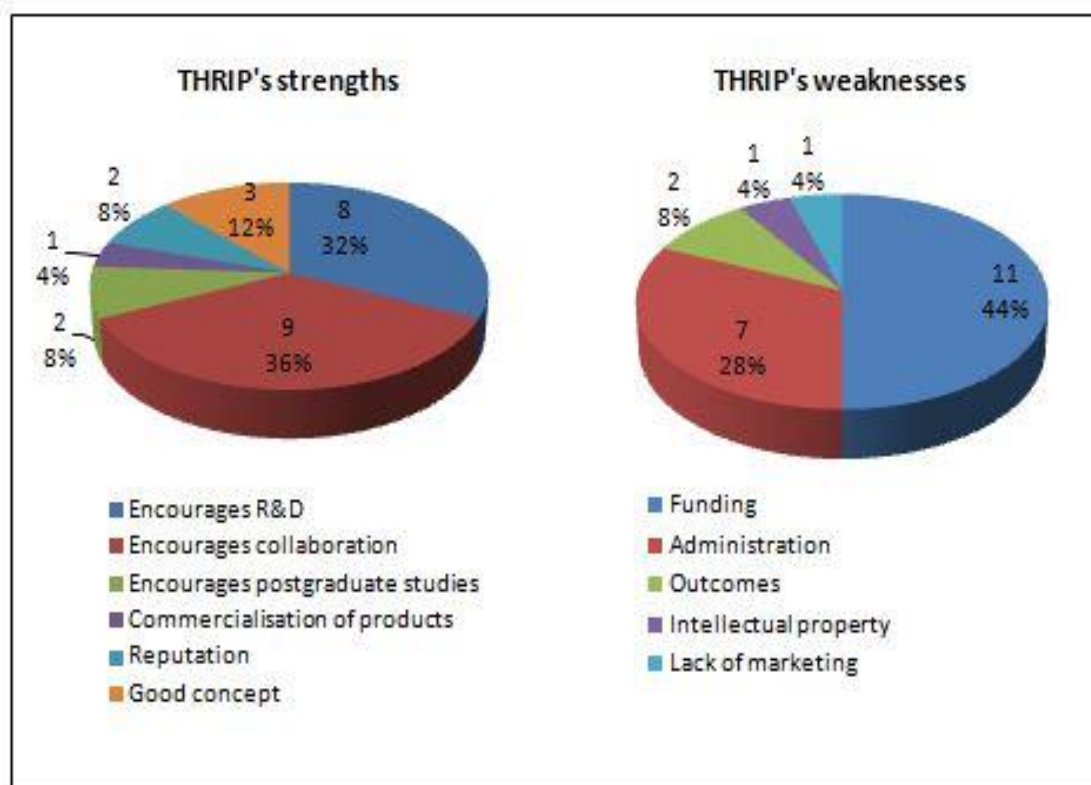


Figure 5: Opinions on strengths and weaknesses of THRIP (Figure 15 p. 78 of the full report)

Against the background of the preceding selective overview of strengths and weaknesses it would be fair to conclude that industrial partners were generally satisfied to participate in the Programme, but that there was room for further strengthening the beneficial effects and impacts. The following selective list is aligned with information reported in this section and the rest of this executive summary:

- The review showed that THRIP's mandate is limited to supporting all types of research necessary to resolve the industrial challenge but that there is a hiatus in the spectrum of funding instruments between applied research and commercialisation of same. One solution would be to widen the mandate of THRIP to include, among others, the funding of outputs and outcomes, such as pilot scale industrial projects, pre-production facilities, as well as new products and processes. The success recorded by THRIP in this assessment and its proven Programme management structures, expertise and experience, suggest that such a step would have a significant effect not only on the beneficial impacts of the Programme itself, but also on the country's economic development as such. The international comparative analyses have shown such a step would constitute good practice. An alternative to extending THRIP's mandate would be to initiate a separate funding instrument that should slot in between applied research and commercialisation of such research.
- This assessment has shown that THRIP would be capable to utilise productively a significant increase in its budget. Initiatives such as extending THRIP's mandate, would obviously put further strains on the budget. To capitalise on the good track record

already established by THRIP, it follows that the financial provision from the public coffer should be increased significantly – the return on investment can be expected to increase at least proportionally.

