References

Africa Trade issue brief. 1995.

AISI Aerospace industry support initiative, Implementation strategy for the Department of Trade and Industry, SA. May **2005**.

AMTS Advanced manufacturing technology strategy for the Department of Science and Technology, SA. **2003**.

Answers Corporation. **2006**.

Antoniou, PH. & Ansoff, HI. 2004. Strategic management of technology. *Technology Analysis & Strategic Management.* June 2004, 16(2), 275-291.

ATAG Consultation report from the Air Transport Action Group to the Department of Transport. **2002**. The future development of air transport in the United Kingdom – 2002. Available from: http://www.atag.org [Accessed 20 November 2003].

Bell, M. & Pavitt, K. 1993. Technological accumulation and industrial growth: Contrasts between developed and developing countries'. *Industrial and Corporate Change,* Vol. 2 (no 2), 157-202.

Bennett, D. & Vaidya, K. 2001. Meeting technology needs of enterprises for national competitiveness. *Global Forum on Management of Technology: Focus on the Arab Region.* Organised by UNIDO, 29-30 May 2001, Vienna, Austria.

Blados, WR., Cotter, GA., and Ryan, RP. 2001. International aerospace information network: International cooperation and resource sharing. *Information Review*, 25(1), 54-61.

Bonaccorsi, A. & Giuri, P. 2001. *Learning, technological competition and network structure in the aero-engine industry*. LEM Papers series. Available from: http://netec.mcc.ac.uk/WoPEc/data/Papers//ssalemwps2000-01.html [Accessed 8 March 2003].

Brand, R. 2004. SAA cancels Airbus orders after loss of R8.7 bn. *Business Report*, 30 August 2004.

British Aerospace: Annual report and accounts. **1998**.

Brusoni, S. & Prencipe, A. 2001. Unpacking the black box of modularity: Technology, products and organisation. *Industrial and Corporate Change*, 10(1), 179-205.

BuaNews. 2004. *New facility for aircraft engines*, South Africa, November 29, 2004.

Burgelman, RA., Maidique, MA. & Wheelwright, EC. 1996. *Strategic management of technology and innovation.* 2nd ed. New York: McGraw-Hill/Irwin.

Buys, AJ. 2001. Technological decolonisation of South Africa by backwards integration of the national system of innovation. *First Conference on Managing Technological Innovation for Global Competitiveness.* 30 May–1 June 2001, Berg-en-Dal, Kruger National Park, SA. Available from South African Association for the Management of Technology and Innovation.

Buys, AJ. 2002. Industrial development in South Africa by backwards integration of the national system of innovation. *11th International Conference on Management of Technology (IAMOT 2002)*. 10–14 March 2002, Miami, Florida, USA.

Buys, AJ. 2004. Industrial innovation in a technology colony. *IEEE Africon 2004 Conference*, 15–17 September 2004, Gaborone, Botswana.

Buys, AJ. 2005. *Research guide for post-graduate students*. Issue 15, Department of Engineering and Technology Management: University of Pretoria.

Calliano, R. & Carpano, C. 2000. National systems of technological innovation, FDI, and economic growth: The case of Ireland. *Multinational Business Review,* Detroit, USA. Fall 2000.

Campbell, K. 2003. SA in big aerospace thrust. *Engineering News*. Available from: http://www.engineeringnews.co.za/eng/utilities/search/?show=42566 [Accessed 20 October 2003].

Campos, LMB. 2001. On the competition between Airbus and Boeing. *Air & Space Europe,* 3(1/2), 11-14.

Canta, A. 2003. Focus areas: Economic growth and international competitiveness. National Research Foundation. Available from: http://www.nrf.ac.za/focusareas/growth [Accessed 15 March 2003].

Chiang, J-T. 1999. Defense conversion and systems architecture: Challenges to Taiwan's aircraft industry. *Technology in Society,* Vol. 21, 263-274.

Cho, M. 2003. Restructuring of Korea's defense aerospace industry: Challenges and opportunities? *Bonn: BICC*, paper 28.

Cho, TH. 2000. Challenges in research and development for the Korean aircraft industry. Rand Publications.

Cohen, WM. & Levinthal, DA. 1990. Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, Vol. 35, 128-152.

Corporate performance and military production in South Africa, 2003.

Costa, I. & de Queiroz, SRR. 2001. FDI and technological capabilities in the Brazilian industry. *Nelson and Winter Conference*. June 2001 Druid.

Crawford, NW. 2000. U.S. Aerospace technology and implications for Korea. Rand Publications.

CSIR. 2003. A strategy for a sustainable, economical and growing aerospace industry (ASSEGAI): CSIR draft document for discussion with contributors, July 2003.

Dahlman, C. & Nelson, R. 1995. Social absorption capability, national innovation systems and economic development. In: Perkins, DH. & Koo, BH. eds. *Social capability and long-term growth*, Basingstoke: Macmillan Press.

DASEF Delaware AeroSpace Education Foundation, **2002**.

Da Silveira, GJC. 2002. Improvement trajectories in operations and technology management: Concept, process and content issues. *Technology Analysis & Strategic Management,* 14(2), 227-240.

Datamonitor. 2005. *Global aerospace & defense*. Industry profile, August 2005.

Davies, A. & Brady, T. 1998. Policies for a complex product system. *Futures,* 30(4), 293-304.

Davies, A. & Brady, T. 2000, Organisational capabilities and learning in complex product systems: Towards repeatable solutions. *Research Policy,* Vol.29, 931-953.

Davies, A., Tang, P., Brady, T., Hobday, M., Rush, H., & Gann, D. 2001. Integrated solutions:The new economy between manufacturing and services.

De Bruijn, EJ. & Steenhuis, H-J. 2004. Freedom of choice in technology strategy? An analysis of technology strategy in the large civil aircraft Industry. *Technology Analysis & Strategic Management,* 16(3), 381-393.

Denel SA. 2002. Input for Aviation Africa.

DTI (SA) Department of Trade and Industry. **2001**. Aerospace & defence industry profile. 2001.

DTI (SA) Department of Trade and Industry. **2003**. A strategy for an aerospace industry in South Africa: A discussion document for the Department of Trade and Industry, Department of Defence and the Department of Public Enterprises.

DTI (SA) Department of Trade and Industry. **2004a**. **the dti** Statistics in brief.

DTI (SA) Department of Trade and Industry. **2004b**. The technology development trends report.

DTI (SA) Department of Trade and Industry. **2005**. Positioning the South African aerospace industry as a priority sector. Presentation, July 2005.

DTI (SA) Department of Trade and Industry. **2007**. Draft technology policy framework for SA.

DTI (UK) Department of Trade and Industry. **2003**. An independent report by the Aerospace Innovation and Growth Team (AeIGT). *The Future of the UK Aerospace Industry - June 2003.*

Dosi, G., Pavitt, K., & Soete, L. 1990. *The economics of technical change and international trade*. New York: New York University Press.

Engineering News. **2003**. *Company highlights the importance of managing vibration in aircraft*. Available from: http://www.engineeringnews.co.za/eng/utilities/search/?show=41927 [Accessed 17 October 2003].

Engineering News. **2004**. *SA moves to create aerospace support programme*. Available from: http://www.engineeringnews.co.za/eng/utilities/search [Accessed 22 September 2004].

Eriksson, S. (1995). Global shift in the aircraft industry: A study of airframe manufacturing with special reference to the Asian NIEs.

Eriksson, S. (2000). Technology spill-over from the aircraft industry: the case of Volvo Aero. Technovation 20, pp. 653-664

Eriksson, S. (2003a). Indonesia's aircraft industry: technology and management impediments. The International Journal of Technology Transfer and Commercialisation (IJTTC), Inderscience Publishers, Vol. 2, No. 2

Eriksson, S. (2003b). Technology Policies in East and Southeast Asia: Creating a new global structure in the aircraft industry. ASIAN GEOGRAPHER, Volume 22, pp. 169-185

Eriksson, S. (2006). Cluster creation and innovation within an emerging Taiwanese "high tech" sector. The International Journal of Technology Transfer and Commercialisation (IJTTC), Inderscience Publishers, Vol. 5, No. 3, pp. 208-236

EUROPA. 2005. *Enterprise & industry, aerospace industry*

European Commission, 1996. EU White paper on innovation, 1996.

FAC Farnborough Aerospace Consortium. **2005**. Centre of excellence for aerospace and defence in the South East, UK. Presentation to DTI (SA) delegation. April 2005.

Flight International, 13th August **2002**.
Focus Group progress report. 2003. National innovation systems in catching-up economies.

Freeman, SP. 2002. Offsets and the development of the Brazilian arms industry. *International Conference on Offsets and International Development.* 25-27 September 2002, University of Cape Town, South Africa.

Gilbert, M. & Cordey-Hayes, M. 1996. Understanding the process of knowledge transfer to achieve successful technological innovation. *Technovation,* Vol. 16, 301-312.

Goel, RK. & Rich, D.P. 1997. On the adoption of new technologies. *Applied Economics*, Vol. 29, 513-518.

Goldstein, A. 2001. From national champion to global player: Explaining the success of EMBRAER. Working Paper Series CBS-17-2001, OECD Development Centre, Paris.

Gulati, R. 1998. Alliances and networks. *Strategic Management Journal*, Vol. 19, 293-317.

Hayward, K. 1994. *The world aerospace industry.* London.

Henderson, RM. & Clark, KB. 1990. Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly,* Vol. 35, 9-30.

Hobday, M. 1995. *Innovation in East Asia: The challenge to Japan.* England: Edward Edgar.

Hobday, M. 1998. Product complexity, innovation and industrial organisation. CoPS working paper.

Holmes, BJ. 1996. *Reinventing government–industry R&D collaboration.*

House of Commons Trade and Industry Committee. **2005**. *The UK aerospace industry: Fifteenth report of session 2004-05*, March 22, 2005. London: The Stationery Office Limited.

Hwang, C. 2000. The Aircraft industry in a latecomer economy: The case of South Korea. *Science Policy Research Unit,* University of Sussex, Brighton, UK.

IADF International Aircraft Development Fund information. **2004**. Available from: http://www.iadf.or.jp/8361/h/IADF-HP/iadf-hp_katudou--E.htm [Accessed 11 March 2004].

Iles, P. & Yolles, M. 2002. Across the great divide: HRD, technology translation, and knowledge migration in bridging the knowledge gap between SMEs and universities. *Human Resource Development International*, 5(1), 23-53.

Info reporter. 2004a. *Regional maintenance hub South Africa*. Available from: http://www.nrf.ac.za/focusareas/growth [Accessed 16 April 2004].

Info reporter. **2004b**. *Two Malaysian contracts for Grintek, South Africa.* 16 April 2004.

Irwin, DA., & Pavcnik, N. 2001. Airbus versus Boeing revisited: International competition in the aircraft market. National Bureau of Economic Research, NBER Working Paper no 8648. Available from: http://netec.mcc.ac.uk/WoPEc/data/Papers//nbrnberwo8648.html [Accessed 8 March 2003].

Jackson, I. 2004. The future of the defence firm: The case of the UK aerospace industry. *Defence and Peace Economics*, Vol. 15(6), 519-534.

JADC. 2004. Outline of Japan Aircraft Development Corporation. Available from: http://www.jadc.or.jp/outline_jadc_e.htm [Accessed 3 March 2004].

Kandebo, SW. 2002. Technology development key to GE's future engine strategy. *Aviation Week & Space Technology,* 157(5), 29 July 2002.

Kim, L. 1997. *From imitation to innovation: The dynamics of Korea's technological learning.* Cambridge, MA: Harvard Business School Press.

Kim, L. & Seong, SM., 1997. Science and technology: Public policy and private strategy.

Kim, L. 1998a. Crisis construction and organizational learning: Capability building in catching-up at Hyundai Motor. *Organization Science*, Vol. 9, 506-521.

Kim, L. 1998b. Technology policies and strategies for developing countries: Lessons from the Korean experience. *Technology Analysis & Strategic Management,* 10(3).

Kim, L. 1980. Stages of development of industrial technology in a developing country: A model. *Research Policy*, Vol.9, 254-277.

Kleiner, MM., Leonard, JS., & Pilarski, AM., 1999. Do industrial relations affect plant performance?: The case of civil aircraft manufacturing. National Bureau of Economic Research, NBER Working Paper no 7414. Available from: http://netec.mcc.ac.uk/WoPEc/data/Papers//nbrnberwo7414.html [Accessed 8 March 2003].

Klesius, M. 2004. The airplane has come a long way in its first hundred years. *National Geographic Magazine*, pp1-2, 23 October 2004.

Lall, S. 1990. Building industrial competitiveness in developing countries. OECD.

Lall, S. 2000. The technological structure and performance of developing country manufactured exports, 1985–1998. QEH Working Paper Series, WP 44, Oxford.
Lall, S. 2001. Competitiveness indices and developing countries: An economic evaluation of the global competitiveness report. *World Development,* 29(9), 1501-1525.

Lall, S. 2003. Reinventing industrial strategy: The role of government policy in building industrial competitiveness. The Intergovernmental Group on Monetary Affairs and Development (G-24).

Leedy, PD. & Ormrod, JE. 2005. *Practical research: Planning and design.* 8th ed. New Jersey: Merrill Prentice Hall.

Leonard-Barton, D. 1995. *Wellsprings of knowledge: Building and sustaining the sources of innovation.* Boston, Massachusetts: Harvard Business School Press.

Lowe, P. 1995. *The Management of technology: Perception and opportunities.* London: Chapman & Hall.

Mathews, JA. 2001. National systems of economic learning: The case of technology diffusion management in East Asia. *International Journal of Technology Management,* 22(5/6), 455-479.

Mathews, JA. 2004. World industrial development in the 21st Century: Catch-up strategies and the latecomer effect. MGSM Working Papers in Management.

Mayindi, DH. & Kachienga, M.O. 2008. Analysis of national technological competitiveness: South Africa's civil aircraft industry. *PICMET 2008 Proceedings*. 27-31 July, Cape Town, South Africa © 2008 PICMET, 99-107.

McGuire, S. (1999). Sectoral innovation patterns and the rise of new competitors: The case of civil aerospace in Asia, *Industry and Innovation*, No 2, pp. 153-170

Mowery, DC. & Rosenberg, N. 1982. Technical change in the civil aircraft industry, 1925–1975, pp163–177. In: Rosenberg, N. 1982. *Inside the black box: Technology and economics,* Cambridge: Cambridge University Press.

Mowery, DC. & Rosenberg, N. 1984. Government policy, technical change, and industrial structure: The U.S. and Japanese civil aircraft industries, 1945–1983. *US/Japan High Technology Research Project Conference*. 21–23 March 1984, Stanford University, US.

Napier, DH. 2005. 2004 Year-end review and 2005 forecast: An analysis. Aerospace Industries Association (AIA).

National Science Board. 2003. *Science and engineering indicators – 2002*. National Science Foundation, Arlington, VA. Available from: http://www.nsf.gov/sbe/srs/seind02/start.htm [Accessed 13 March 2003].

Neven, D. & Seabright, P. 1995. European industrial policy: The Airbus case. *Economic Policy*, 0(21), 314-344.

Niosi, J. & Zhegu, M. (2005). Aerospace clusters: Local or global knowledge spillovers? Industry and Innovation, Vol. 12, Issue 1, p. 5-29

NIPP The National Industrial Participation Programme in review. **2002**. Leveraging growth in the South African economy. DTI Industrial Participation Secretariat.

NRC The National Research Council Report, **1994**. U.S. needs new approach towards aircraft cooperation with Japan. Available from: http://www4.nationalacademies.org/news.nsf/isbn/0309050456?OpenDocument [Accessed 11 March 2004].

OECD. 1996. Review of national science and technology policy: Republic of Korea, OECD, Paris.

Oerlemans, LAG., Pretorius, MW., Buys, A. & Rooks, G. 2004. *Industrial innovation in South Africa, 1998–2000.* University of Pretoria, Pretoria.

Oerlemans, LAG., Pretorius, MW., Buys, A. & Rooks, G. 2005. Industrial innovation in South Africa: A comparative study. *South African Journal of Science,* March/April 2005, Vol. 101, 149-150.

Okamoto, Y. & Sjöholm, F. 2001. Technology development in Indonesia: Chapter 14.

Orsenigo, L., Pammolli, F., & Riccaboni, M. 2001. Technological change and network dynamics: Lessons from the pharmaceutical industry. *Research Policy,* Vol. 30, 485-508.

Paras Report. 1998. *The role of government to promote technology in industry.* The Department of Trade and Industry, South Africa.

Parker, R. 2004. Foundations of technology development, innovation and competitiveness in the globalised knowledge economy. *Prometheus,* 22(3), September 2004.

Patel, P. & Pavitt, K. 1993. National systems of innovation: Why they are important, and how they might be defined, compared and assessed. Science Policy Research Unit, University of Sussex, Falmer, Brighton, UK.

Pavitt, K. 1999. *Technology, management and systems of innovation.* Massachusetts: Edward Elgar.

Pelc, KI. 2002. Knowledge mapping: The consolidation of the technology management discipline. *Knowledge, Technology, & Policy,* 15(3), 36-44, Fall 2002.

Porter, ME. 1990. *The competitive advantage of nations.* Macmillan Press Ltd.

Prencipe, A. 1997. Technological competencies and product's evolutionary dynamics: A case study from the aero-engine industry. *Research Policy*, Vol. 25, 1261-1276.

Prencipe, A. 2000. Breadth and depth of technological capabilities in CoPS: The case of aircraft engine control system. *Research Policy*, Vol. 29, 895-911.
Research, NBER Working Paper no 8648.

Prencipe, A. 2001. Exploiting and nurturing in-house technological capabilities: lessons from the aerospace industry. *International Journal of Innovation Management,* 5(3), 299-321.

Reuters News. 2004. *Boeing sees lucrative market in Africa*. 6 March **2004**.

SAA Technical: Presentation to SA aerospace industry players. 2003.

Sajid, M. 1995. Strategic management of technology. *Hydrocarbon Processing*, 74(6), 116-B, June 1995.

Saunders, M., Lewis, P., & Thornhill, A. 2003. *Research methods for business students.* 3rd ed. Boston: Prentice Hall Financial Times.

Science and Technology. 2003. High Flyers: Brazil: Sharing innovative experiences. Vol. 1, 8-11.

September 11 effects on aerospace industry: Terrorism attack on World Trade Center. Available from: http://www.eds.com/about_eds/homepage/home_page_911_heath_assess.shtml [Accessed 24 March 2003].

Smrcka, K. 2003. Aircraft maintenance: preparation in 3D. Engineering News. Available from: http://www.engineeringnews.co.za/eng/utilities/search/?show=41742 [Accessed 23 October 2003].

South African Embassy in Sweden: SA overview on agricultural economy – **2003**. Agricultural Economy. Available from: http://www.southafricanemb.se/agriae.htm [Accessed 23 March 2003]

Statistics South Africa, 2003: Statistical release p0441. Gross Domestic Product. Available from: http://www.statssa.gov.za/Products/Releases/GDP/GDPCurrent.htm [Accessed 24 March 2003]

Steenhuis, H-J. & de Bruijn, EJ. 2001. Developing countries and the aircraft industry: Match or mismatch? *Technology in Society,* Vol. 23, 551-562

Teece, D. & Pisano, G. 1994. The dynamic capabilities of firms: An introduction. *Industrial and Corporate Change*, 3(3), 537-555.

Teece, DJ. 1977. Technology transfer by multinational firms: The resource cost of transferring technological know-how. *The Economic Journal*, Vol. 87, 242-261.

The Israel aircraft industries: Past, present and future. Quality Translations Job 31401.

The US report on aerospace, 2003.

Thomas, R. 2002. The Aero club of South Africa. Available from: http://www.flying.org.za/news28.htm [Accessed 7 September 2004].

Tidd, J., Bessant, J., & Pavitt, K. 2001. *Managing innovation: Integrating technological, market and organizational change.* 2nd ed. Chichester: Wiley.

TISA Trade and Investment SA, **2004**. South African aerospace industry analysis – 2004.

TISA Trade and Investment SA, **2002**. Trade statistics. Available from: http://www.isa.org.za/transport/aircraft.asp [Accessed 14 August 2002].

Trade & Industry Monitor, 2004. *Newsletter of Trade and Industrial Policy Strategies* (TIPS), Vol 30, June 2004.

US Technology Position and Trend Report: Transportation category. **1995**. Washington DC: US Government Printing Office.

Van den Bosch, F., Volberda, H., & de Boer, M. 1999. Co-evolution of firm absorptive capacity and knowledge environment: Organizational forms and combinative capabilities. *Organization Science*, 10(5), 551-568.

Werksmans Attorneys. **2003**. Business guide to South Africa: The South African economy. Available from: http://www.mbendi.co.za/werksmns/sabus01.htm [Accessed 26 March 2003].

Wise, R. & Baumgartner, P. 1999. Go downstream: The new profit imperative in manufacturing. *Harvard Business Review,* pp133-141 September-October 1999.

Yin, RK. 1993. *Applications of case study research*. Applied Social Research Methods Series, Vol. 34. Thousand Oaks, CA. SAGE Publications.

Yin, RK. 1994. *Case study research design and methodology*. In Applied Social Research Methods Series, 2nd ed, Vol. 5. Thousand Oaks, CA. SAGE Publications.

Yin, RK. 2003. *Case study research: Design and methods*. 3rd ed. Applied Social Research Methods Series, Vol. 5. Thousand Oaks, CA. SAGE Publications.

Bibliography

Berenson, ML., Levine, DM., & Krehbiel, TC. 2002. *Basic business statistics: Concepts and applications. Student's solution manual*. 8th ed. Upper Saddle River, New Jersey: Prentice Hall.

Chen, J., Fujimoto, T., & Lee, C. 2000. The advance to car production and globalization of the Chinese munitions enterprises. Working paper for MIT IMVP Draft 30 June 2000.

Crawley, MJ. 2005. S*tatistics: An introduction using R.* Chichester, West Sussex, England: Wiley.

Dancey, CP. & Reidy, J. 2002. *Statistics without maths for psychology: Using SPSS for Windows*. 2nd ed. Harlow: Pearson Education.

Dosi, G. 1988. Sources, procedures, and microeconomic effects of innovation. *Journal of Economic Literature*, Vol. 26, 1120-1171.

Enis, BM., Cox, KK., & Mokwa, M.P. 1995. *Marketing classics: A selection of influential articles*. New Jersey: Prentice Hall.

Kim, J. 1999. Technology transfer, adoption and catching up: Innovation issues on South Korea. *Technology, Region and Policy*.

Mani, S. 2001. Role of government in promoting innovation: An international comparative study, Netherlands.

Mathers, N., Fox, N., & Hunn, A. 2002. *Trent focus for research and development in primary health care: Surveys and questionnaires*.

Mowery, DC. & Oxley, JE., 1995. Inward technology transfer and competitiveness: The role of national innovation systems. *Cambridge Journal of Economics*, Vol. 19, 67-93.

National science and technology policy for Guyana, 2005. Available from: www.iastguyana.org/st/stpolicy [Accessed 4 August 2005].

Penrose, E. 1995. *The theory of the growth of the firm*. Oxford, England: Oxford University Press.

Teece, DJ., Pisano, G., & Shuen, A. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal*, Vol. 18, 509-533.

Textier, F. 1999. The take of the Korean aerospace industry, from license production to aircraft development. *3rd International Conference on Technology Policy and Innovation*.
Available from: http://www.utexas.edu/depts/ic2/austin99/abstracts/8_tex.htm [Accessed 19 May 2002]

Van der Westhuizen, LJ. & Le Roux, JH., 1997. *Armscor: The leading edge*. Institute for Contemporary History, UOFS, Bloemfontein.

Appendix I: Capabilities of South African aircraft firms

COMPANY		CAPABILITIES													
		Design & Produce Complete Systems	Design & Produce Major Sub-systems	Design & Produce Minor Sub-systems	Major Upgrades of Systems	Minor Upgrades of Systems	Systems Engineering and Integration	Provide Engineering Support Services	Provide Other Support Services	Manufacture of Major Sub-systems	Manufacture of Minor Sub-systems	Manufacture of Components	Manufacture of Parts	Repair and Overhaul Major Systems	Repair and Overhaul Minor Systems
DENEL	Denel Aviation	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Denel Kentron	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Turbomeca Africa					X	X			X	X	X	X	X	X
	Overberg Test Facility							X	X						X
	LIW			X			X				X	X	X		
	Eloptro			X		X	X	X			X	X	X	X	X
GRINTEK	Avitronics		X	X			X			X	X	X	X		
	Grintek Communications Systems		X	X			X			X	X	X	X		
	Ewation		X	X			X			X	X	X	X		
	Logtronics			X		X	X	X	X			X		X	X
REUNERT	Reunert Radar Systems		X	X			X			X	X	X	X		
	Reunert Defence Industries		X	X			X			X	X	X	X		
	Reunert Defence Logistics					X	X	X	X					X	X
CSIR	Defencetek			X			X	X	X				X		
	Manufacturing and Materials			X				X	X		X	X	X		X
ARMSCOR	Gennan							X	X						
	Gerotek							X	X						
African Defence Systems			X	X	X	X	X			X	X	X		X	X
Advanced Technologies and Engineering		X	X	X	X	X	X			X	X	X	X		
Alvis OMC		X	X	X	X	X	X				X			X	

	SAA Technical						X	X	X	X				X	X	X
	Aircraft Monitoting Systems			X								X	X	X		
	Telumat			X	X		X	X			X	X	X	X	X	X
	Aerosud				X	X	X	X	X		X	X	X	X		
	Ansys Integrated Systems				X		X	X				X	X	X		
	Epsilon Engineering				X		X	X	X			X	X	X		
	IST Dynamics			X	X			X			X	X	X	X		
	ISIS Information Systems			X	X	X	X	X								
	Aztec Components				X							X	X	X		X
	Contactserve											X	X			X
	Cybersim						X	X	X	X						
	Geopgraphic Information Sustems				X				X	X			X			
	Isiziba						X	X								
	Lachabile Quality Systems								X	X		X	X	X		
	M-Tek				X			X	X			X	X			
	Parachute Industries SA				X							X	X	X	X	X
	Paramount Group						X	X	X	X						
	Sattelite Application Centre									X						
	Volt Ampere				X			X				X	X	X		X
	Xcel Engineering			X	X	X	X	X								
	Sinjana Engineering													X		
	Ubombo Cliff's Way											X	X	X		
	Advanced Worx				X			X	X			X	X	X		X
	Aeromac				X		X	X	X	X		X	X	X		
	Isomac				X			X	X	X						
	Incomar				X		X	X	X	X						
	MMS				X		X	X	X			X	X	X		
	Parsec				X							X	X			
	Kreon				X			X				X				

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Appendix II: Research questionnaire for South African experts

AREA OF STUDY

INDUSTRIAL CAPABILITY AND NATIONAL TECHNOLOGICAL COMPETITIVENESS: THE CASE OF SOUTH AFRICA'S CIVIL AIRCRAFT INDUSTRY

RESEARCH CONDUCTED BY:

Ms Daphney H Mhlanga

Director: Innovation & Technology

Department of Trade & Industry

Tel: +2712 - 394 1272

Fax: +2712 - 394 2272

Cell: +2782 806 7435

Email: Daphney@thedti.gov.za

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

RESEARCH QUESTIONNAIRE

Confidentiality (The information provided by the interviewee remains confidential and shall not be disclosed in any way to any other persons/firms)

PERSONAL BACKGROUND

(*Optional, for follow up purposes on responses*)

NAME OF INTERVIEWEE:

ORGANIZATION:

JOB TITLE:

TELEPHONE NO:

FAX NO:

EMAIL:

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

1. Please indicate your field of expertise below *(Mark on the relevant box)*

Engineering	1	
Management Sciences	2	
Natural Sciences	3	
Other (Please state …. ……)	4	

2. Please indicate your field of work within the organisation *(Mark on the relevant box)*

Technical Production	1	
Manufacturing	2	
Sales & Marketing	3	
Other (Please state ……)	4	

3. Please indicate your work experience within the aircraft industry or within aircraft-related policy development *(Mark on the relevant box)*

Less than 6 months	1	
Between 6 and 12 months	2	
Between 1 and 2 years	3	
Between 2 and 3 years	4	
Between 3 and 5 years	5	
More than 5 years	6	

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

RESEARCH QUESTIONS (PART I)

Please choose your answer by ticking on the relevant box.

1. Does your institution/organization/firm have or previously had any joint ventures with other international aircraft institutions? *(Please tick where appropriate)*

   Yes ☐ No ☐

2. Has your institution/organization/firm been involved in aircraft projects for an international contractor? *(Please tick where appropriate)*

   Yes ☐ No ☐

   If yes, please state the percentage contribution of such contract to the turnover of your institution/organization/firm.

   _____

3. Has your institution/organization/firm been involved in any form of collaboration with other local institutions? *(Please tick where appropriate)*

   Yes ☐ No ☐

4. Has your institution/organization/firm been involved in any form of technological innovation or improvement within the aircraft industry? *(Please tick where appropriate)*

   Yes ☐ No ☐

5. Did your institution/organization/firm acquire some business contracts through Government assistance in the past, where without their involvement it might have been difficult if not impossible to attain such business? *(Please tick where appropriate)*

Yes ☐ No ☐

6. Has your institution/organization/firm been involved in any form of aircraft-related Technology Transfer with global institutions? *(Please tick where appropriate)*

Yes ☐ No ☐

If yes, please state the country where technology is transferred from and the area of application of such technology.

_____

7. In what area of the Aircraft industry structure is your institution/organization/firm making a major contribution? (*More than one answer could be chosen)*

1st tier (System integration)	1	
2nd tier (Major sub-system supply)	2	
3rd tier (Minor sub-system supply)	3	
4th tier (Component supply)	4	
5th tier (Parts supply)	5	

Other (please state) ……

8. Where do you think South African firms should be playing more important role within the Aircraft industry structure? (*More than one answer could be chosen for this question).*

1st tier (System integration)	1	
2nd tier (Major sub-system supply)	2	
3rd tier (Minor sub-system supply)	3	
4th tier (Component supply)	4	
5th tier (Parts supply)	5	

Other (please state) ……

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

RESEARCH QUESTIONS (PART II)

9. The following are assumed to be the current major gaps that affect the technology capability-building process of the South African civil aircraft industry.
(Please rate on a scale of 1-5, where 1=Strongly disagree and 5=Strongly agree)

Insufficient in-house technological capability	
Under-developed National Systems of Innovation	
Lack of firm collaboration	
Poorly developed aircraft Infrastructure	
Insufficient skilled resources	
Under-developed technological capabilities	
Lack of appropriate technologies	
Insufficient R&D investment	

9.cont. The following are assumed to be the current major gaps that affect the technology capability-building process of the South African civil aircraft industry.

(Please rate on a scale of 1-5, where 1=Strongly disagree and 5=Strongly agree)

Insufficient knowledge	
Insufficient skills development programme	
Insufficient strategic alliances with global firms	
Lack of skills transfer/knowledge transfer programme	
Poor levels of innovation	
Poor external environment	
Poor governing structures to oversee the industry	

10. Where do you think South African private sector firms within the aircraft industry should be playing a bigger role in building national technological competitiveness within the civil industry?
(Please rank them on a scale of 1-5, with 1=highest priority and 5=least priority)

Research and technology development	
Business development	
Skills development	
Infrastructure development	
Support higher education & research institutions	
Other (please state)	

11. What form of interventions is your firm doing in relation to Human Resource development to enhance in-house technological capabilities? *(More than one answer could be chosen for this question. Also indicate if you have been involved or not in such interventions)*

		Already involved	Envisage involvement
In-house skills development programme			
Inter-firm skills exchange program (national)			
Inter-firm skills exchange program (international)			
Knowledge transfer during technology transfer			
Inter-firm research collaboration (national)			
Inter-firm research collaboration (international)			
Other …… …… ……			

12. Which countries do you think South African aircraft firms should place their emphasis in terms of developing their market relations as part of enhancing national technological competitiveness and technology capability-building? *(Please rank them on a scale of 1-5, with 1=highest priority, 5=least priority).*

Africa	
Europe (excluding United Kingdom)	
United Kingdom	
United States	
Asia	
Latin America	
Other (please state)	

13. To what extent do you agree or disagree with the following statements?

Statements	**Strongly disagree** *1*	**Disagree** *2*	**Neither agree nor disagree** *3*	**Agree** *4*	**Strongly agree** *5*
Inter-firm collaboration can enhance technology & business capability development within SA aircraft firms through skills transfer, joined investment and learning from each other.					
Government interventions are necessary for business acquisition and improved market access by SA aircraft firms.					
R&D programme, in line with applied technology development could improve the technology base of the SA aircraft industry.					
Technology transfer would be key towards development of technology capabilities, improved innovation and competitiveness of SA aircraft industry.					
SA firms should form joint ventures with global firms to have improved technology and business development capabilities, as well as better market accessibility.					
Collaborative efforts from academia, research institutions, firms and government are essential for enhancing innovation and technology development within the aircraft industry.					
SA government should collaborate with governments from other countries on major projects so as to facilitate development and market access for SA aircraft firms.					

14. For technology development to improve within the civil aircraft industry, the following should be established:

(Please rank them on a scale of 1-5, with 1=highest priority, 5=least priority).

Research and technology development programme	1	
Firm collaboration (national)	2	
Firm collaboration (international)	3	
Aircraft-related research institutes	4	
Government support/involvement	5	
Market acquisition assistance	6	
Research collaboration (government, research institutes, academia, firms)	7	
Technology transfer	8	
Skills development	9	

15. The following are assumed to be the factors hampering business acquisition and technology capability-building for South African civil aircraft firms:
(Please rate on a scale of 1-5, where 1=Strongly disagree and 5=Strongly agree)

Highly regulated environment (global & local)	
Insufficient financial resources	
Inadequate skilled resources	
Lack of appropriate technologies	
Projects too costly	
Poor strategic alliances or networks	
Not meeting customers' demands	
Insufficient government support	
Insufficient experience in global supply	
Negative perception by global customers on quality of products	

16. What are the existing competencies, capabilities, skills and technologies available within the South African aircraft industry?
(More than one answer could be chosen for this question.)

Aircraft maintenance skills	1	
Aircraft conversions and modification skills	2	
Manufacture of components and sub-system levels	3	
Manufacture of composites, rotor wing propeller blades, gear-boxes	4	
Specialists in avionics	5	
Capabilities for interior designs	6	
Design and manufacturing skills for helicopters	7	
Manufacture of military aircraft	8	
Other (please state) …… …… …… ……	9	

17. What would be the ideal key competencies, capabilities, skills and technologies needed for technology development within the South African civil aircraft industry?

(Please rank them on a scale of 1-5, with 1=highest priority, 5=least priority).

Aircraft maintenance skills	1	
Aircraft conversions and modification skills	2	
Manufacture of components and sub-system levels	3	
Manufacture of composites, rotor wing propeller blades, gear-boxes	4	
Design and manufacturing of complete engines	5	
Specialists in avionics	6	
Capabilities for interior designs	7	
Design and manufacturing skills for helicopters	8	
Design and manufacturing skills for passenger aircraft	9	
Full assembling skills for passenger aircraft	10	
Civil-military technology linkages	11	
Other (please state) …… ……	12	

18. How would you rate the current level of innovation in South Africa as compared to that of other successful organizations/institutions/firms in developing countries (South Korea, Japan, Brazil, etc) within the civil aircraft industry?

Extremely poor	1	
Poor	2	
Moderate	3	
Strong	4	
Very strong	5	

Please state the percentage level of investment on innovation (R&D) by your institution towards technological development within the civil aircraft industry _____%

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Appendix III: Research questionnaire for international experts

AREA OF STUDY

INDUSTRIAL CAPABILITY AND NATIONAL TECHNOLOGICAL COMPETITIVENESS: THE CASE OF SOUTH AFRICA'S CIVIL AIRCRAFT INDUSTRY

CONTACT PERSON:

Ms Daphney H Mhlanga

Director: Innovation & Technology

Dept of Trade & Industry (South Africa)

Tel: +2712 - 394 1272

Fax: +2712 - 394 2272

Cell: +2782 806 7435

Email: Daphney@thedti.gov.za

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

RESEARCH QUESTIONNAIRE

Confidentiality (The information provided by the interviewee remains confidential and shall not be disclosed in any way to any other persons/firms)

PERSONAL BACKGROUND
(***Optional***, *for follow up purposes on responses*)

NAME OF INTERVIEWEE:

ORGANIZATION:

JOB TITLE:

TELEPHONE NO:

FAX NO:

EMAIL:

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

1. Please indicate your field of expertise below *(Mark on the relevant box)*

Engineering	1	
Management Sciences	2	
Natural Sciences	3	
Other (Please state …. ……)	4	

2. Please indicate your field of work within the organisation *(Mark on the relevant box)*

Technical Production	1	
Manufacturing	2	
Sales & Marketing	3	
Other (Please state ……)	4	

3. Please indicate your work experience within the aircraft industry or within aircraft-related policy development *(Mark on the relevant box)*

Less than 6 months	1	
Between 6 and 12 months	2	
Between 1 and 2 years	3	
Between 2 and 3 years	4	
Between 3 and 5 years	5	
More than 5 years	6	

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

RESEARCH QUESTIONS (PART I)

(To be completed by firms only)

Please choose your answer by ticking on the relevant box.

1. Does your firm have or had any joint ventures with other aircraft firms/institutions/organisations outside your country? *(Please tick where appropriate)*

   Yes ☐ No ☐

2. Has your firm been involved in any form of collaboration with other local firms/institutions/organisations? *(Please tick where appropriate)*

   Yes ☐ No ☐

3. Is your firm subcontracting some of its work to firms/institutions/organisations outside your country? *(Please tick where appropriate)*

   Yes ☐ No ☐

   If yes, please state the percentage contribution of such subcontract(s) to the turnover of your firm/institution/organisation.

   _____

4. Has your firm/institution/organisation been involved in aircraft projects for an international contractor? *(Please tick where appropriate)*

Yes ☐ No ☐

If yes, please state the percentage contribution of such contract to the turnover of your firm/institution/organisation.

_____

5. Has your firm/institution/organisation been involved in any form of technological innovation or improvement within the aircraft industry? *(Please tick where appropriate)*

Yes ☐ No ☐

6. Did your firm/institution/organisation acquire some business contracts through Government assistance in the past, where without their involvement it might have been difficult if not impossible to attain such business? *(Please tick where appropriate)*

Yes ☐ No ☐

7. Has your firm/institution/organisation been involved in any form of aircraft-related Technology Transfer with global firms/institutions? *(Please tick where appropriate)*

Yes ☐ No ☐

If yes, please state the country where technology is transferred from and the area of application of such technology.

_____

8. In what area of the Aircraft industry structure is your firm/institution making a major contribution? (*More than one answer could be chosen for this question).*

1st tier (System integration)	1	
2nd tier (Major sub-system supply)	2	
3rd tier (Minor sub-system supply)	3	
4th tier (Component supply)	4	
5th tier (Parts supply)	5	

Other (please state) ……

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

RESEARCH QUESTIONS (PART II)

9. It is the role of government to promote national technological competence through interventions such as these: *(Mark on the relevant box to show the extent that you agree or disagree with such possible government interventions)*

Government interventions	**Strongly agree** *5*	**Agree** *4*	**Neither agree nor disagree** *3*	**Disagree** *2*	**Strongly disagree** *1*
Support R&D programmes					
Support infrastructure development					
Stimulate local & international partnerships					
Provide safety and Regulatory environment guidelines					
Oversee establishment of enabling or governing structures					
Support skills development					

10. The following are essential interventions for successful technology capability-building or technological competitiveness within the aircraft industry: *(Mark on the relevant box to show the extent that you agree or disagree with the statements)*

Statements	**Strongly agree** *5*	**Agree** *4*	**Neither agree nor disagree** *3*	**Disagree** *2*	**Strongly disagree** *1*
Inter-firm collaboration can enhance Technology capability development within aircraft firms through skills transfer, joined investment and learning from each other.					
Government interventions are essential for fostering proper structures necessary for building technology competence.					
Large investment on R&D could improve technology competence within firms thereby enhancing technological competitiveness of the national aircraft industry.					
Technology transfer would be key towards development of technology capabilities, improved innovation and competitiveness of aircraft industry.					
Firms should form joint ventures or strategic alliances with global firms to have improved technology development capabilities, as well as better market accessibility.					
Government should collaborate with governments from other countries on major projects so as improve technology competence and global market access for aircraft firms.					

10Cont. The following are essential interventions for successful technology capability-building or technological competitiveness within the aircraft industry: *(Mark on the relevant box to show the extent that you agree or disagree with the statements)*

Statements	**Strongly agree** *5*	**Agree** *4*	**Neither agree nor disagree** *3*	**Disagree** *2*	**Strongly disagree** *1*
Collaborative efforts from academia, research institutions, firms and government are essential for enhancing innovation and technology development within the aircraft industry.					
User-producer kind of linkages should be maintained to foster inter-firm learning and proper understanding of technology development requirements.					
Government should invest in developing future engineers at all levels of training, so as to build a strong technology development skilled nation.					

11. To grow the aircraft industry towards national technological competitiveness, the following should be established:

(More than one answer could be chosen for this question. Also rate them on a scale of 1-5, with 1=highest priority and 5=least priority)

Research and technology development programme	1	
Firm collaboration (national)	2	
Firm collaboration (international)	3	
Aircraft-related research institutes	4	
Government support for technological innovation	5	
Market acquisition assistance	6	
Research collaboration (government, research institutes, academia, firms)	7	
Technology transfer	8	
Skills development programme	9	
Good governance structures	10	
Well-supported higher education & research institutions	11	
Appropriate infrastructure	12	
Other ……..	13	

12. The following are the most well known aspects that impact on the technological competitiveness of firms within the civil aircraft industry. *(Mark on the relevant box to show the extent that you agree or disagree with the following)*

Aspects of impact	**Strongly agree** ***5***	**Agree** ***4***	**Neither agree nor disagree** ***3***	**Disagree** ***2***	**Strongly disagree** ***1***
Insufficient in-house technological capability					
Under-developed National Systems of Innovation					
Lack of firm collaboration					
Poorly developed aircraft Infrastructure					
Insufficient skilled resources					
Under-developed technological capabilities					
Insufficient R&D investment					
Insufficient skills development programme					
Insufficient strategic alliances with global firms					
Lack of skills transfer/knowledge transfer programme					
Poor levels of innovation					
Poor external environment (e.g govt policy, demand, firm rivalry)					
Poor governing structures to oversee the industry					

13. What form of interventions should firms do in relation to human resource development to enhance in-house technological capabilities? *(More than one answer could be chosen for this question. Please rate them on a scale of 1-5, with 1=highest priority, 5=least priority. Also indicate if you have been involved or not in such interventions)*

		Have been involved	**Never involved**
In-house skills development programme			
Inter-firm skills exchange program (national)			
Inter-firm skills exchange program (international)			
Knowledge transfer during technology transfer			
Inter-firm research collaboration (national)			
Inter-firm research collaboration (international)			
Other …… …… ……			

14. The following are assumed to be the factors hampering global business acquisition and technology capability-building needed for enhancing technology development within the civil aircraft firms:

(Please rate on a scale of 1-5, where 1=Strongly disagree and 5=Strongly agree)

Highly regulated environment (global & local)	
Insufficient financial resources	
Inadequate skilled resources	
Lack of appropriate technologies	
Projects too costly	
Poor strategic alliances or networks	
Not meeting customers' demands	
Insufficient government support	
Insufficient experience in global supply	
Negative perception by global customers on quality of products	

15. What would be the ideal key competencies, capabilities, skills and technologies needed for civil aircraft technology development by developing economies? *(More than one answer could be chosen for this question. Also rate them on a scale of 1-5, with 1=highest priority and 5=least priority)*

Aircraft maintenance skills	1	
Aircraft conversions and modification skills	2	
Manufacture of components and sub-system levels	3	
Manufacture of composites, rotor wing propeller blades, gear-boxes	4	
Design and manufacturing of complete engines	5	
Specialists in avionics	6	
Capabilities for interior designs	7	
Design and manufacturing skills for helicopters	8	
Design and manufacturing skills for passenger aircraft	9	
Full assembling skills for passenger aircraft	10	
Civil-military technology linkages	11	
Other (please state) …… ……	12	

16. How would you rate the current level of innovation in your firm/country as compared to that of successful firms/countries specifically within the civil aircraft industry? *(Please mark on the relevant box)*

Extremely poor	1	
Poor	2	
Moderate	3	
Strong	4	
Very strong	5	

Please state the percentage level of investment on innovation (R&D) by your firm or country towards technological development within the civil aircraft industry _____%

Appendix IV: Discussion on data collected from South African experts

On the **Research questionnaire for South African experts** the responses were categorised as follows:

A. Responses by aircraft *Firms*
B. Responses by *Research institutions*
C. Responses by *Academia* (Higher education institutions), and
D. Responses by *Government* officials.

On **personal background**, three (3) questions were asked as follows:

1. Please indicate your field of expertise.

Engineering

Management Sciences

Natural Sciences

Other (Combination of natural and management sciences)

The dominant field of expertise from respondents was '*engineering'*, where these experts were mostly from *Firms* and *Academia*, with 100% score on that particular category. The analysis would mean that '*engineering'* is a critical field needed for Aerospace technology development and competence. Table (iv)1 and Figure (iv)1 below indicate the distribution of the findings.

Table (iv)1 Field of expertise by respondents (Percentages)

	Firms	**Govt**	**Research**	**Academia**	**Total %**
Engineering	100	0	60	100	**73.33**
Management Sciences	0	50	0	0	**6.67**
Natural Sciences	0	0	40	0	**13.33**
Management/Natural Sciences	0	50	0	0	**6.67**

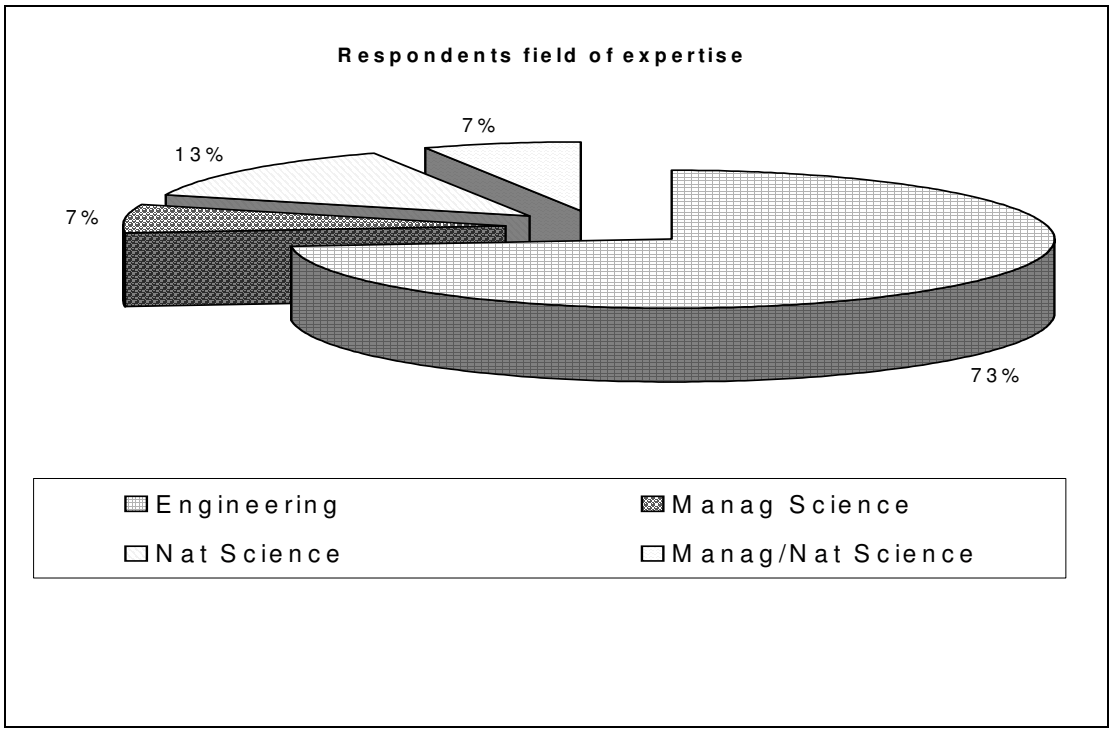

Figure (iv)1 Distribution of respondents' field of expertise

2. Please indicate your field of work within the organisation.

The majority of respondents fell outside the listed fields, where the score was 61% ('*others*'). The next higher score was on the field of '*manufacturing'* (15%). The distribution is graphically illustrated on Figure (iv)2. The analysis would mean that most of the top personnel within the aircraft industry were not directly involved on the listed fields, possibly because they were in top management positions, they would fall under the field named '*others'*, which could mean '*management*' field.