- This summary reported several times, also in **Figure 5** (p. 26), that communication and marketing of THRIP on the one hand and establishing relationships with industry on the other were weaknesses. The effects of an often underrated specific *Activity* (see Section 5, **Figure 1** p. 13), namely communication (including marketing), would contribute to further strengthening the beneficial effects of THRIP. More particularly, the management of THRIP could facilitate mutual understanding between SETIs and industry and partnering by helping to establish forums, by actively participating in conferences – also of the business sector – and thereby help facilitating partnering and mutual understanding
- A weak thread running through this report is the inhibiting effects of the intellectual property regime and could it be expected that resolving this weakness would strengthen the beneficial effects of THRIP.
- An effective administration is a necessary condition for a funding programme to positively impact on training of researchers and producing new knowledge. In general, the respondents in the two surveys rated the administration of THRIP positively. However, the industrial respondents perceived the time required for the evaluation of applications and releasing the funds after approval of applications as being too long (and thereby delaying the projects, one would assume). One reason for this perception is probably the different financial control regimes of government service and the private sector. Nevertheless, streamlining these ‘activities’ (see **Figure 1** p. 13) and communicating with current and potential industrial partners could further strengthen the beneficial effects – both in terms of impact and partnership relationships - of the Programme.

5.6 Recommendations

To review the performance of THRIP, the present review has used a relatively wide spectrum of tools including existing data bases, stakeholder interviews, two stakeholder surveys and a workshop. The triangulated findings strongly support the conclusion that for more than 20 years the Programme has successfully been fulfilling its objectives i.e., to address the challenges of skills development in science, engineering and technology and to promote competitiveness in the South African industry.

Following international best practice the Programme attracts substantial resources from industry and creates linkages between industry; academia and government. During the most recent period the Programme has so far had a substantial impact on SMMEs as well. THRIP can indeed serve as an example of the positive effects of a funding programme on the NSI.

The findings summarised above, serve as bases for the following recommendations each of which is accompanied by cross-references to the relevant findings discussed in Section 6:

Recommendation 1: the dti should retain THRIP and enhance the government’s financial support. A doubling of the Programme’s funding should be the first objective over the intermediate term.

From the evidence presented, (especially on relevance, benchmarking and impacts) it should be apparent that THRIP is a valid and important and very successful - indeed essential - element of the South African government's portfolio of innovation support measures. Following international best practice, it offers considerable value for money and has not yet reached the stage where it is running into diminishing returns. It is recommended that THRIP should be retained and its available funding should be increased according to industrial absorptive capacity and needs.

Recommendation 2: the dti and NRF should protect and enforce the core principles contributing to THRIP's successes.

The success of THRIP in contributing to national objectives, according to evidence from benchmarking and relevant stakeholders' opinions – both in the science base and industry - , depends on its ability to retain a number of core principles. Failure to do so would result in a dilution of the Programme and diminishing its contribution to technology transfer and innovation in the country. The recommended principles that should constitute the Programme's "hurdles" (minimum entry requirements) are as follows:

- Collaborative research involving at least two partners – one business and one from the research base;
- Quality scientific research;
- Pre-commercial character of research, which can be safeguarded through the participation of more than one firm;
- The maximum funding available from government of 1:2 for most research and 1:1 for projects with particular requirements should be reconsidered by **the dti** with the objective of bringing the Programme on a par with international standards and supporting the local industry appropriately.

Recommendation 3: the dti and NRF should act to improve the operational challenges of the Programme, viz. the relatively broad spectrum of objectives; the discouraging effect of partial funding; the promotion of participation by companies partially owned by HEI/SETIs; encouragement of participation by universities that were previously unsuccessful in obtaining THRIP funds; and programme evaluation.