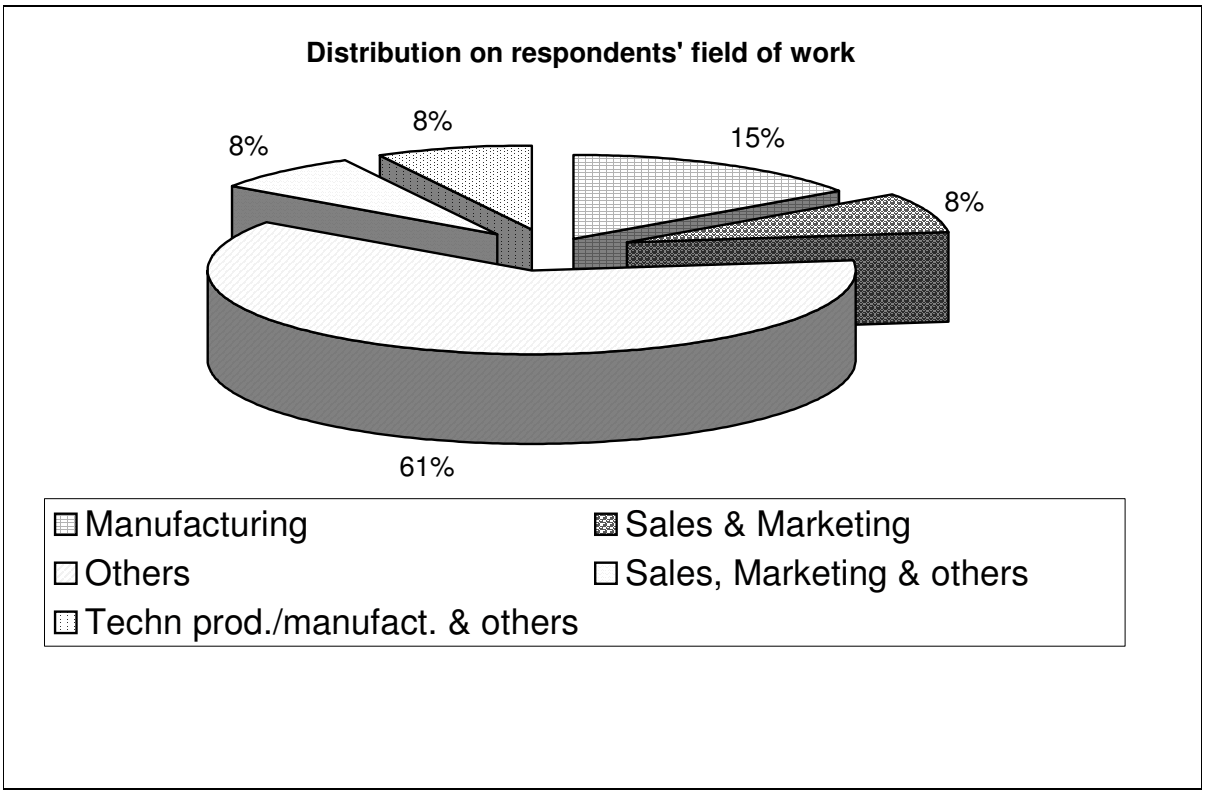

Figure (iv)2 Distribution of respondents' field of work

3. Please indicate your work experience within the aircraft industry.

About 67% of the respondents have been in the industry for over 5 years. When specifically looking at *Firms* there was 100% indication that they have been working on this industry for over 5 years, which could mean that it is quite critical to have experienced people because of the complexity of such an industry. This is graphically illustrated on Figure (iv)3.

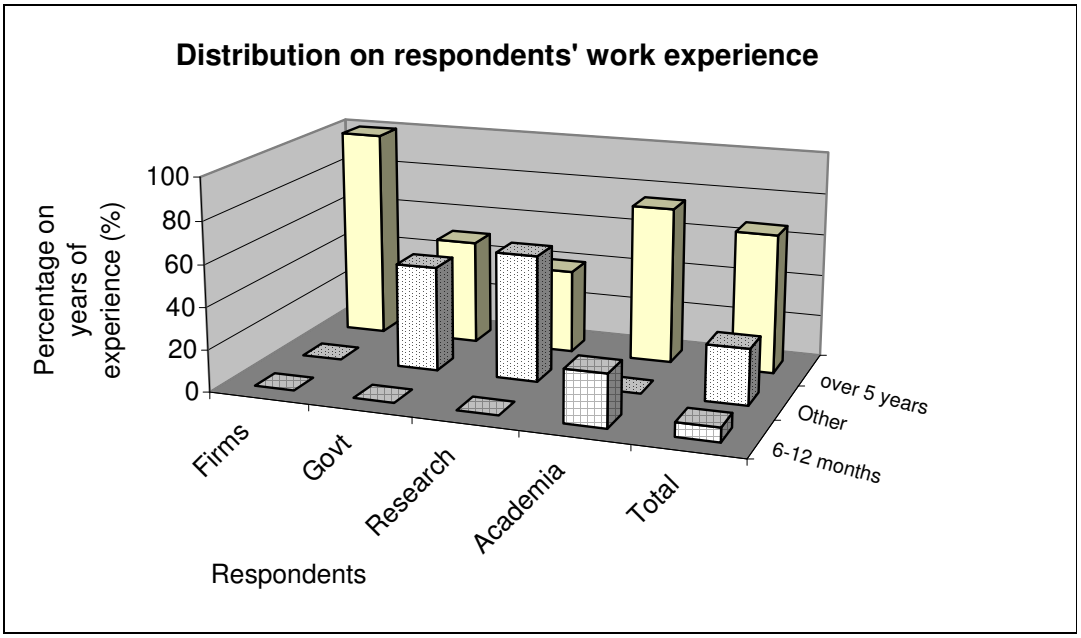

Figure (iv)3 Distribution of respondents' work experience

On the **main research questions** there were two sections, Part I and II.

Part I looked at the technological innovation related background in the form of activities (both current and previous) that firms have embarked on, so as to be able to make a comparison to the successful countries' pattern of technology development. This was in line with the theory on technological competence and capability building paths followed by most of the successful countries studied (Chapter 2). It also looked at the current and future positioning of firms in relation to the aircraft industry structure.

Responses to **Part I** questions were received as follows:

1. Does your institution/organisation/firm have or previously had any joint ventures with other international aircraft institutions?

About 60% of the total respondents said 'NO', meaning that they do not have joint ventures with international aircraft institutions. Responses by *Firms* indicated that only 50% have had joint ventures with international institutions, whereas *Research institutions* had 80% of such joint ventures. This is graphically illustrated on Figure (iv)4.

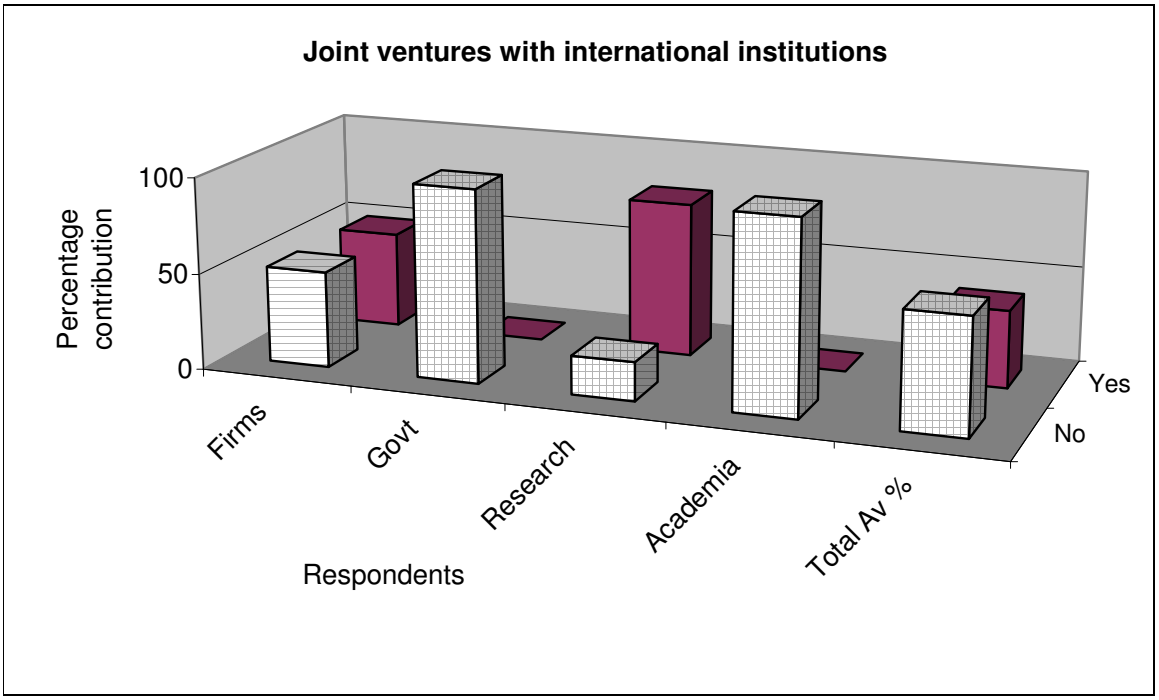

Figure (iv)4 Existing joint ventures with international institutions

2. Has your institution/organisation/firm been involved in aircraft projects for an international contractor?

About 47% of the total respondents agreed to have been involved in aircraft projects for an international contractor. Of such responses, *Firms* showed a 100% involvement in that they all agreed to have been involved. *Firms* further indicated that such involvement on projects for international contractors contribute about 95% to their total turnover. This could mean that the firms are getting opportunities to learn and could also be an indication of the existing capability by local firms when they are in a position to do work for international market. It also indicates that the international market is very crucial to the success of the local firms if such kind of work contributes about 95% to the total of their turnover. The distribution is graphically illustrated on Figure (iv)5.

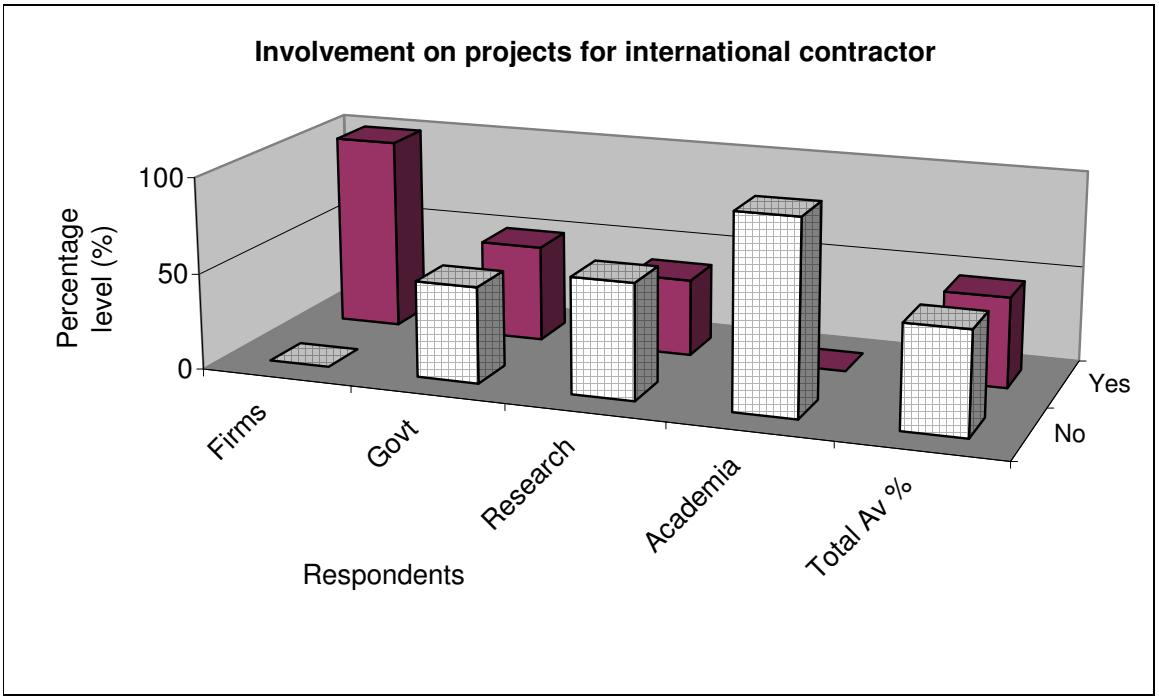

Figure (iv)5 Respondents' involvement on projects for international contractor

3. Has your institution/organisation/firm been involved in any form of collaboration with other local institutions?

A 100% response was received from all respondents, meaning that they all agree that they have been involved in some form of collaboration activities with local institutions.

4. Has your institution/organisation/firm been involved in any form of technological innovation or improvement within the aircraft industry?

Majority of respondents agreed to have been involved in technological innovation within the aircraft industry, where 93% of the total said 'YES'. A 100% response was received from *Firms, Government* and *Research institutions*, whereas 75% indication of such involvement was by *Academia*. This is graphically illustrated on Figure (iv)6.

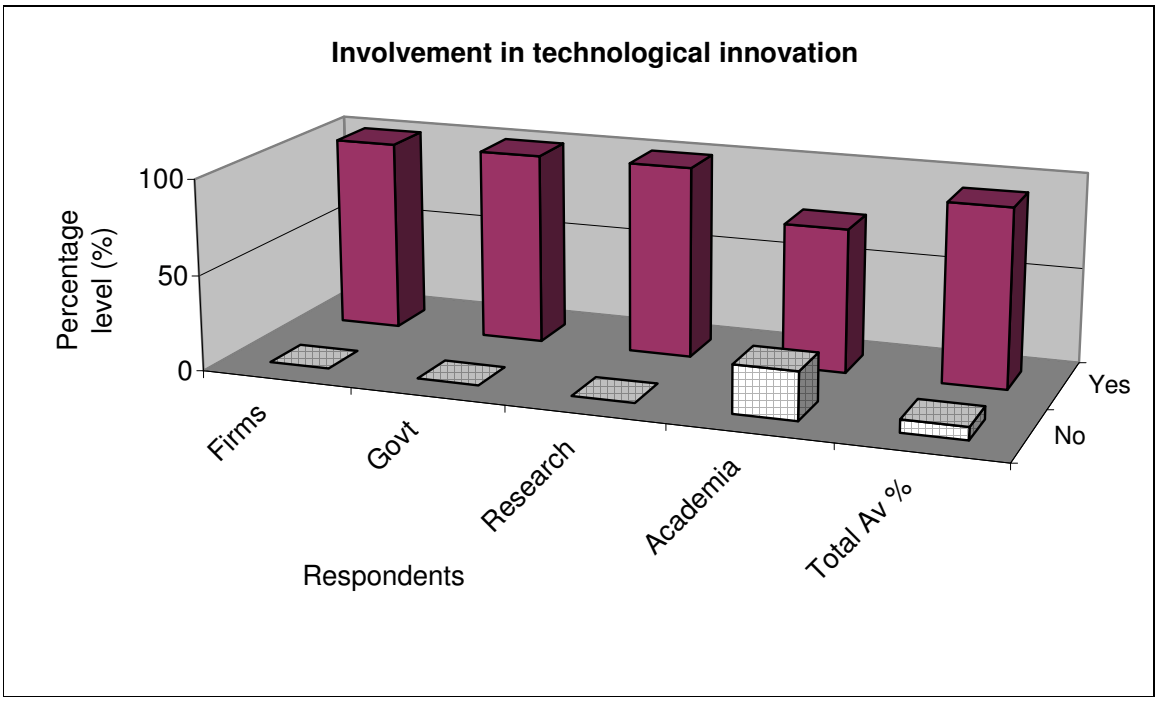

Figure (iv)6 Involvement in technological innovation by respondents

5. Did your institution/organisation/firm acquire some business contracts through government assistance in the past, where without their involvement it might have been difficult if not impossible to attain such business?

About 73% of the total respondents agree that government assistance has contributed towards their acquisition of some business contracts. Out of that, *Firms* had a 100% response, also agreeing that government has somehow assisted them to acquire some business contracts. This is graphically illustrated on Figure (iv)7.

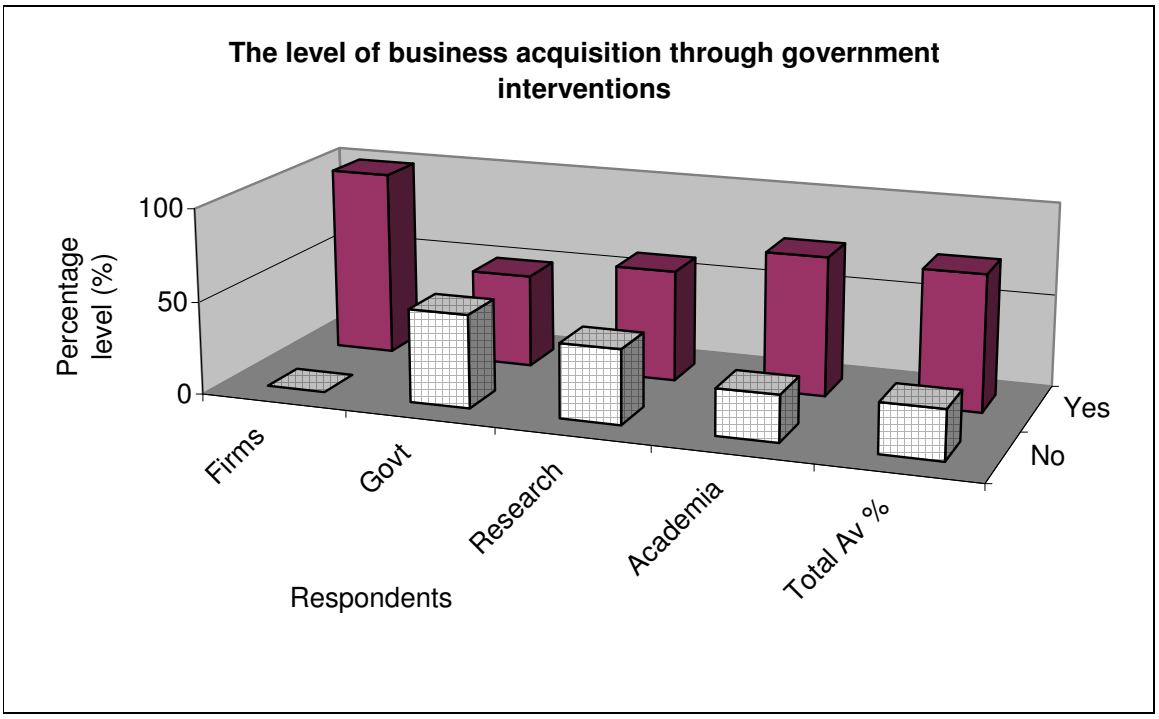

Figure (iv)7 The level of business acquisition through government interventions

6. Has your institution/organisation/firm been involved in any form of aircraft-related technology transfer with global institutions?

The responses received were not very different, where about 53% of the total respondents answered 'YES' to the question, and 47% answered NO. However, for *Firms*, it appeared that technology transfer is very critical for their success in that they had a 100% response, where they agreed that they have been transferring technology. This is graphically illustrated on Figure (iv)8.

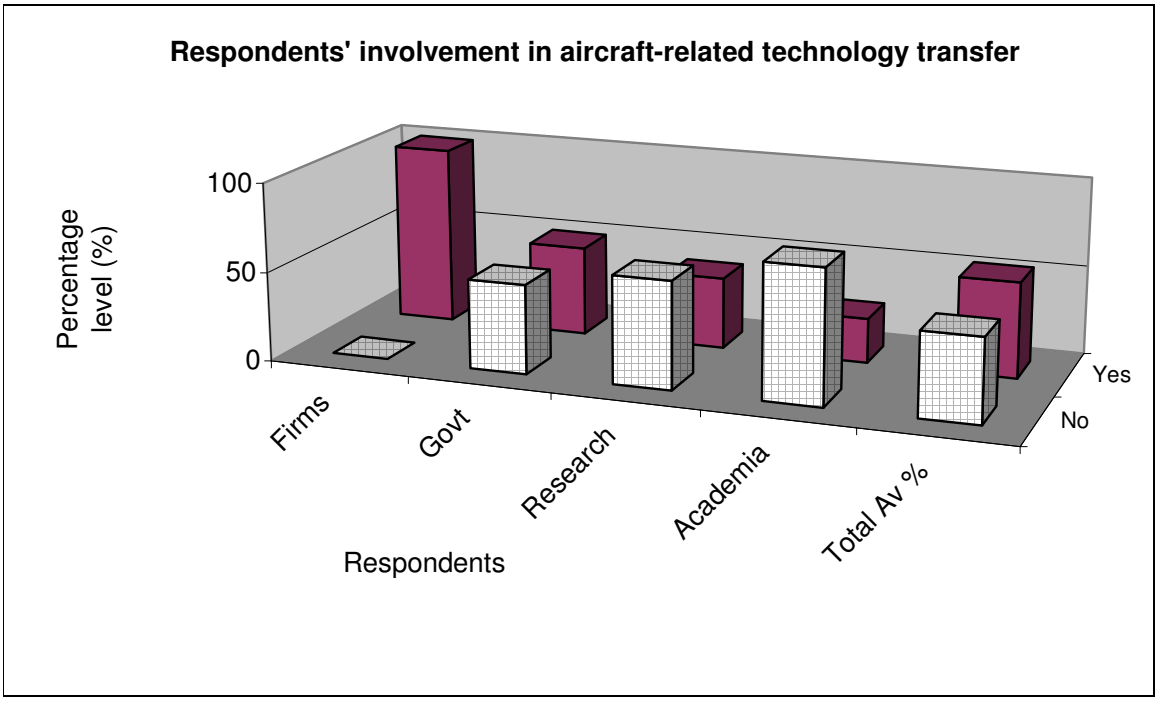

Figure (iv)8 Respondents' involvement in aircraft-related technology transfer

7. In what area of the aircraft industry structure is your institution/organisation/firm making a major contribution?

On average respondents indicated that their major contribution is on **fourth tier** (component supply) with a 47% overall response, and also **third tier** (minor subsystem supply) with a 40% overall response. *Firms* specifically had a 100% response rate, showing that they make a contribution in both third and fourth tiers equally. However, they had a 75% response with regard to

contribution they make on **first tier** (full assembly/system integrators) and **second tier** (major subsystem supply). For **fifth tier** (parts supply), the total respondents showed that it is only 20% contribution that they make. These results show that firms and research institutions are already moving up the value chain supply system (pyramid) of the aircraft industry structure as indicated on Figure 1.1 (from Chapter I). This does not necessarily mean that they cannot have technologies that could contribute towards the development of the first tier, but the market could be the determining factor as well.

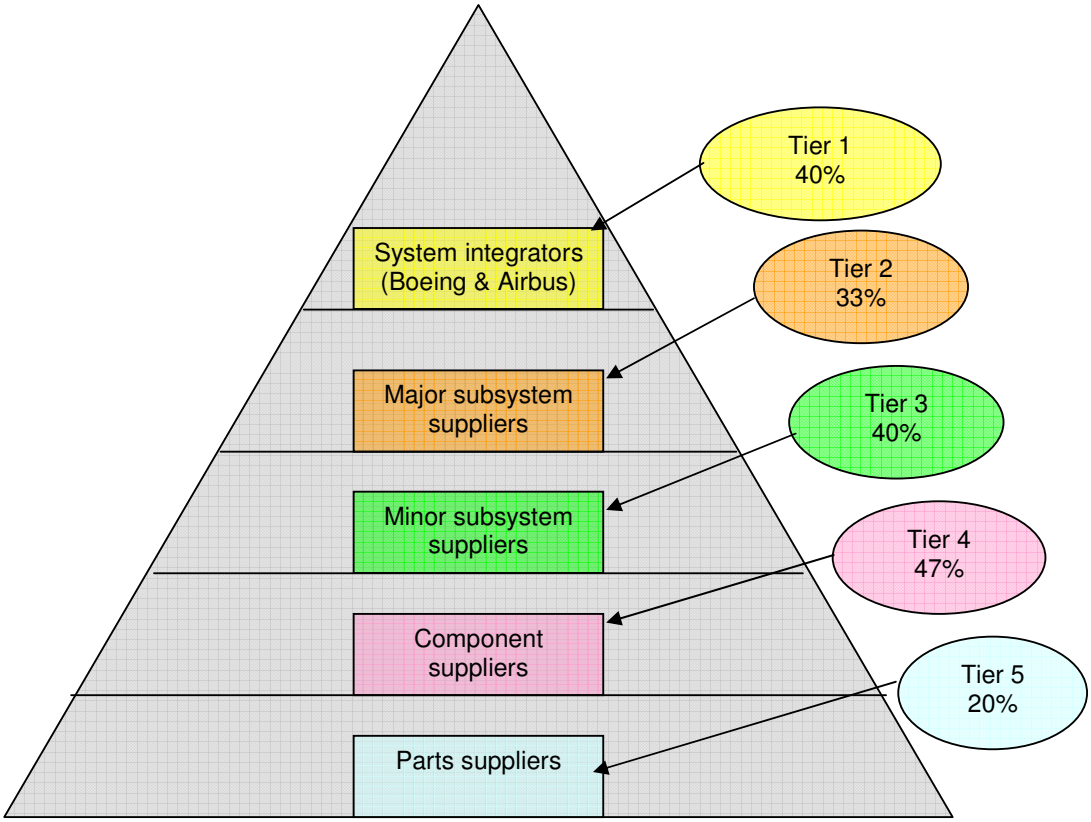

Figure 1.1 The aircraft industry structure

Source: Adapted from British Aerospace Annual Report and Accounts (1998), include respondents contribution percentages on tier levels.

Figure (iv)9 shows findings on South Africa's major contribution percentages by tier levels.

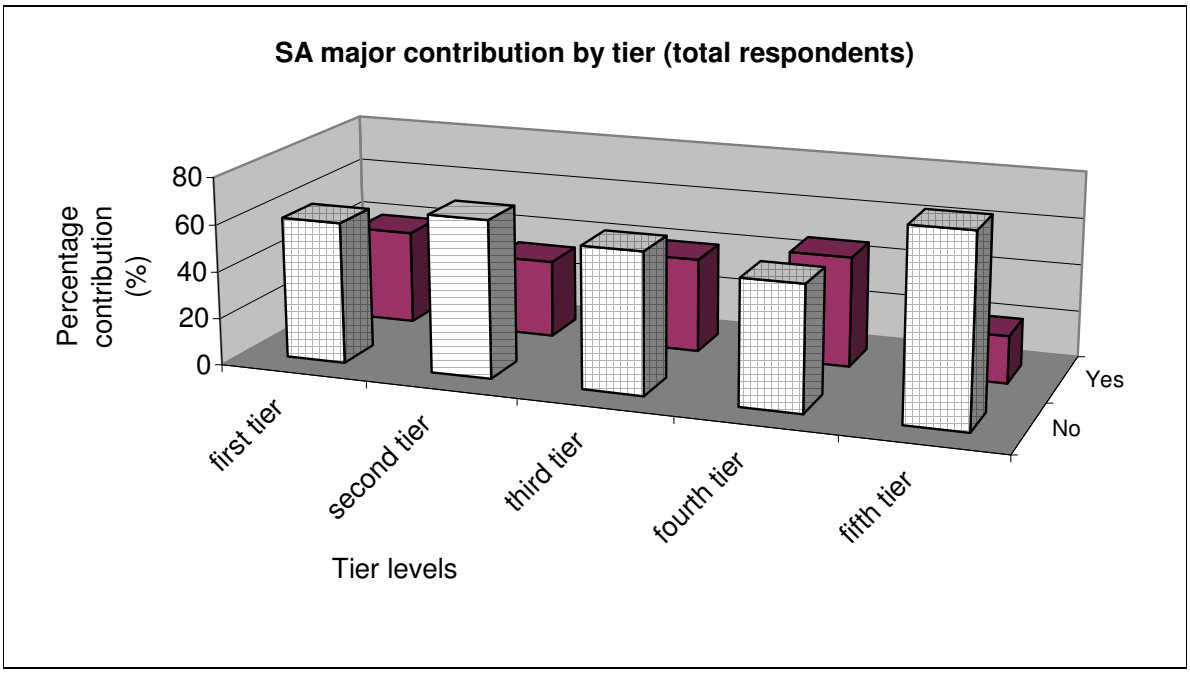

Figure (iv)9 South Africa's major contribution percentages by tier levels

The graphical representation of the contribution by respondents on the tier with the highest contribution (fourth tier) is illustrated on Figure (iv)10.

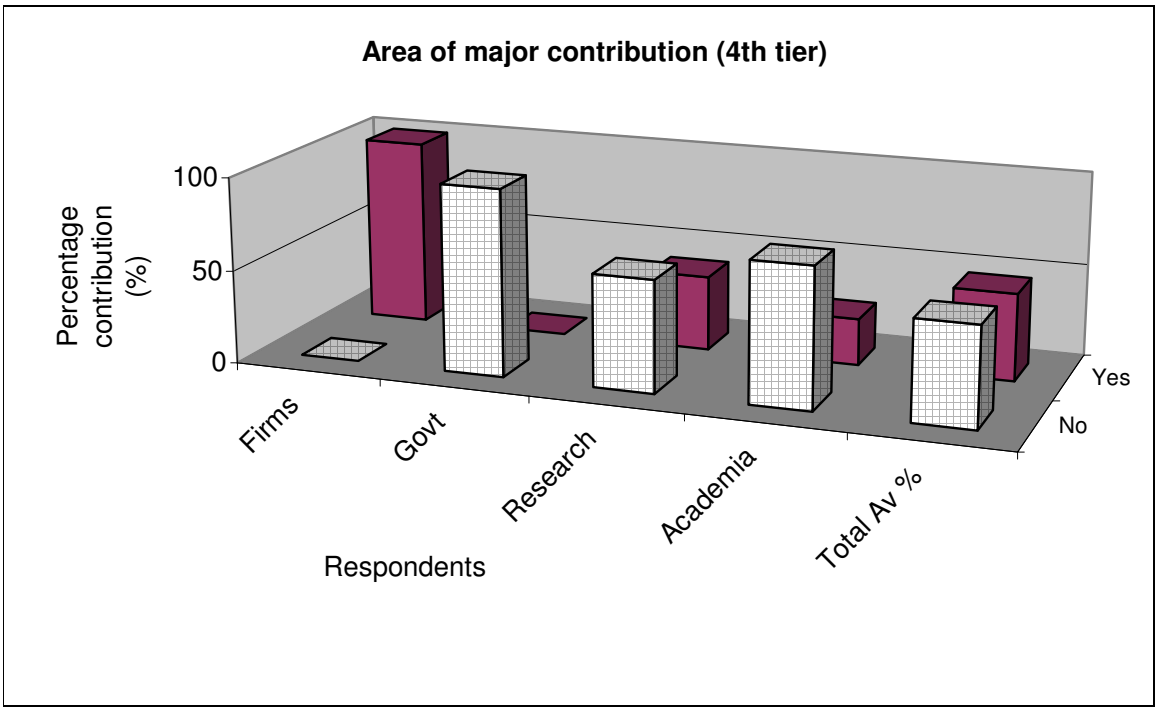

Figure (iv)10 Respondents' contribution on the fourth tier

8. Where do you think South African firms should be playing more important role within the aircraft industry structure?

Respondents believe that South African firms should be contributing more towards developing the second and third tier levels. The total response was about 87% for second tier and 80% for third tier. *Firms* responded with 100% in both categories, indicating that the bigger contribution should equally be on second and third tier levels. The interpretation of the result is that firms can therefore develop technological capabilities more within the second and third tiers of the aircraft industry structure. A graphical representation of the results is illustrated on Figure (iv)11.

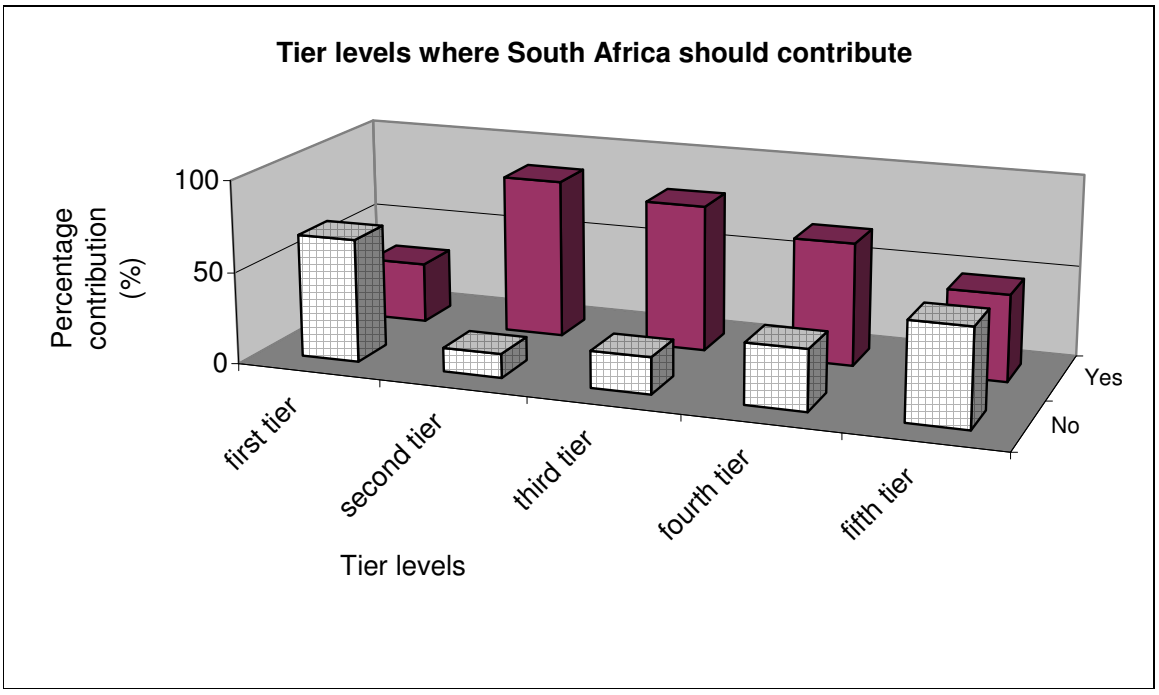

Figure (iv)11 Percentage levels by tier level where South Africa should contribute

Both *Firms* and *Government* responses converged when they responded by answering 'YES' (100%), indicating that South African firms should contribute more on the second tier. Responses by *Research institutions* and *Academia* had 80% and 75% respectively, also agreeing to South African firms' need to contribute more towards developing the second tier. This is illustrated on Figure (iv)12.

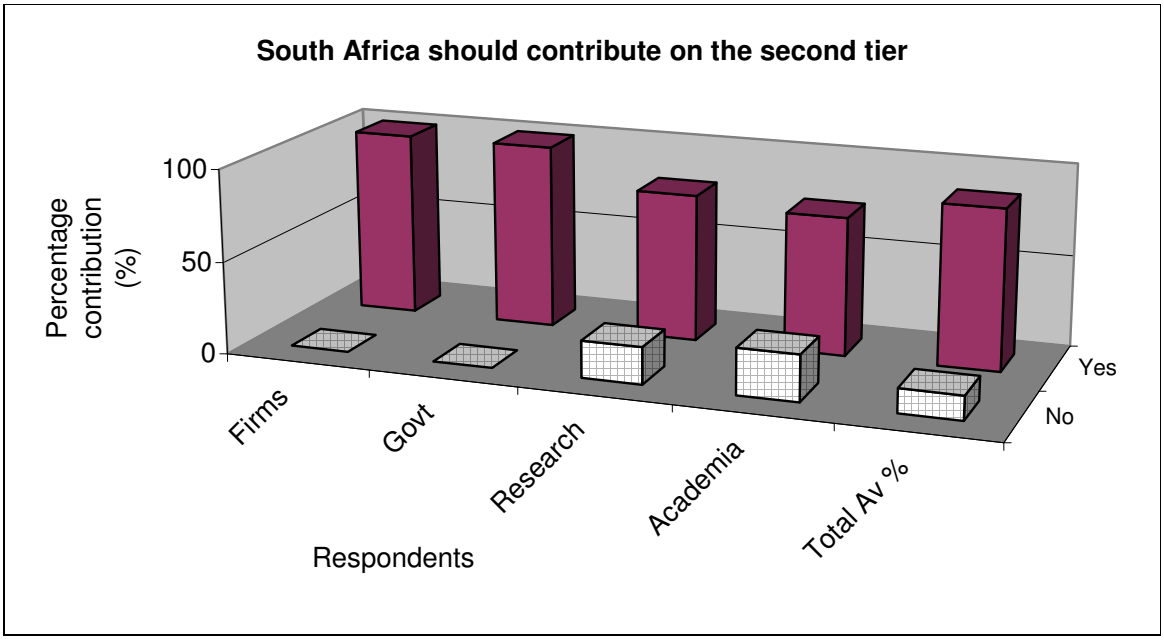

Figure (iv)12 Respondents' percentage contribution for the second tier

Part II, looked at the technological competencies, factors that impact on technological capability-building process for South African civil aircraft industry, market feasibility for South African firms, and testing the conceptual framework as proposed by the researcher. This is based on the theory on technological competence and capability building paths followed by most of the successful countries. In short, the section is aimed at identifying the technological challenges believed to be faced by the local civil aircraft industry, and if the framework proposed by the researcher on building technological competencies could be useful in resolving such challenges.

For **Part II,** responses were received as follows:

9. The following are assumed to be the current major gaps that affect the technology capability-building process of the South African civil aircraft industry:

a) Insufficient in-house technological capability

When focusing on the total responses combined, those that *Strongly agree* had the highest score **(33%)**, followed by those that *Agree* (20%). *Firms* had the highest score of 75% (*Strongly agree* + *Agree*), agreeing that the above is a major gap affecting technology capability-building process of the South African civil aircraft industry. The findings are graphically represented on Figure (iv)13.

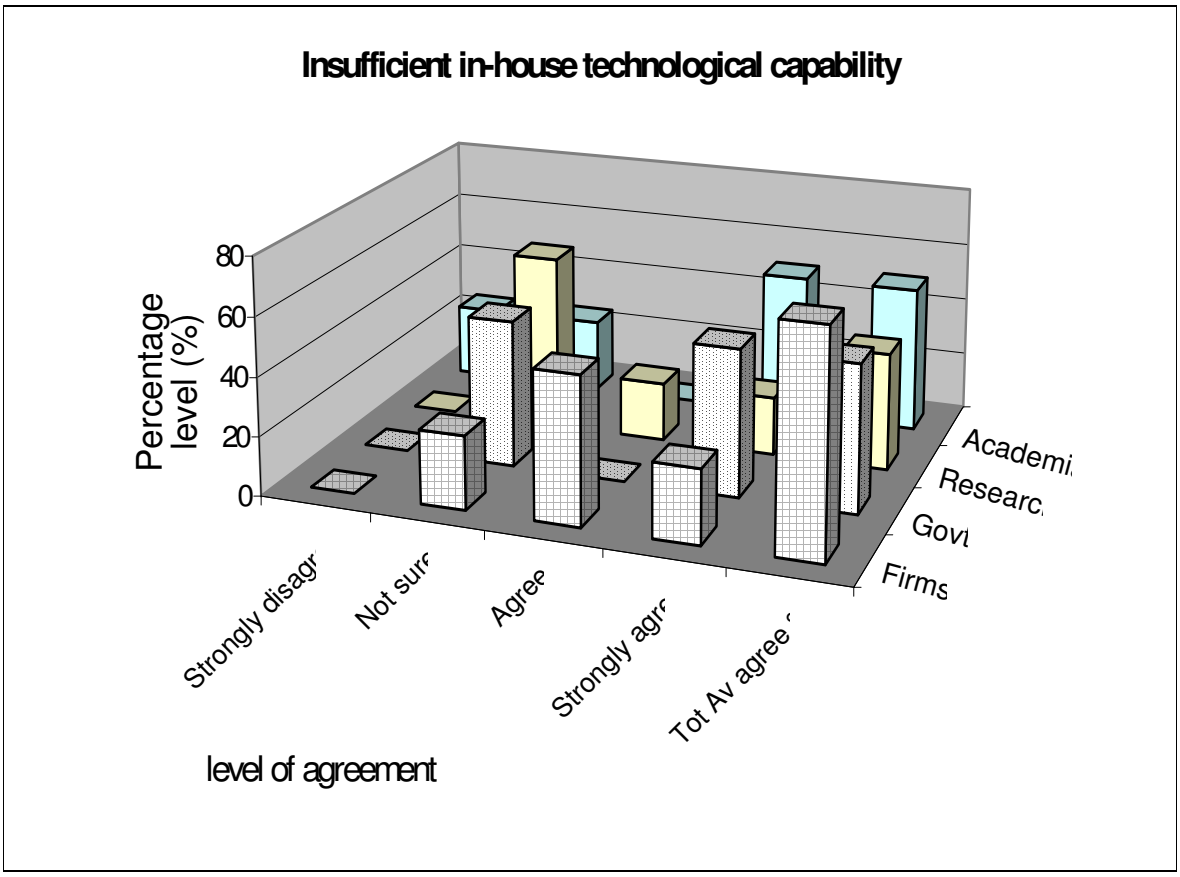

Figure (iv)13 "Insufficient in-house technological capability" as a gap that impacts on the technology capability-building process

b) Underdeveloped National System of Innovation

For this aspect, the highest score for total respondents was on *Strongly agree* **(53%)**. *Disagree* and *Agree* had a score of 13% each. *Firms* had a 100% score on *Strongly agree*. The findings are illustrated on Figure (iv)14.

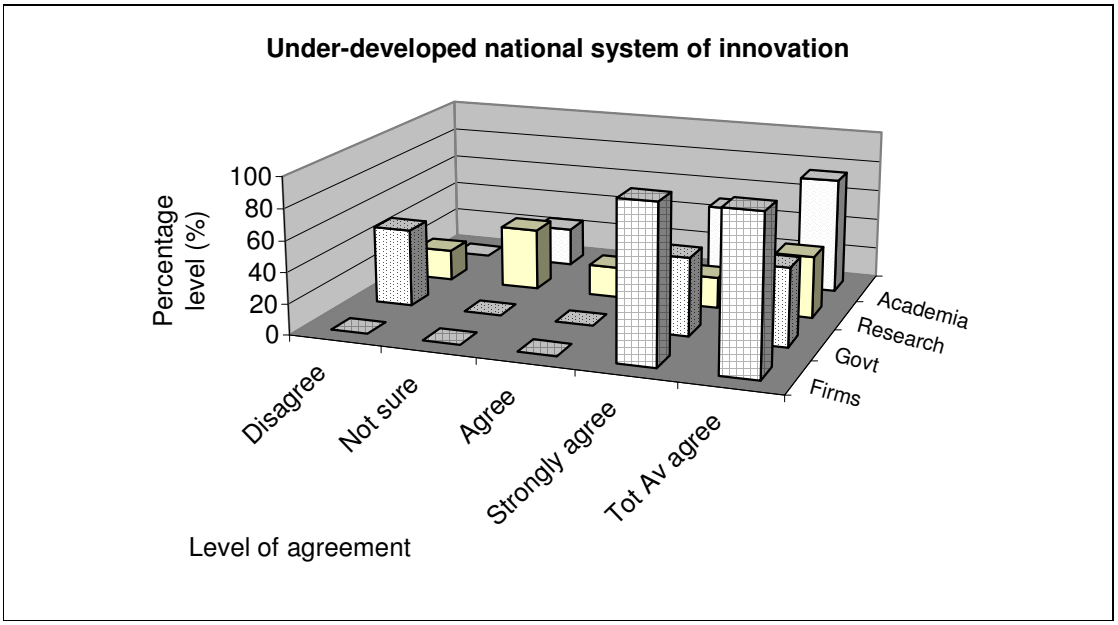

Figure (iv)14 "Under-developed national system of innovation" as a gap that impacts on the technology capability-building process

c) Lack of firm collaboration

Total respondents scored **33%** on both *Strongly agree* and *Agree*. *Government* had a 50% score on *Strongly agree*, with *Research institutions* scoring 40%. The findings are illustrated on Figure (iv)15.

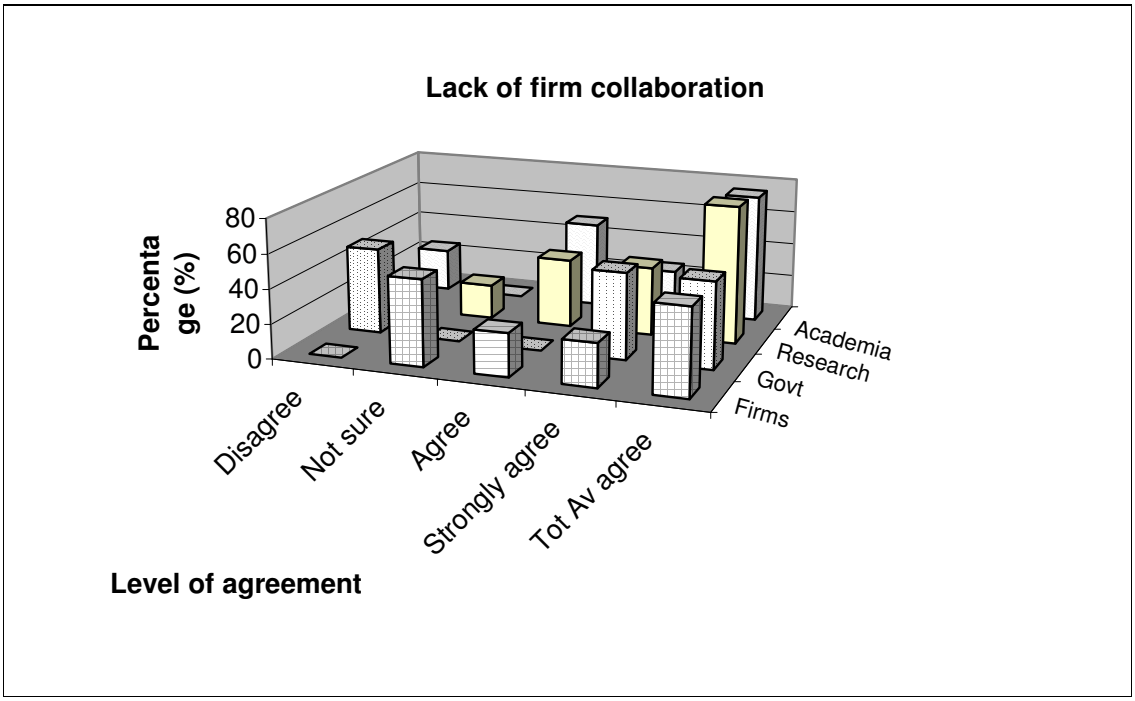

Figure (iv)15 "Lack of firm collaboration" as a gap that impacts on the technology capability-building process

d) Poorly developed aircraft infrastructure

Total respondents scored **27%** on both *Agree* and *Disagree*. *Strongly agree* scored 13%. A graphical representation on the findings is shown on Figure (iv)16.