Evidence from the process and benchmarking questions reveals that there is a need to continuously review the processes that underpin and support THRIP in order to ensure that users are provided with the most efficient and effective service possible. Areas where refinements are required as a matter of priority are the following:

- THRIP should reduce the number of Programme objectives following international good practice;
- The issue of partial funding of projects should be applied only when the relevant committee has reasons to believe that the relevant costs are inflated;
- The monitoring of the projects should be expanded so that their impacts could be monitored after their completion;
- THRIP should consider accepting contributions from companies owned wholly or partly by HEIs/SETIs up to a limit of 25% ownership;

- THRIP should consider developing separate approaches linking universities that were previously unsuccessful in obtaining THRIP funds with relevant industrial establishments and successful THRIP institutions; and.
- Programme evaluations (like this one) should be undertaken every five years. The ten-year horizon is too long for evaluation as the majority of the early participants are no longer available to participate in the evaluation and consequently there is also a loss of corporate memory.

Recommendation 4: The THRIP management and executive should create links with similar international programmes and learn from their experiences.

In the review a number of international programmes that are similar to THRIP has been identified, among others the Canadian CRD grants and the ATP in the USA. THRIP could benefit by establishing active linkages with such programmes and learn from their experiences and approaches.

Recommendation 5: the dti should consider the expansion and supplementation of THRIP in support of industry for the uptake and commercialisation of the knowledge generated, as well as for the monitoring and evaluation of THRIP project outcomes beyond project conclusion.

THRIP plays a unique role in the country's system of innovation. Its domain covers all research necessary to resolve industrial challenges. Following international good practise and according to evidence from the THRIP theory of change it is important for the dti and the country to develop additional programmes that support industry to take THRIP projects further and commercialise THRIP-produced know-how. Such an approach would have the additional advantage that existing programmes will not have to operate on the basis of the "one-size-fits-all".

Recommendation 6: the dti should engage with DST in order to resolve the challenge of intellectual property ownership.

THRIP participants identified the intellectual property (IP) regime, within which the Programme operates, as an obstacle to commercialisation. THRIP and the dti should engage with the DST to identify ways of simplifying the IP regime for THRIP projects. The *IP Draft Policy* that is being developed by the dti could also provide the relevant recommendations.

5.7 Conclusions

This summary provides evidence-based responses to the implementation and impact questions contained in the original Terms of Reference and offers a small set of recommendations based on the findings. The evidence was produced by a mixed-methods evaluation design that offered the opportunity of triangulation of the findings. On the basis of the evidence presented here, it can be concluded that:

- THRIP should be retained and even be further strengthened. It is a valid and important element of the South African government's portfolio of innovation support measures. It is

- efficient and offers considerable value for money both in terms of technology development and in terms of developing human resources with industry-related skills. Its core principles of collaboration and quality of research and development are in accordance to international best practise.
- The total funding available to THRIP should be increased according to the industrial absorptive capacity and needs.
- While the Programme is efficient and achieve its objectives (creating new technologies and knowledge and providing human resources for industry) it can benefit by reducing the number of its objectives; streamlining its funding administration to meet stakeholders requirements; introducing post-project monitoring; and assisting non-participating science and technology institutions to participate in the Programme.
- THRIP plays a unique role in the country's system of innovation, but its domain is primarily designed to support applied research. Following international best practise, it is important to develop additional programmatic activities supporting industry to take further and commercialise the THRIP produced know-how, including the monitoring and evaluation of THRIP project outcomes beyond project conclusion.
- Two major challenges confronting THRIP is that of addressing the intellectual property regime surrounding THRIP and increasing the public financial support to the Programme.

The various sources of information gathered in this evaluation, viz. official statistics; analyses of the NSI strategic ecology; stakeholder interviews; comparative international analysis of similar programmes; two stakeholder surveys; and a theory of change workshop, converge to support the overriding conclusion that THRIP has up to the time of this evaluation been a highly successful Programme. Furthermore, there seems no reason why its success should diminish in future, especially if it would respond positively to the recommendations in this evaluation report.