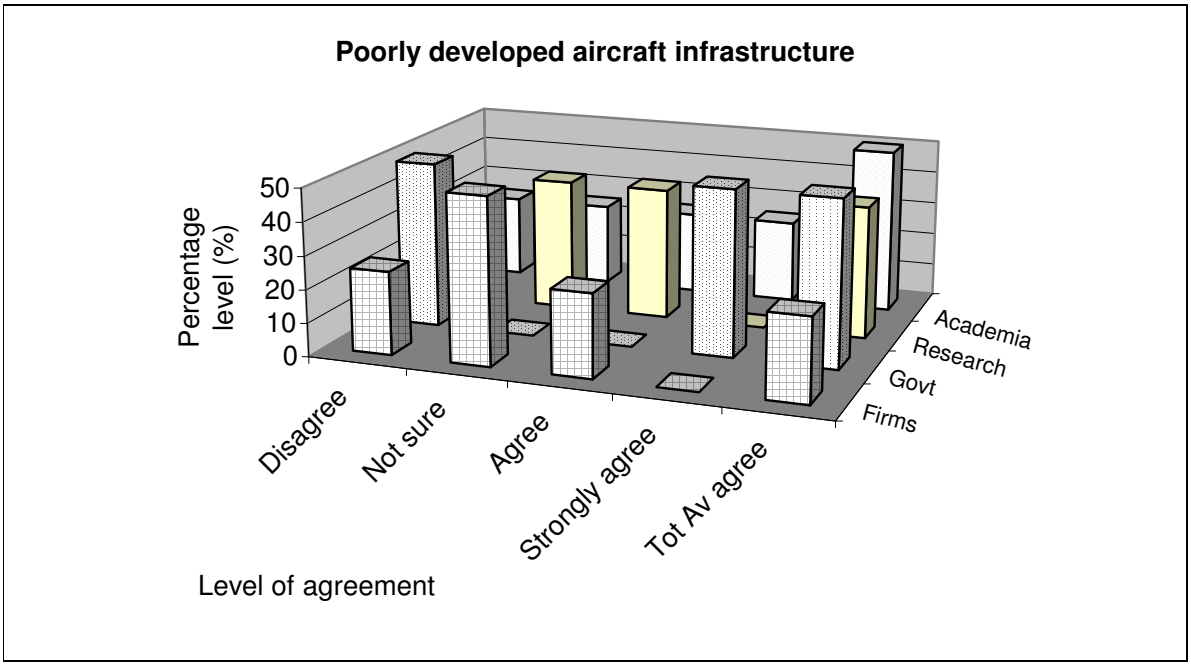

Figure (iv)16 "Poorly developed aircraft infrastructure" as a gap that impacts on the technology capability-building process

e) Insufficient skilled resources

The highest score for total respondents was on *Strongly agree*, with **40%**, followed by 27% on *Agree*. Both *Firms* and *Government* had a 50% score on *Strongly agree*. A graphical representation of the findings is shown on Figure (iv)17.

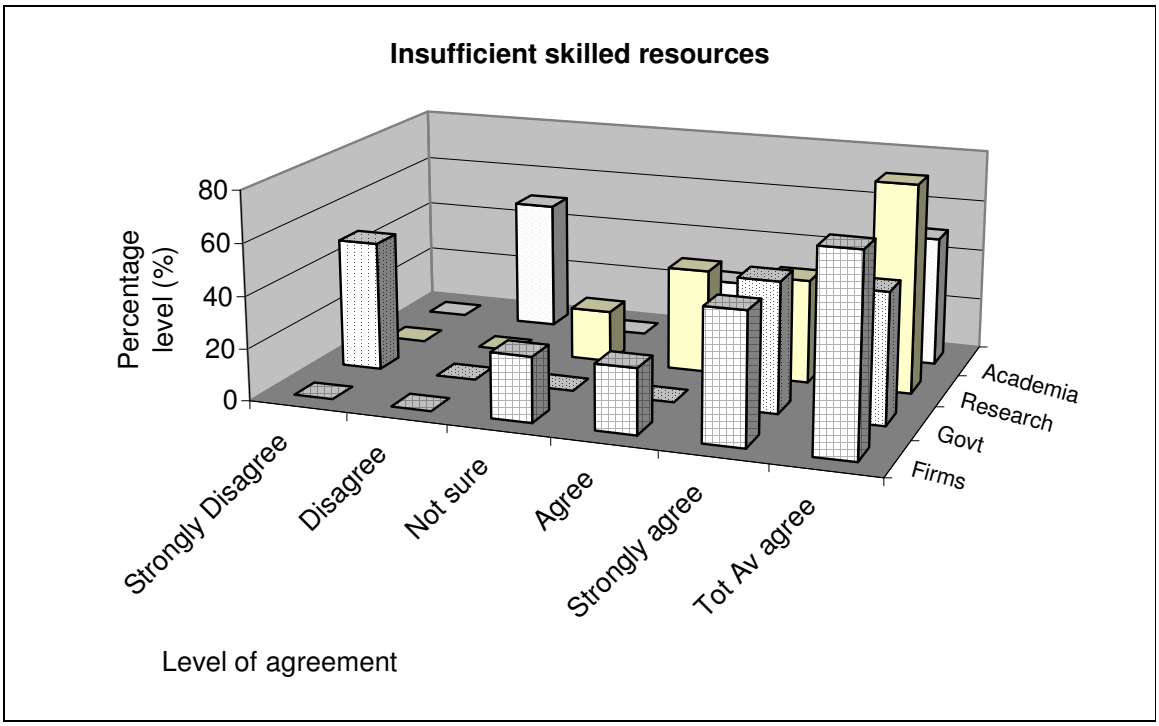

Figure (iv)17 "Insufficient skilled resources" as a gap that impacts on the technology capability-building process

f) Underdeveloped technological capabilities

Total respondents had a highest score of about **27%** on both *Strongly agree* and *Agree*. Responses under *Not sure* had a total score of 40%. *Academia* specifically had a score of 50% on both *Strongly agree* and *Agree*, when *Firms* had 25% in both *Strongly agree* and *Agree*. A graphical representation of the findings is shown on Figure (iv)18.

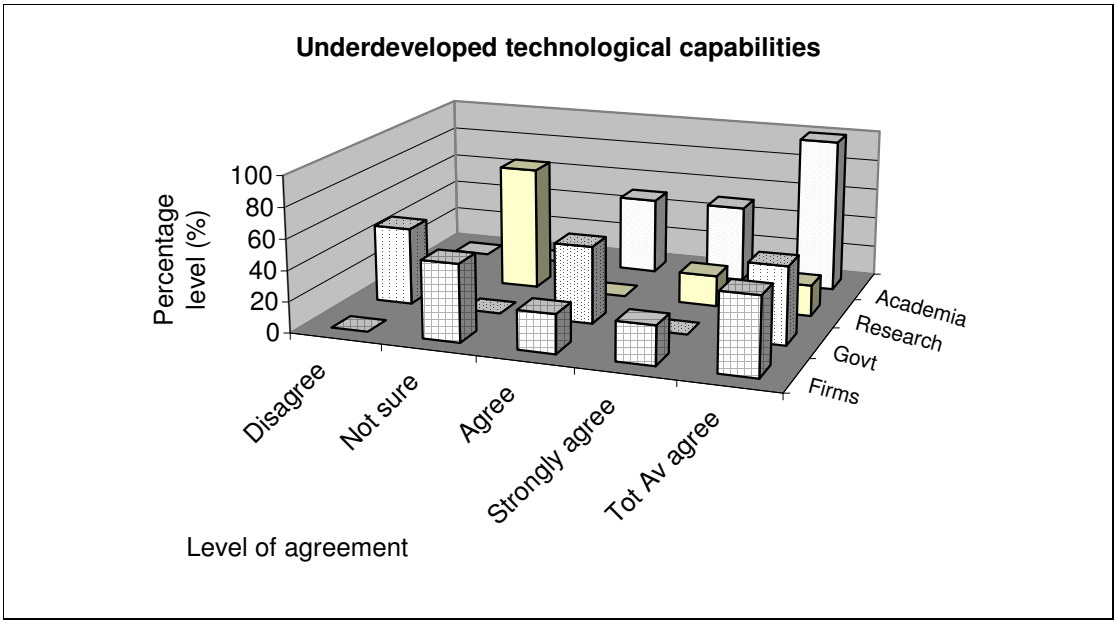

Figure (iv)18 "Underdeveloped technological capabilities" as a gap that impacts on the technology capability-building process

g) Lack of appropriate technologies

Total respondents had the highest score of about **33%** on *Agree*, and also 33% on *Disagree*. However, on *Strongly agree* the score was 20%, which when combined with the score on *Agree* (33%) leads to total agreement. *Firms* had a highest score of 50% on *Strongly agree*, with another 25% on *Agree*. *Research institutions* had 60% on *Agree*. A graphical representation of the findings is illustrated on Figure (iv)19.

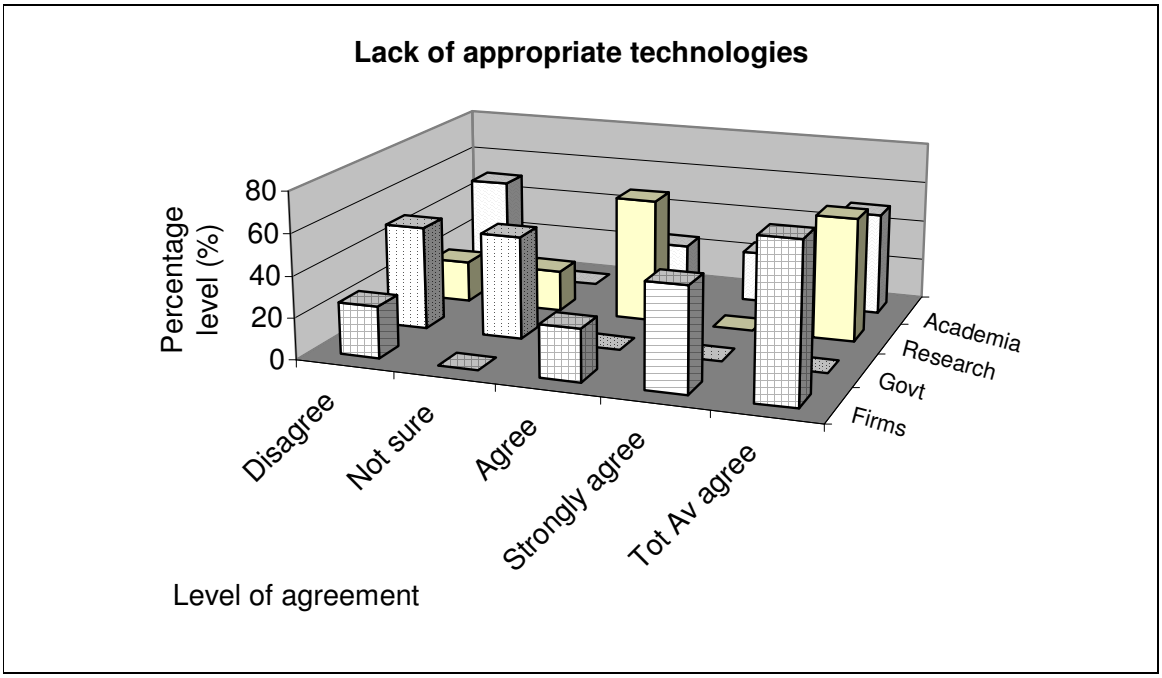

Figure (iv)19 "Lack of appropriate technologies" as a gap that impacts on the technology capability-building process

h) Insufficient R&D investment

Responses in total had a highest score of **60%** on *Strongly agree*, followed by 27% on *Agree*. *Not sure* had a score of 13%. Both *Firms* and *Academia* had a 75% score on *Strongly agree*, with *Research institutions* scoring 60% on the same aspect. Figure (iv)20 illustrates the graphical representation of the findings.

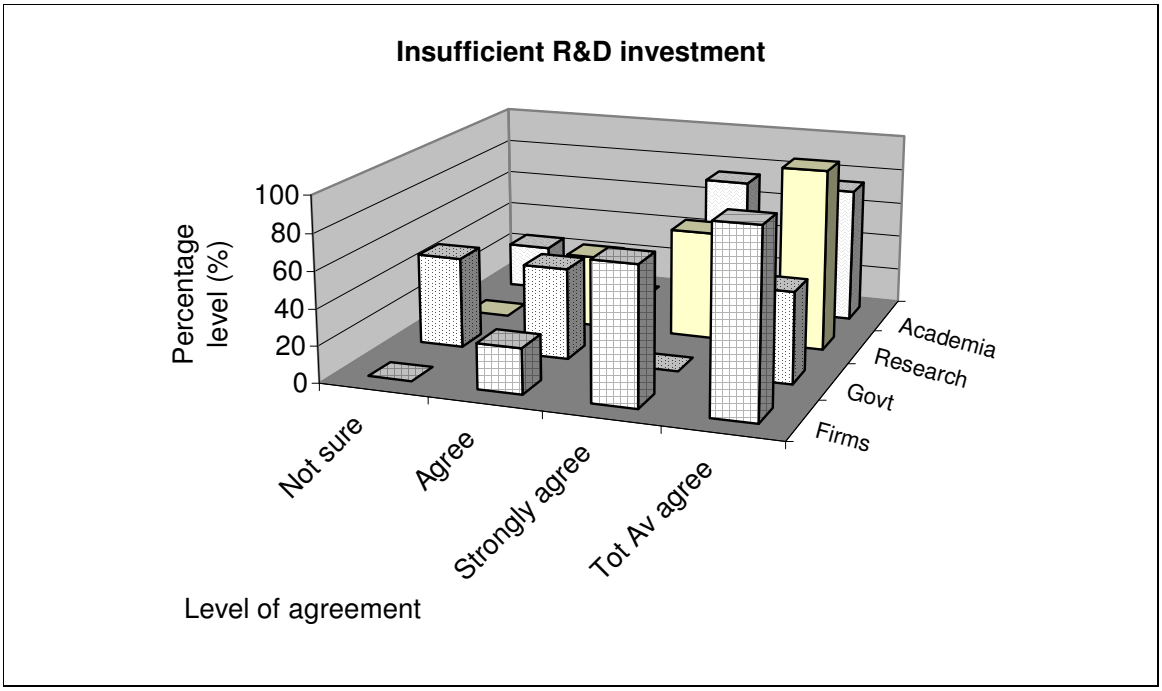

Figure (iv)20 "Insufficient R&D investment" as a gap that impacts on the technology capability-building process

i) Insufficient knowledge

The highest score on total respondents was **40%** at both *Agree* and *Not sure*. Both *Strongly agree* and *Disagree* had a similar score of about 7%. *Firms* only had a score of 50% on *Agree*, whereas *Research institutions* had 60% score on same aspect of *Agree*. A graphical representation on the findings is shown on Figure (iv)21.

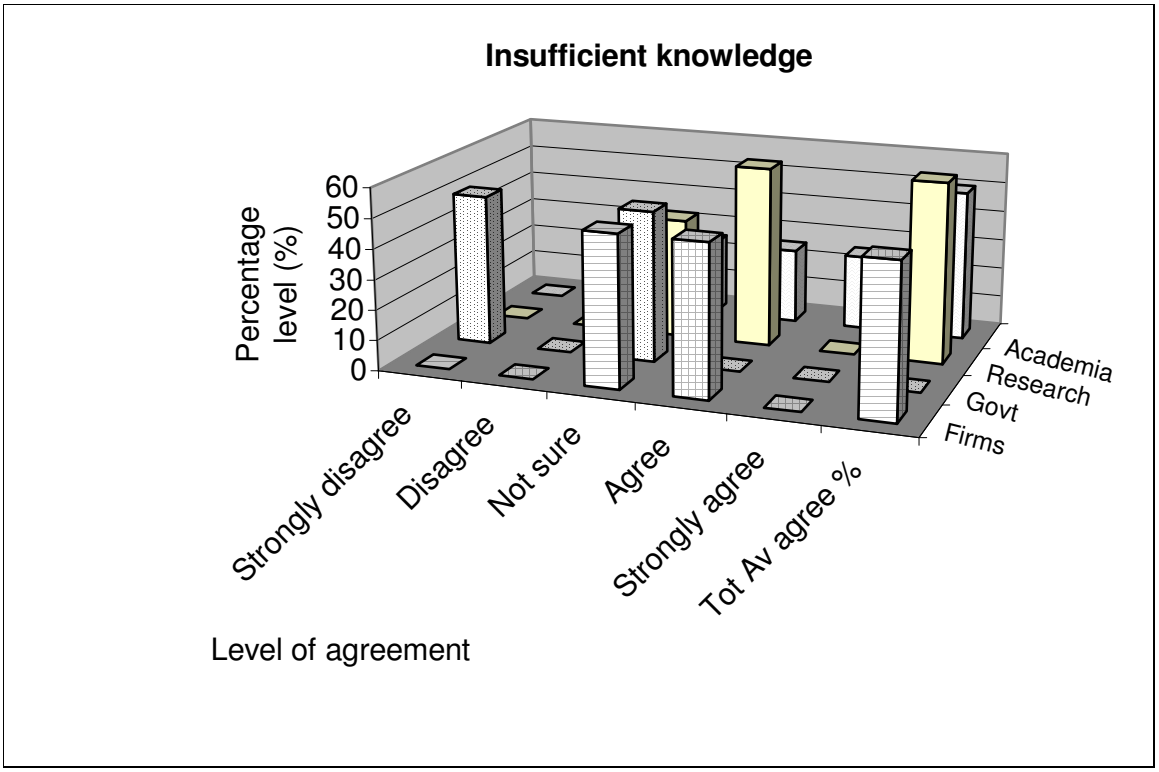

Figure (iv)21 "Insufficient knowledge" as a gap that impacts on the technology capability-building process

j) Insufficient skills development programmes

On this aspect, the highest score on total respondents was **33%** for both *Strongly agree* and *Agree*. A graphical representation on the findings is shown on Figure (iv)22.

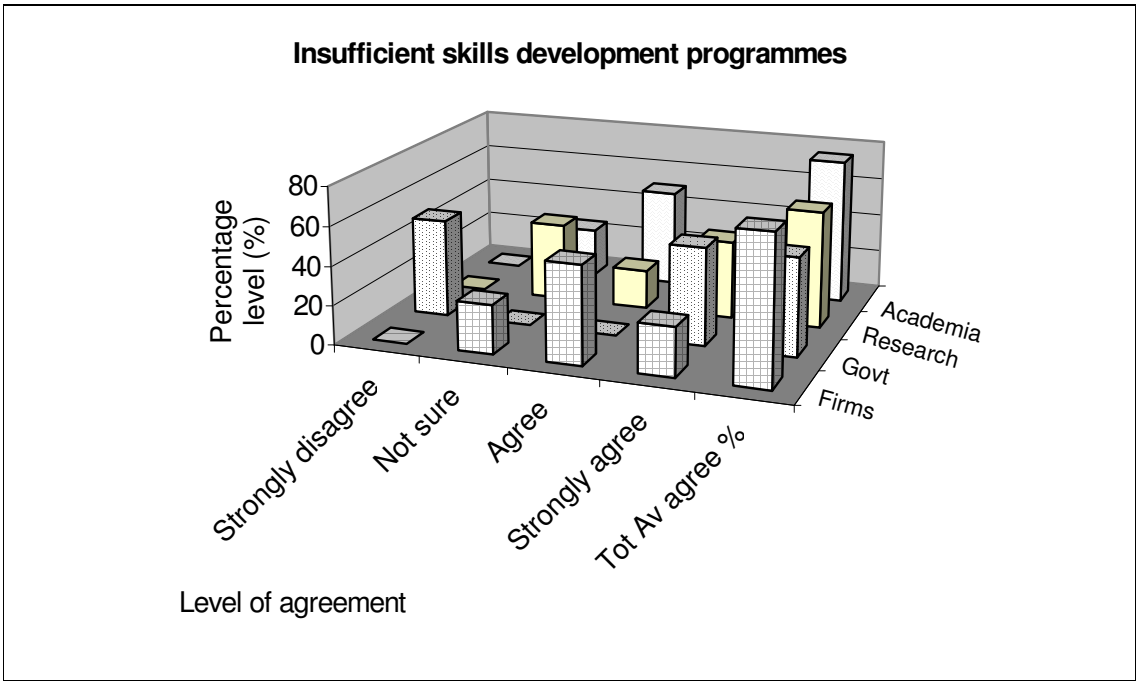

Figure (iv)22 "Insufficient skills development programmes" as a gap that impacts on the technology capability-building process

k) Insufficient strategic alliances with global firms

The total respondents' score was **33%** for both *Strongly agree* and *Agree*. A graphical representation on the findings is shown on Figure (iv)23.

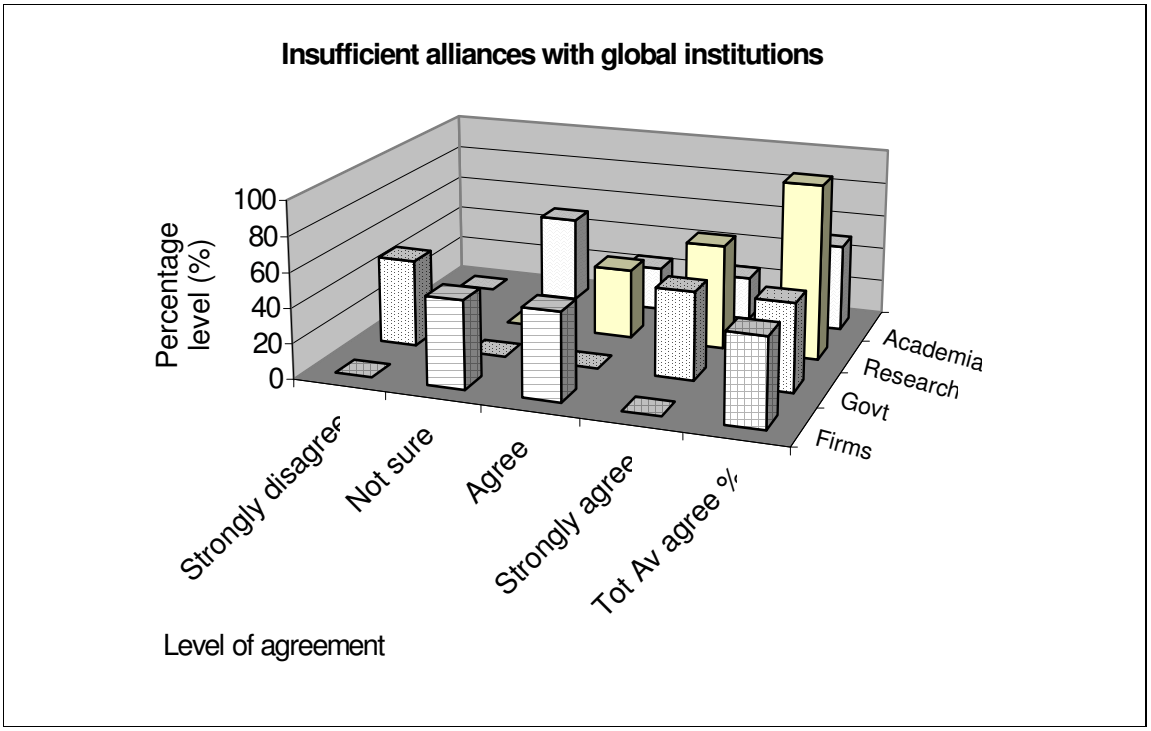

Figure (iv)23 "Insufficient alliances with global institutions" as a gap that impacts on the technology capability-building process

l) Lack of skills/knowledge transfer programmes

A highest score of **53%** was obtained for *Agree* on total respondents, followed by 20% on *Strongly agree*. Both *Strongly disagree* and *Disagree* had a score of about 7% each. *Not sure* had a score of 13%. *Firms* scored 75% on *Agree*, followed by *Research institutions* (60%) and *Government* (50%). *Research institutions* had a further 40% on *Strongly agree*. A graphical representation on the findings is shown on Figure (iv)24.

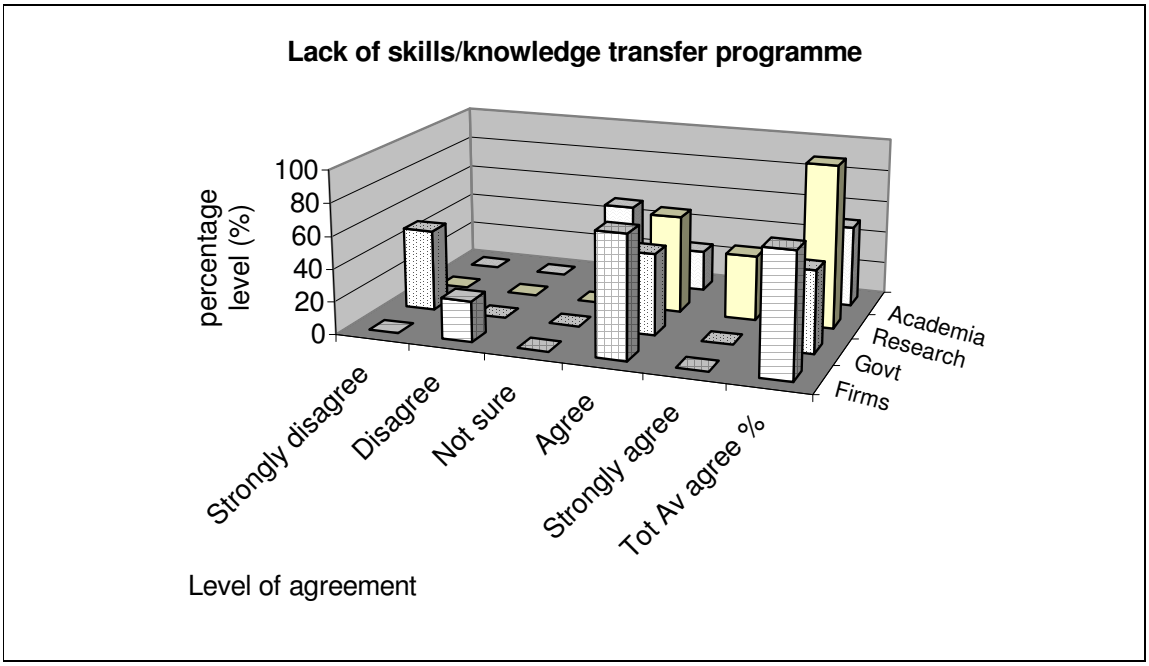

Figure (iv)24 "Lack of skills/knowledge transfer programmes" as a gap that impacts on the technology capability-building process

m)Poor levels of innovation

The total respondents' score was **33%** for both *Strongly agree* and *Agree*. This was followed by *Disagree* (20%), then *Strongly disagree* (7%). *Not sure* scored 7%. *Firms* specifically scored high on *Agree* (75%). *Government* and *Research institutions* had higher scores on *Strongly agree*, with 50% and 40% respectively. A graphical representation on the findings is shown on Figure (iv)25.

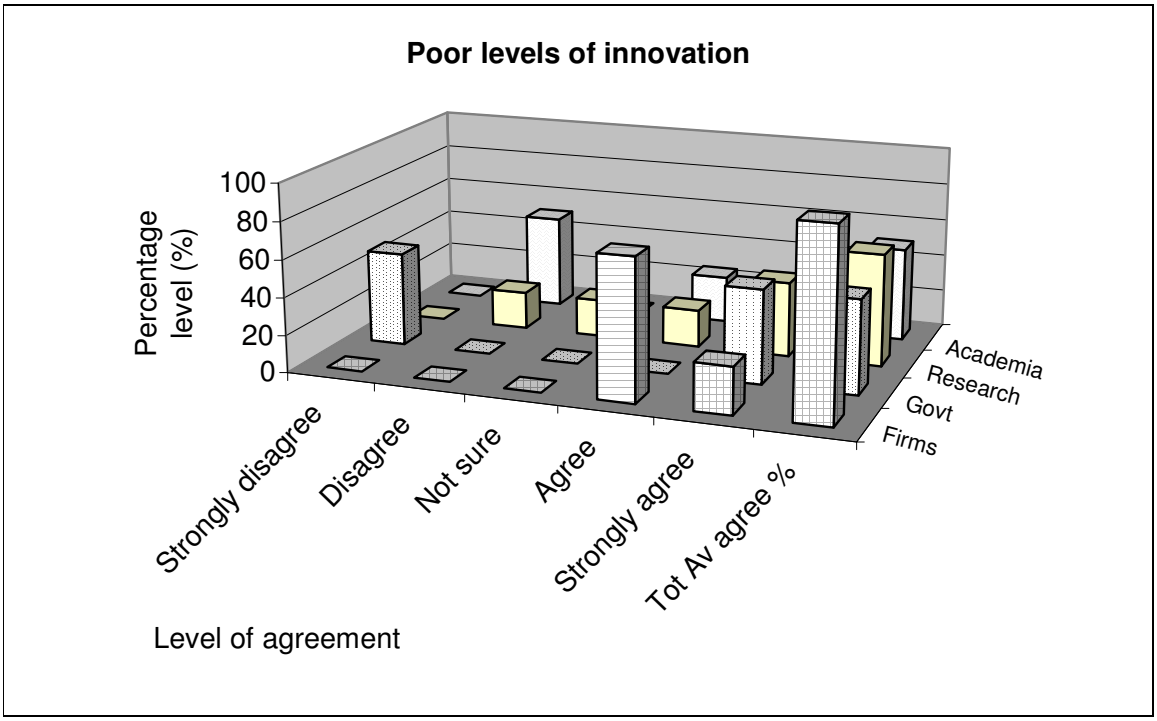

Figure (iv)25 "Poor levels of innovation" as a gap that impacts on the technology capability-building process

n) Poor external environment

A highest score of **40%** was obtained for *Agree* on total respondents, with a further 13% on *Strongly agree*. *Strongly disagree* also scored about 13%. *Not sure* had 33%. *Firms* specifically scored 50% on *Agree*, with a further 25% on *Strongly agree*. *Research institutions* scored 60% on *Agree*. A graphical representation on the findings is shown on Figure (iv)26.

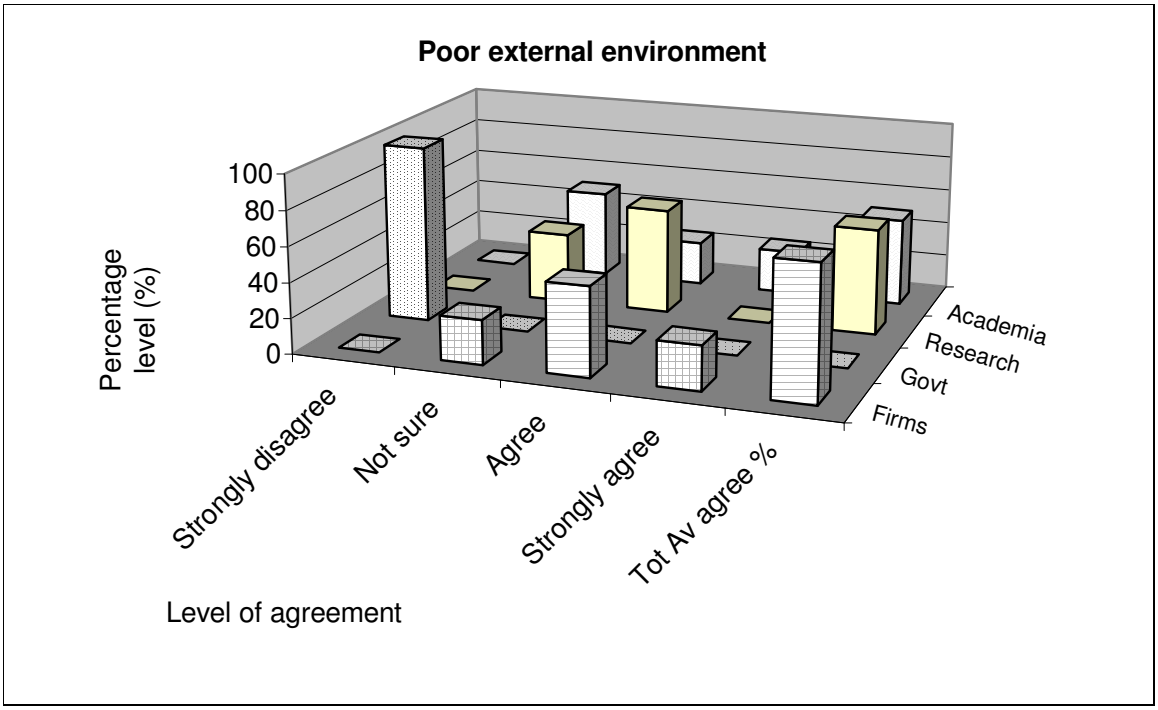

Figure (iv)26 "Poor external environment" as a gap that impacts on the technology capability-building process

o) Poor governing structures

A highest score of **47%** was obtained for *Agree* on total respondents, followed by 20% on *Strongly agree*. For *Disagree* the total respondents' score was 13%. *Not sure* had 13% score. *Firms* specifically scored 100% on *Agree*. A graphical representation on the findings is shown on Figure (iv)27

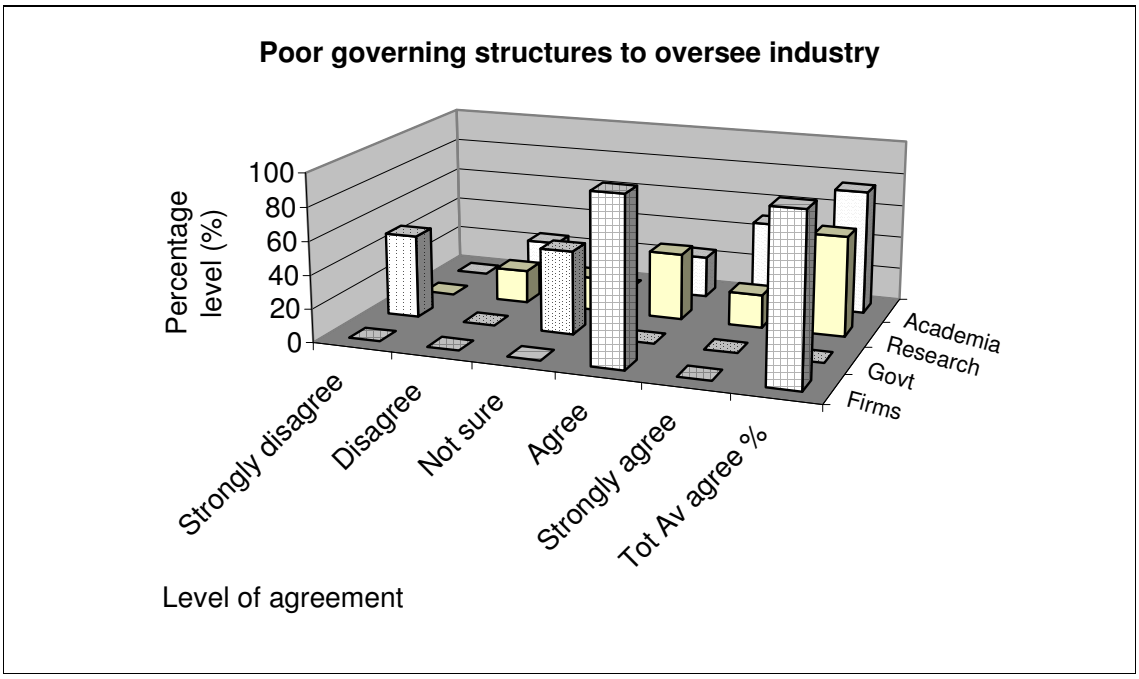

Figure (iv)27 "Poor governing structures" to oversee industry as a gap that impacts on the technology capability-building process

10. Where do you think South African private sector firms within the aircraft industry should be playing a bigger role in building national technological competitiveness within the civil industry?

a) Research and technology development

In total the highest score of **40%** for *Highest priority* was obtained, followed by 33% on *Medium*. *Government* scored 100% on *Highest priority*, whereas *Firms* found the aspect to be of *Medium* (100%) *priority*. A graphical representation of the scores is illustrated on Figure (iv)28.

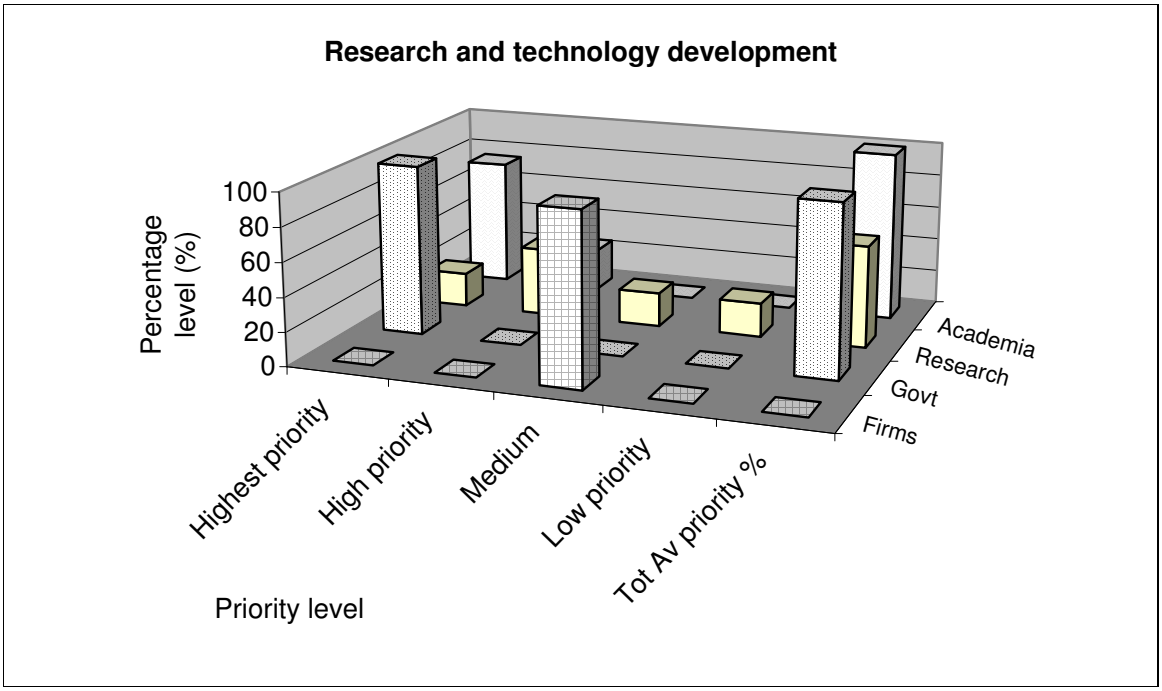

Figure (iv)28 Percentages for prioritising focus on research and technology development

b) Business Development

Total respondents scored **40%** on *Highest priority*, with a further 20% on *High priority*. A score of 20% was also obtained on *Least priority*. *Government* found this aspect to be of *Highest priority* (100% score), whereas *Firms* had a score of 50% on *Highest priority*. *Academia* scored 75% (*Highest priority*). A graphical representation of the scores is illustrated on Figure (iv)29.

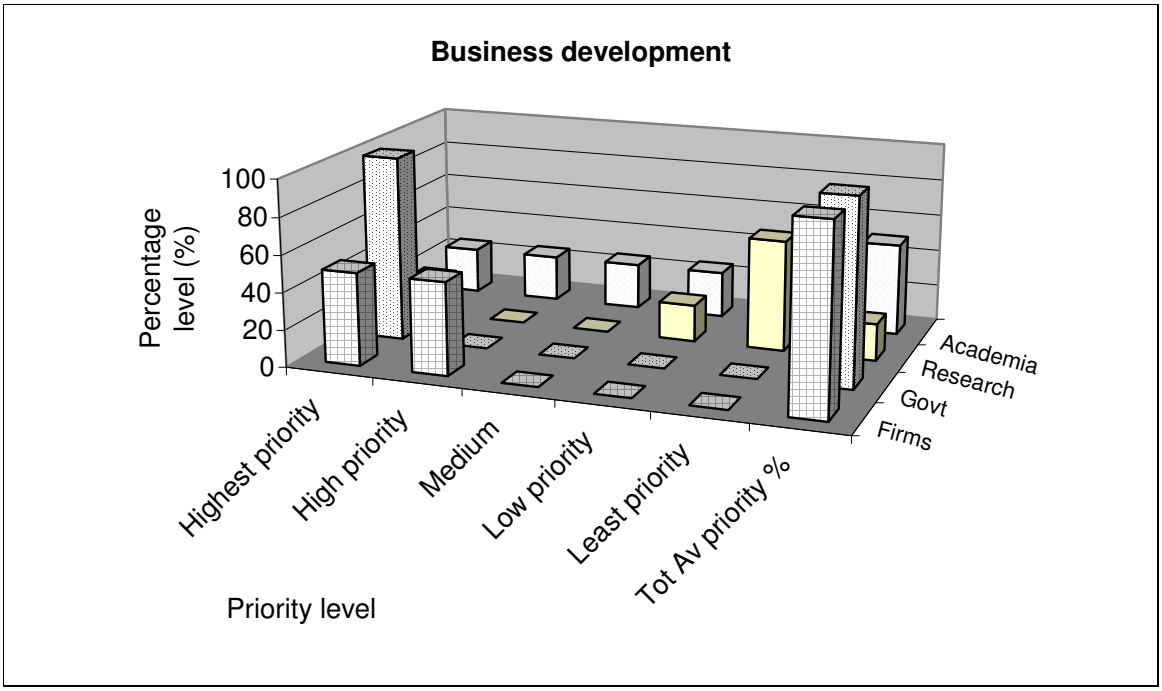

Figure (iv)29 Percentages for prioritising focus on business development

c) Skills Development

The highest score by total respondents was **53%** on *Highest priority*, followed by 27% on *High priority*. *Government* found this aspect to be of *Highest priority* (100% score), whereas *Firms* had a score of 50% on *Highest priority*. A graphical representation of the scores is illustrated on Figure (iv)30.

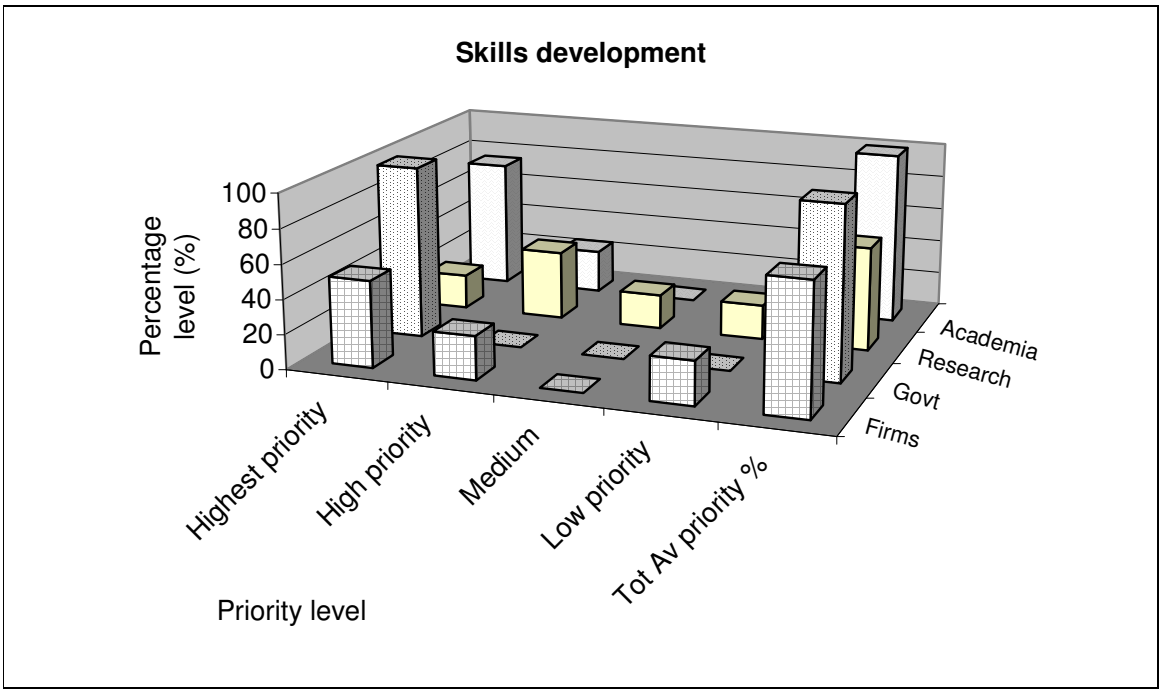

Figure (iv)30 Percentages for prioritising focus on skills development

d) Infrastructure development

The highest score by total respondents was **40%** on *High priority*, followed by 33% on *Highest priority*. *Government* found this aspect to be of *Highest priority* (100% score), whereas *Firms* found it to be of *High priority* (100%). A graphical representation of the scores is illustrated on Figure (iv)31.

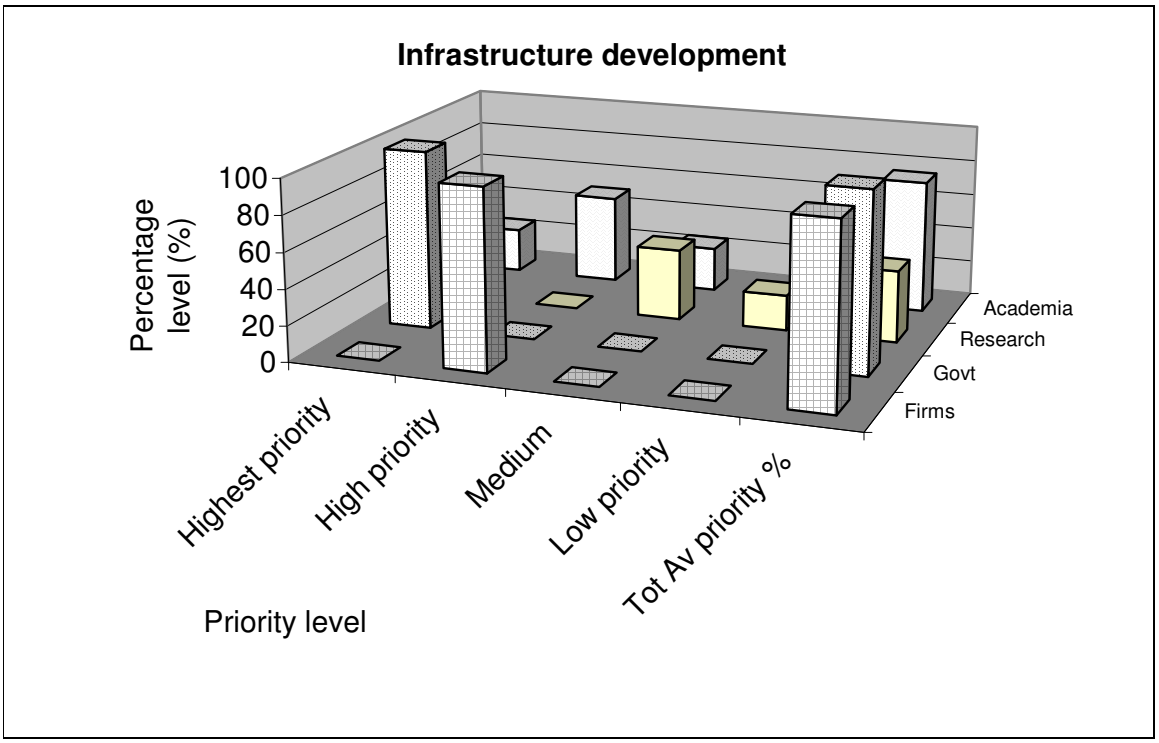

Figure (iv)31 Percentages for prioritising focus on infrastructure development

e) Support higher education

The highest score by total respondents was **40%** on *Highest priority*, with a further 13% on *High priority*. 27% was scored on *Low priority*. Both *Government* and *Academia* found this aspect to be of *Highest priority (*100% score), whereas *Firms* found it to be of *Low priority* (50%). A graphical representation of the scores is illustrated on Figure (iv)32.