Appendix A: Selected references

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Appendix B: Proposed theory of change including support activities closer to commercialisation

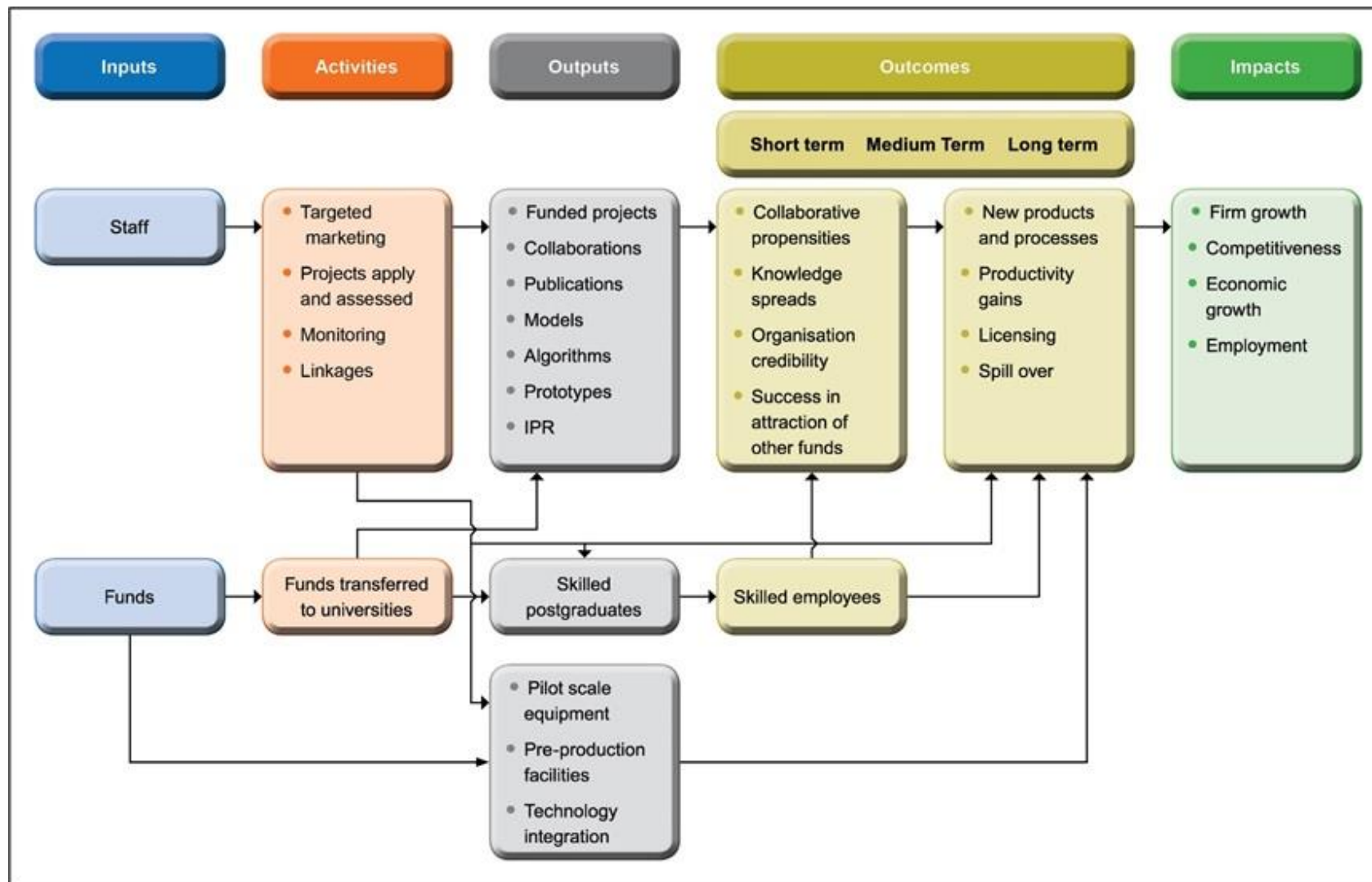


Figure 6: Proposed theory of change including support activities closer to commercialisation (Figure 5 on p. 53 of the full report)