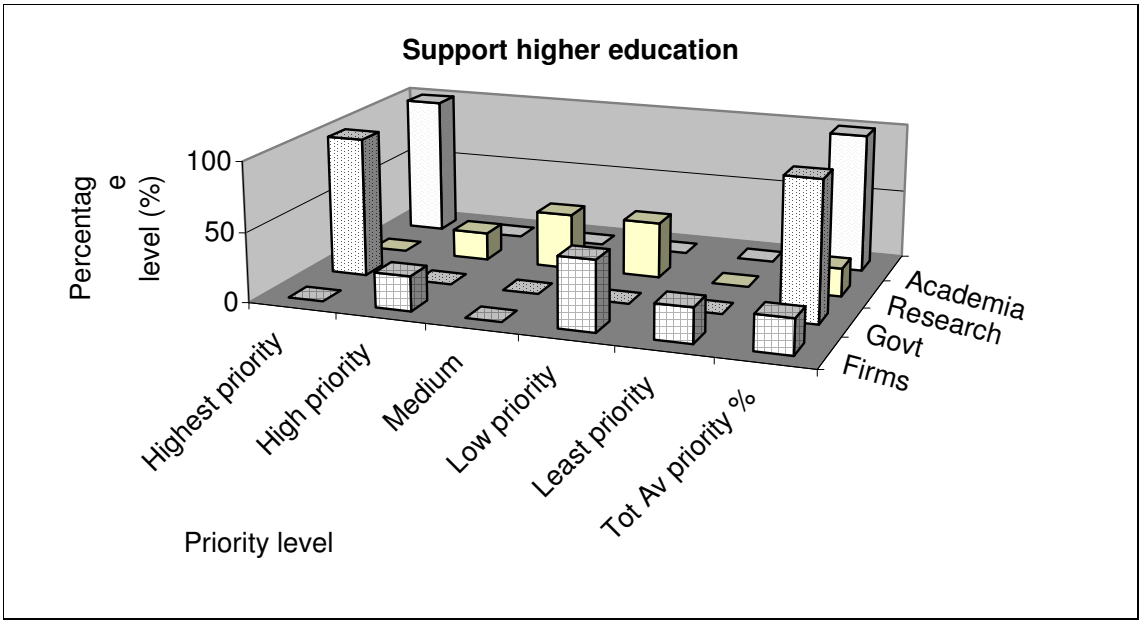

Figure (iv)32 Percentages for prioritising focus on support for higher education

11. What form of interventions is your firm doing in relation to human resource development to enhance in-house technological capabilities? Indicate if you have been involved or not in relation to such interventions.

Responses were obtained on the following list of interventions:

A. In-house skills development programme

B. Inter-firm skills exchange programme (national)

C. Inter-firm skills exchange programme (international)

D. Knowledge transfer during technology transfer

E. Inter-firm research collaboration (national)

F. Inter-firm research collaboration (international)

For intervention **A** *(In-house skills development programme)*, the highest score of **92%** on total responses was obtained, indicating that majority of respondents were *Already involved* in that intervention. *Firms*, *Government* and *Research institutions*, all had individual scores of 100%, indicating that they were fully involved in such intervention. A graphical representation of the scores for intervention **A** is illustrated on Figure (iv)33.

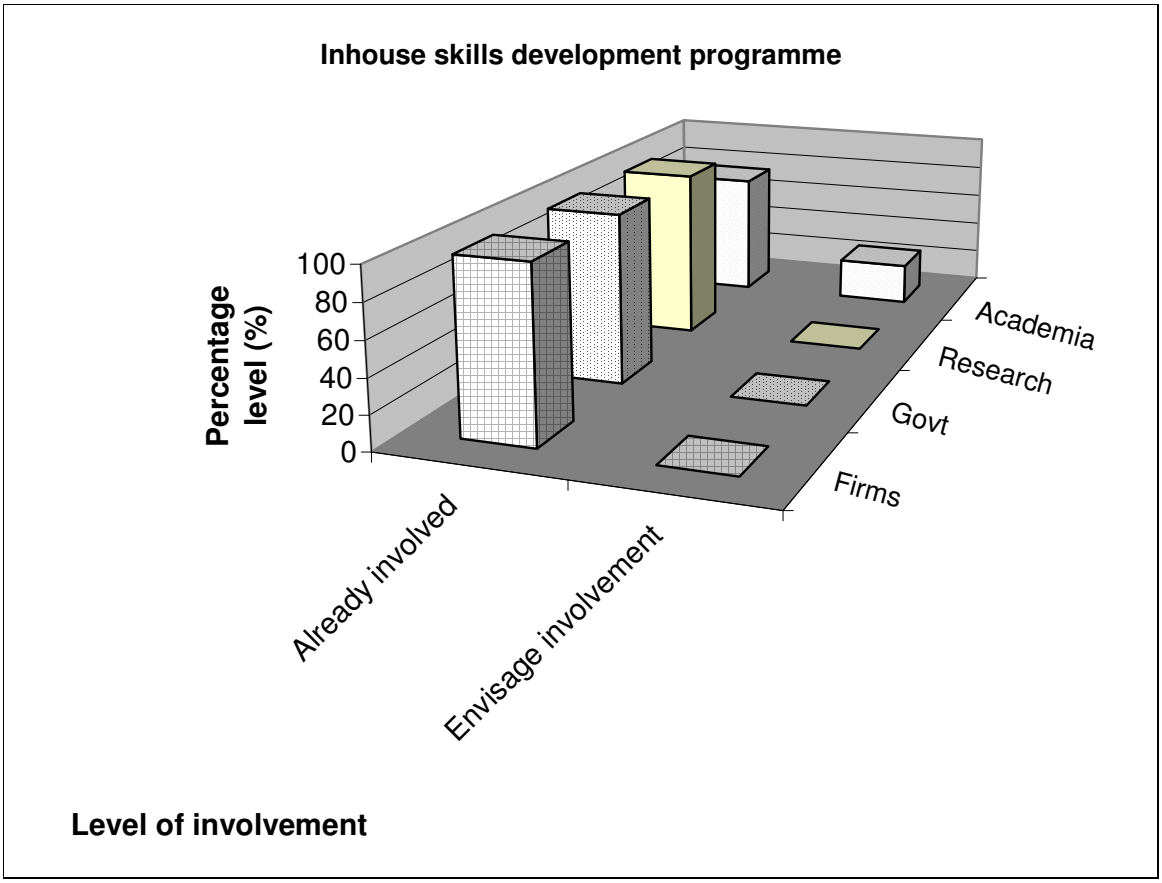

Figure (iv)33 Level of involvement in "In-house skills development programme" as an intervention for human resource development

Intervention **C** (*Inter-firm skills exchange programme - international)* had the second highest score of **70%** by total respondents, also showing that they were *Already involved* in that intervention. Third highest score **(64%)** was obtained on intervention **D** (*Knowledge transfer during technology transfer)*, also indicating that firms were *Already involved* in that intervention. A graphical representation of the scores showing the level of involvement on all interventions is illustrated on Figure (iv)34.

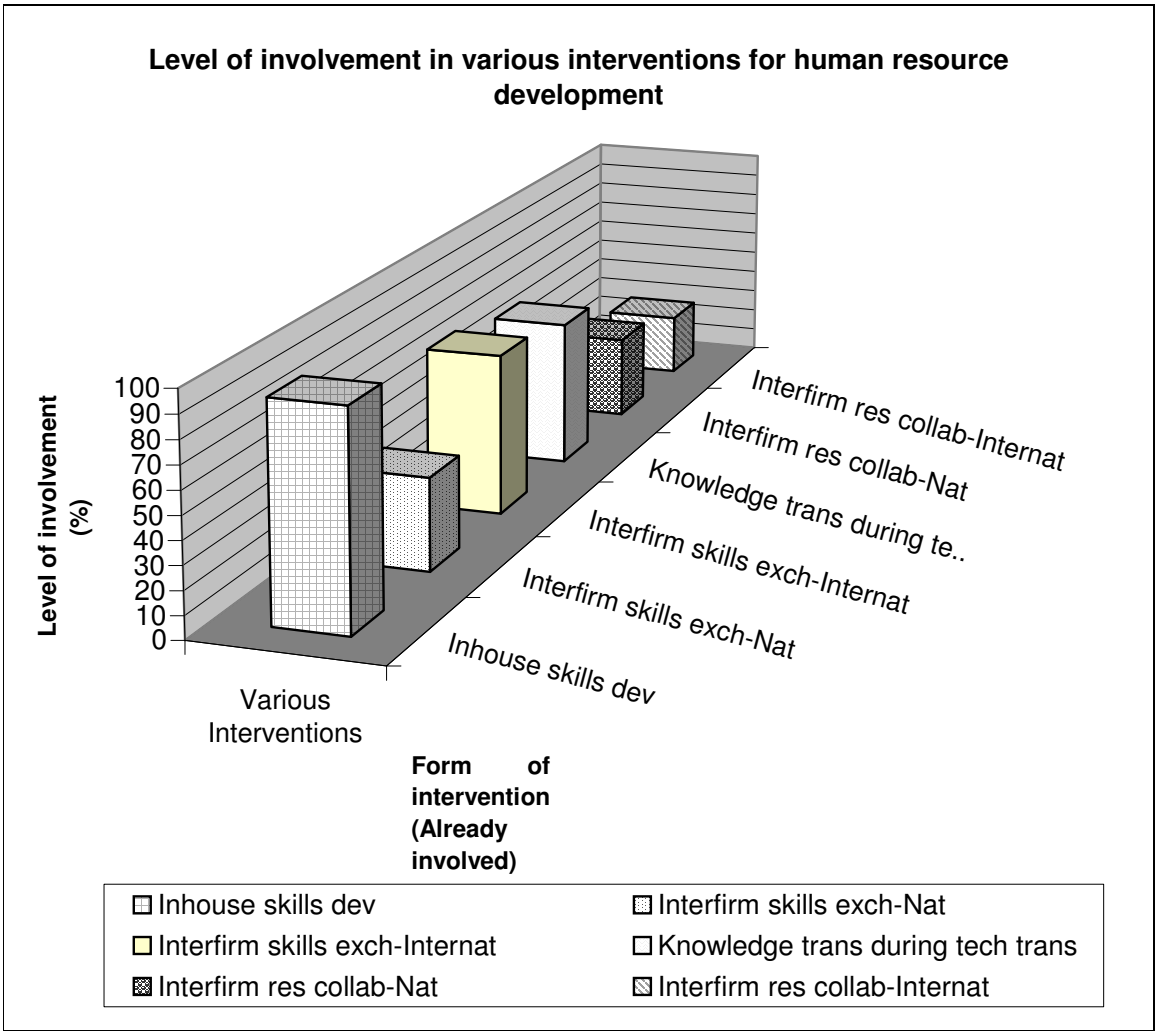

Figure (iv)34 Level of involvement in various interventions for human resource development

12. Which countries/continents do you think South African aircraft firms should place their emphasis in terms of developing their market relations as part of enhancing national technological competitiveness and technology capability-building?

Responses were obtained on the following list of countries/continents:

A. Africa
B. Europe
C. United Kingdom (UK)
D. United States (US)
E. Asia
F. Latin America

The highest score of **71%** (*Highest priority*) on total responses was obtained for Europe, thereby indicating that majority of respondents think Europe should be the business focus area for South African aircraft firms. Both *Firms* and *Government* had individual scores of 100% (*Highest priority*), with *Research institutions* at 60% (*Highest priority*) and *Academia* at 33%. A graphical representation of the scores is illustrated on Figure (iv)35.

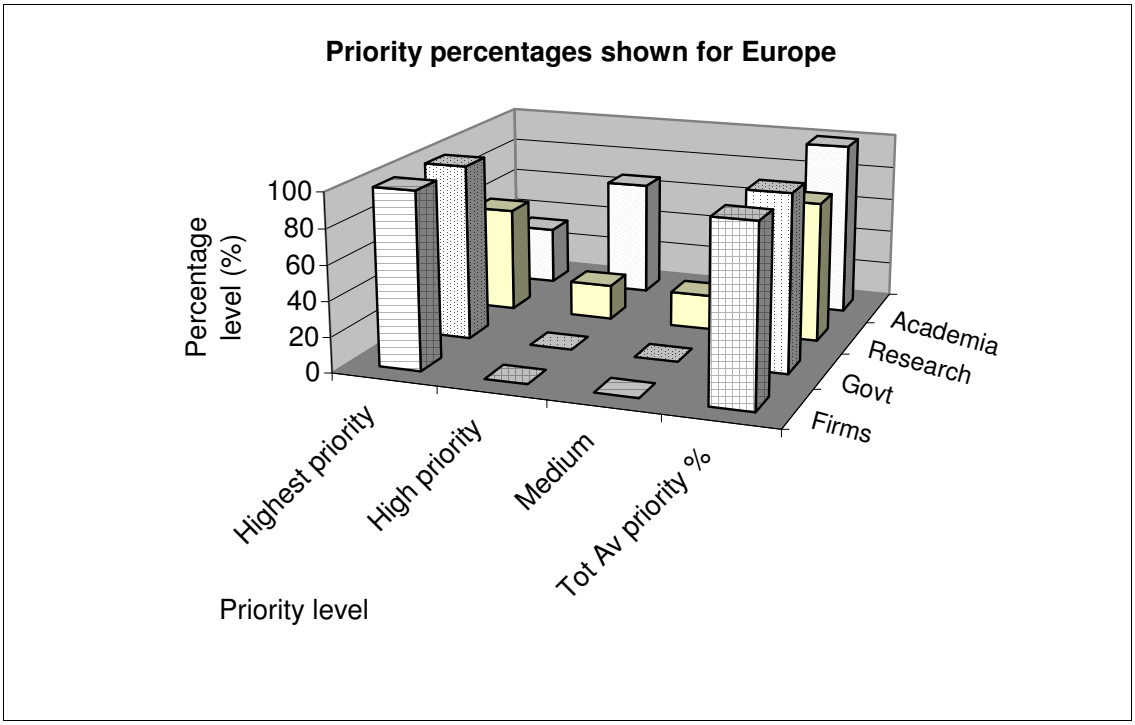

Figure (iv)35 Percentages for Europe as priority for business market by South African aircraft industry

The second highest score of **69%** (*Highest priority*) on total responses was obtained for UK, with a difference of 2% when compared with the highest score (Europe). An obvious conclusion would be that the majority of respondents think that UK should also be the business focus area for South African aircraft firms. In this instance, *Firms*, *Government* and *Academia* had individual scores of 100% (*Highest priority*). A graphical representation of the scores is illustrated on Figure (iv)36.

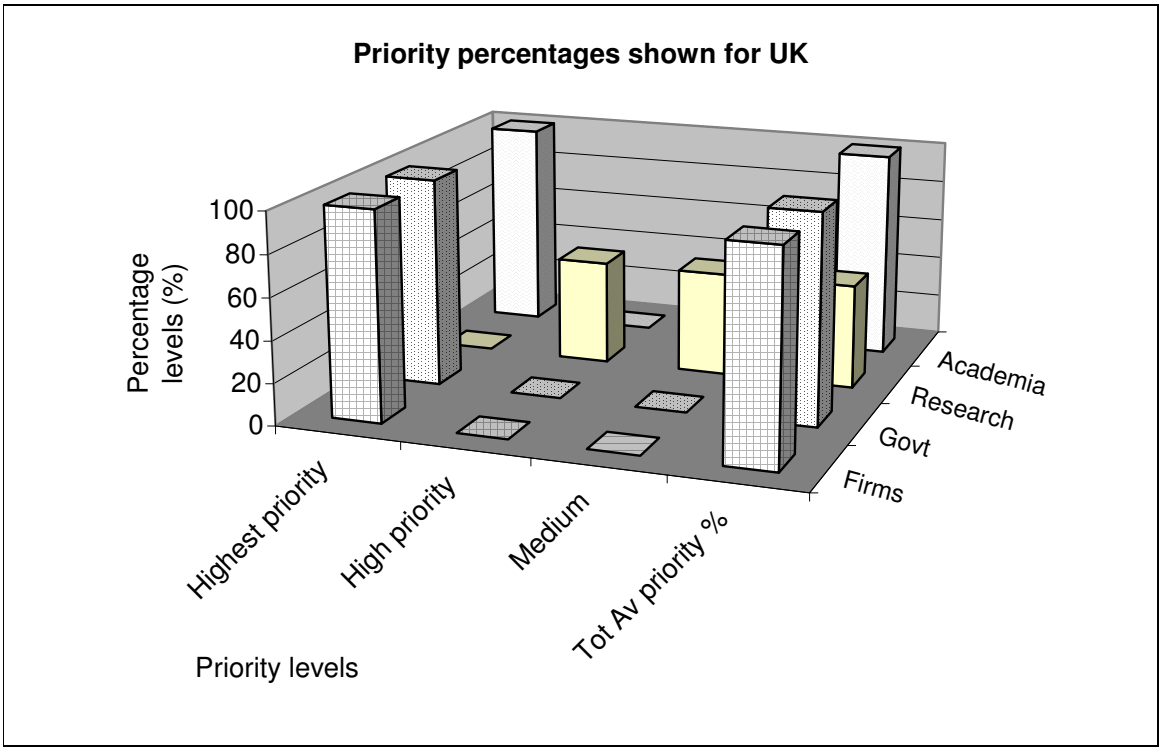

Figure (iv)36 Percentages for UK as priority for business market by South African aircraft industry

In summary, total responses shown the highest score of **71%** (*Highest priority*) for Europe, followed by a score of 69% (*Highest priority*) for UK, then Africa at 54% (*Highest priority*), USA at 42% (*Highest priority*), Latin America at 10% (*Highest priority*) and Asia at 8% (*Highest priority*). A graphical representation of the scores is illustrated on Figure (iv)37.

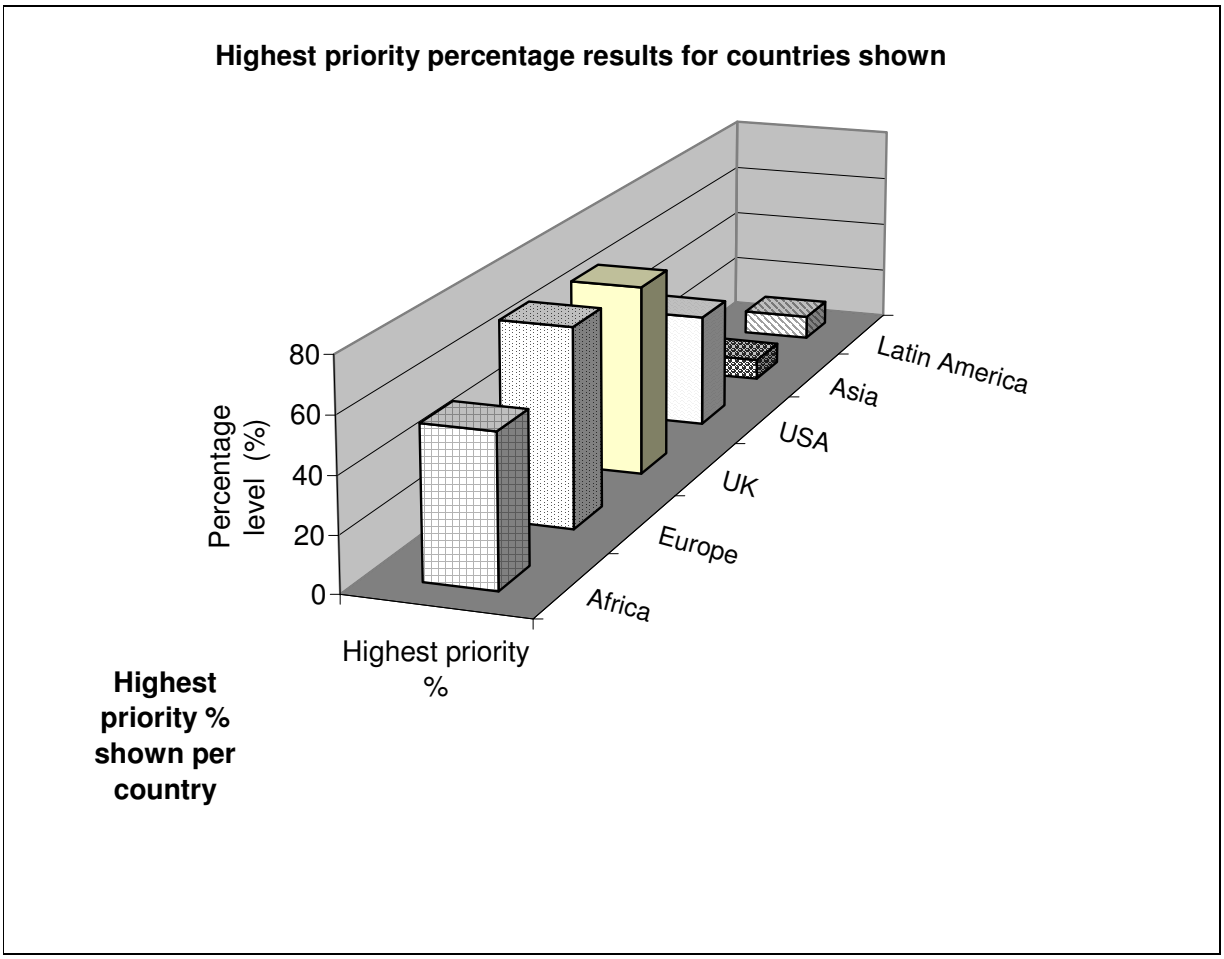

Figure (iv)37 Highest priority percentages for countries/continents of focus by South African aircraft industry to develop market

13. To what extent do you agree or disagree with the following statements?

A. Inter-firm collaboration can enhance technology & business capability development within South African aircraft firms through skills transfer, joined investment and learning from each other.

On this statement the highest score for total respondents was on *Agree* (**53%**), followed by *Strongly agree* (40%). *Government* scored 100% on *Strongly agree*. *Firms* and *Academia* both agree, with individual scores of 75% each on *Agree*. A graphical representation of the scores is illustrated on Figure (iv)38.

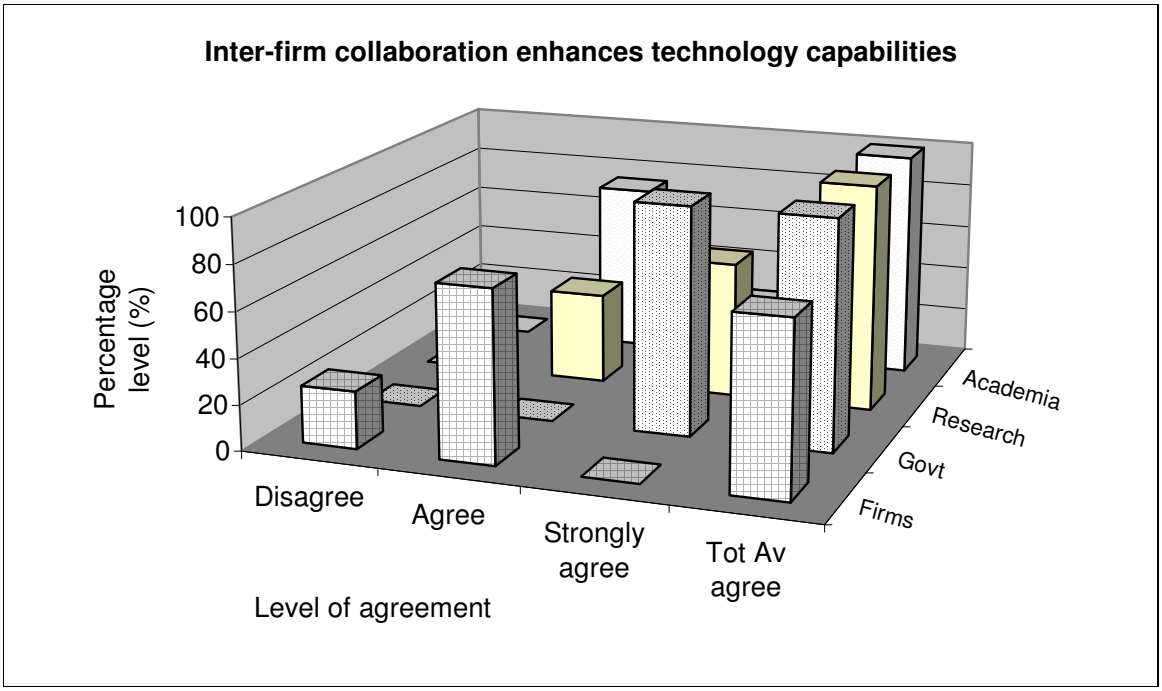

Figure (iv)38 Level of agreement on Statement A: "Inter-firm collaboration enhances technology capabilities ….".

B. Government interventions are necessary for business acquisition and improved market access by South African aircraft firms.

On this statement the highest score for total respondents was equal for both *Strongly agree* (**50%**) and *Agree* (**50%**). *Government* scored 100% on *Strongly agree*, with *Firms* scoring 75% on the same (*Strongly agree*). *Academia* scored 80% on *Agree*. A graphical representation of the scores is illustrated on Figure (iv)39.

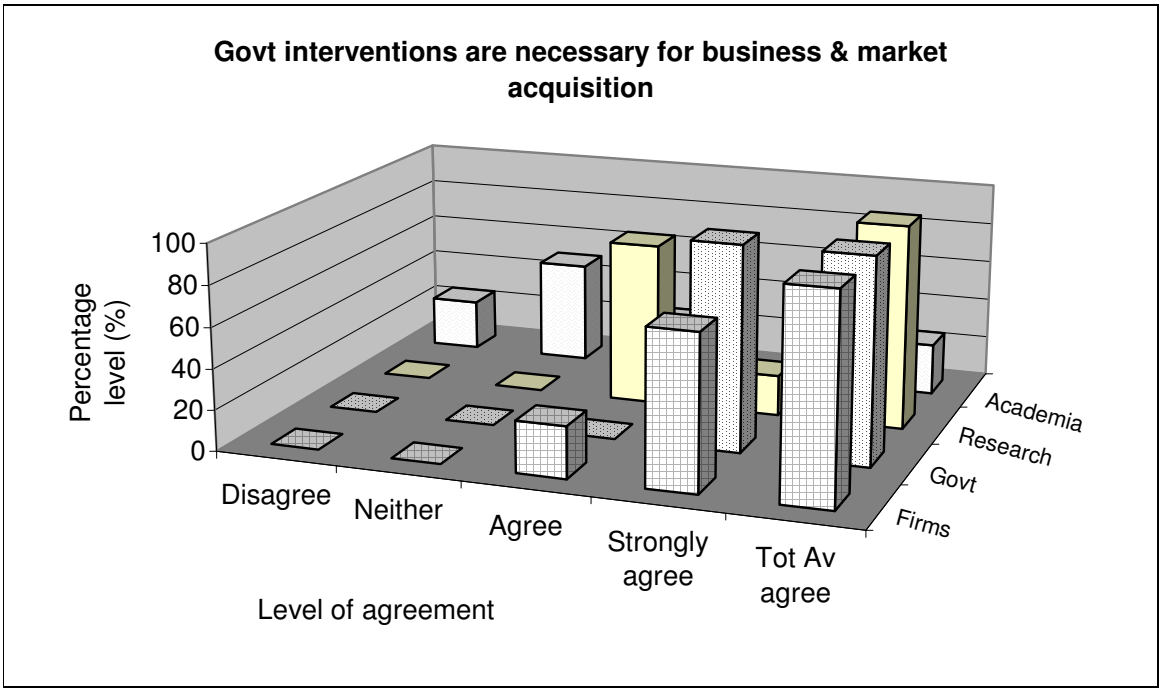

Figure (iv)39 Level of agreement on Statement B: "Government interventions are necessary for business acquisition …".

C. R&D programme, in line with applied technology development could improve the technology base of the South African aircraft industry.

For this statement the highest score on total respondents was **80%** on *Strongly agree*. Both *Government* and *Research institutions* had individual scores of 100% each on *Strongly agree*, with *Firms* scoring 75% on the same (*Strongly agree*). The graphical representation of the scores is illustrated on Figure (iv)40.

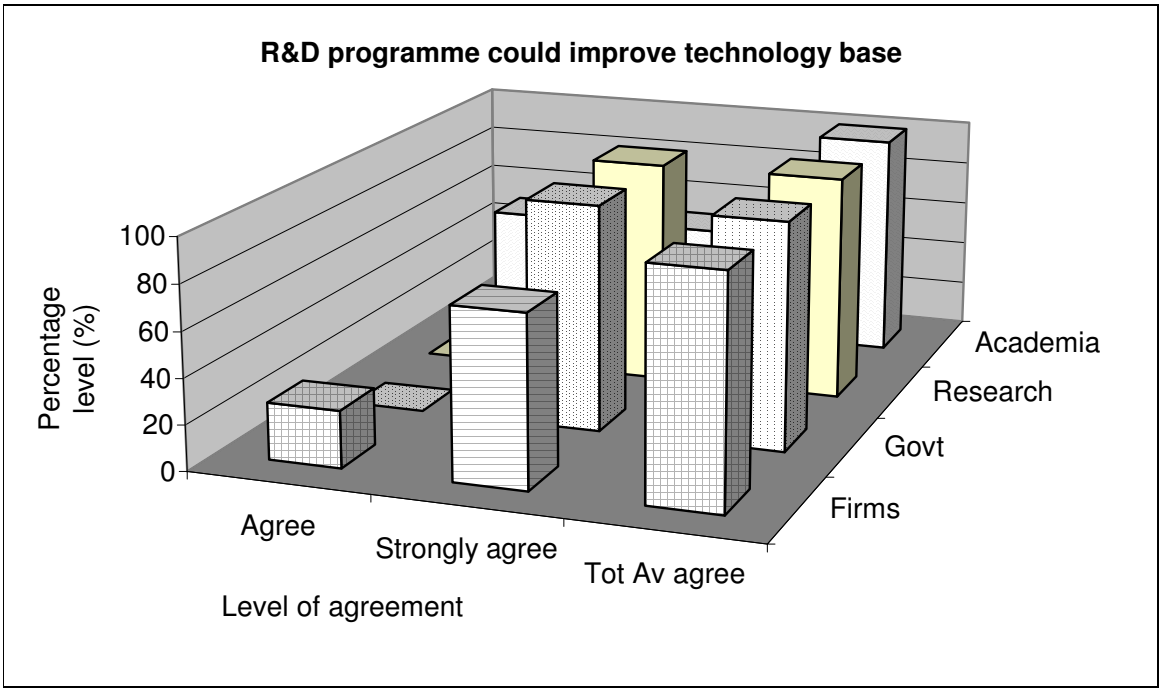

Figure (iv)40 Level of agreement on Statement C: "R&D programme could improve technology base ...."

D. Technology transfer would be key towards development of technology capabilities, improved innovation and competitiveness of South African aircraft industry.

The highest score for total respondents was equal on both *Strongly agree* (**47%**) and *Agree* (**47%**). *Government* scored 100% on *Strongly agree*, with *Firms* scoring 50% on both categories of *Strongly agree* and *Agree*. *Academia* scored 75% on *Agree*. A graphical representation of the scores is illustrated on Figure (iv)41.

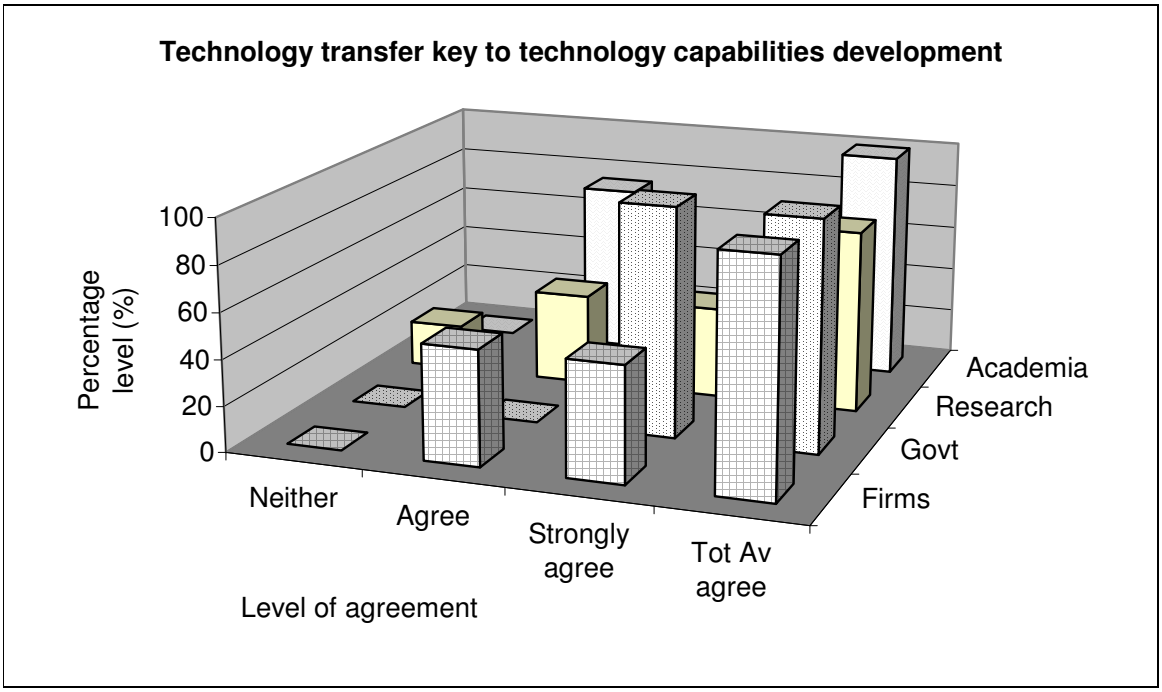

Figure (iv)41 Level of agreement on Statement D: "Technology transfer would be key to development of technology capabilities …"

E. South African firms should form joint ventures with global firms to have improved technology and business development capabilities, as well as better market accessibility.

Total respondents had a score of **60%** on *Strongly agree*, and 40% on *Agree*. *Government* still had a 100% score on *Strongly agree*, followed by *Research institutions* with 60% (*Strongly agree*). When *Strongly agree* and *Agree* are combined, all individual respondents had 100% as average for agreeing. The graphical representation of the results is illustrated on Figure (iv)42.

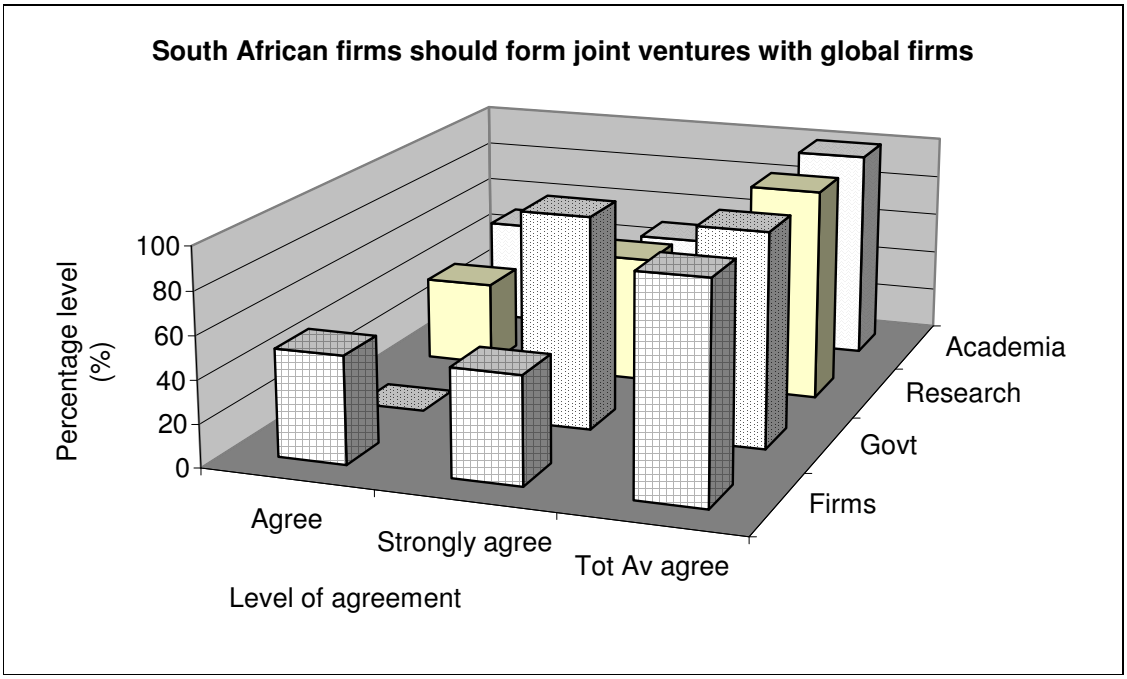

Figure (iv)42 Level of agreement on Statement E: "South African firms should form joint ventures with global firms …..".

F. Collaborative efforts from academia, research institutions, firms and government are essential for enhancing innovation and technology development within the aircraft industry.

For this statement the highest score on total respondents was **80%** on *Strongly agree*. Both *Government* and *Research institutions* had individual scores of 100% each on *Strongly agree*, with *Firms* scoring 50% on the same (*Strongly agree*). *Academia* scored 75% on the same (*Strongly agree*). The graphical representation of the scores is illustrated on Figure (iv)43.

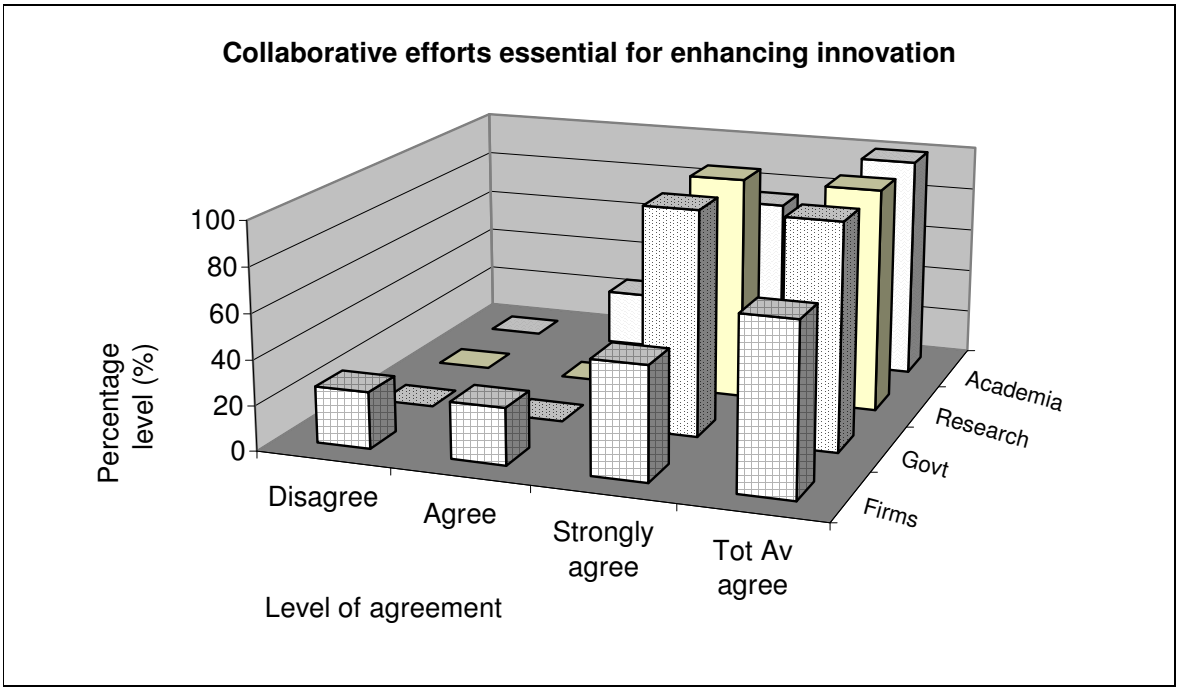

Figure (iv)43 Level of agreement on Statement F: "Collaborative efforts from academia, research institutions, firms and government key to enhancing innovation ……".

G. South African government should collaborate with governments from other countries on major projects so as to facilitate development and market access for South African aircraft firms.

Total respondents had a score of **60%** on *Strongly agree*, and 33% on *Agree*. Both *Firms* and *Government* had a 100% score on *Strongly agree*. Figure (iv)44 illustrates the findings.

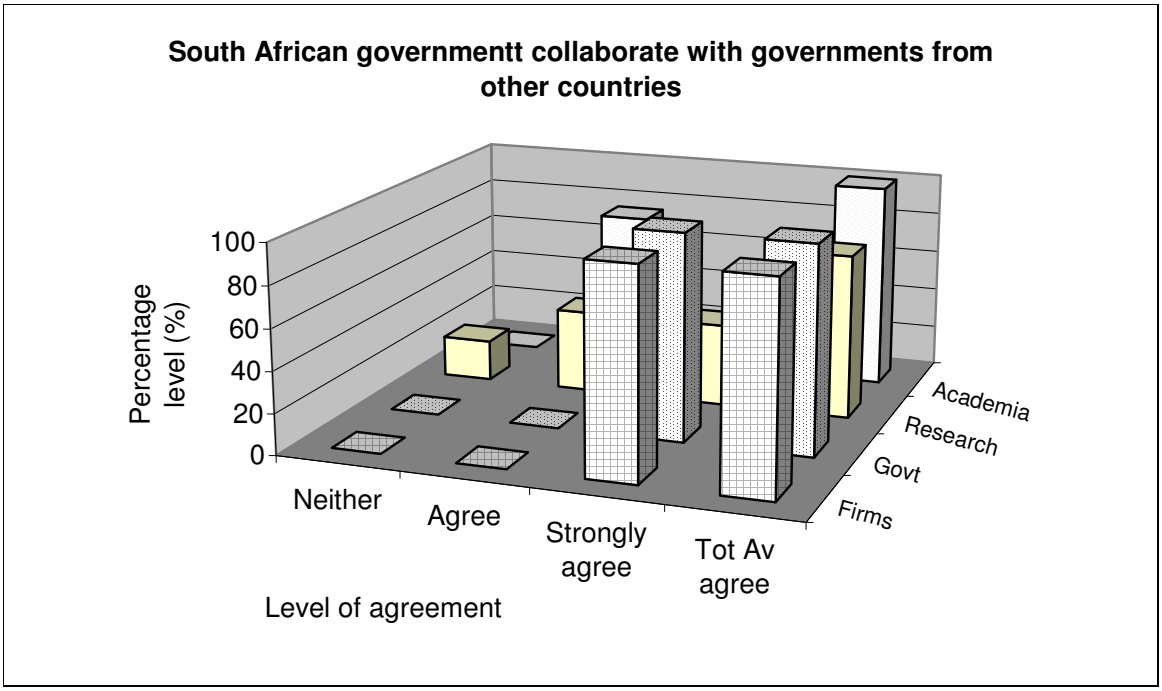

Figure (iv)44 Level of agreement on Statement G: "South African government should collaborate with government from other countries …".

In all statements grouped together, on total respondents, Statement **C** *(R&D programme, in line with applied technology development could improve the technology base of the South African aircraft industry Research and development)* had the highest score of **80%** on *Strongly agree*, and 20% on *Agree*. Statement **F** *(Collaborative efforts from Academia, Research institutions, Firms and Government are essential for enhancing innovation and technology development within the aircraft industry)* also had the highest score of **80%** on *Strongly agree*, but only 13% on *Agree*. Statement **E** *(South African firms should form joint ventures with global firms to have improved technology*

and business development capabilities, as well as better market accessibility) had the second highest score of **60%** on *Strongly agree*, and 40% on *Agree*. Statement **G** *(South African government should collaborate with government from other countries on major projects so as to facilitate development and market access for South African aircraft firms)* also had the second highest score of **60%** on *Strongly agree*, but only 33% on *Agree*.

14. For technology development to improve within the civil aircraft industry, the following should be established:

a) Research and technology development programme

For this aspect total respondents had a score of **60%** on *Highest priority*, with *Government* and *Academia* scoring 100% each on the same (*Highest priority*). *Firms* scored 50% on *High priority*.

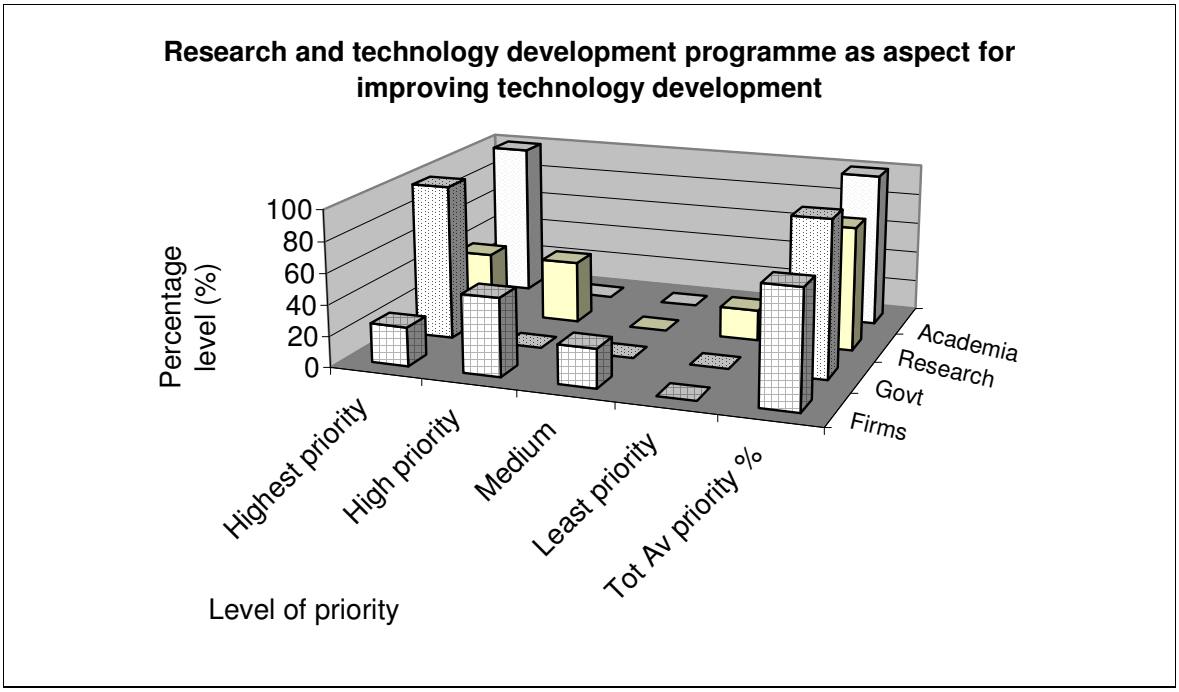

Figure (iv)45 Level of priority of "Research and technology development programme" as aspect for improving technology development

b) Firm Collaboration (national)

The total respondents' score on *Highest priority* was low (**31%**), although *Government* had a score of 100% (*Highest priority*).

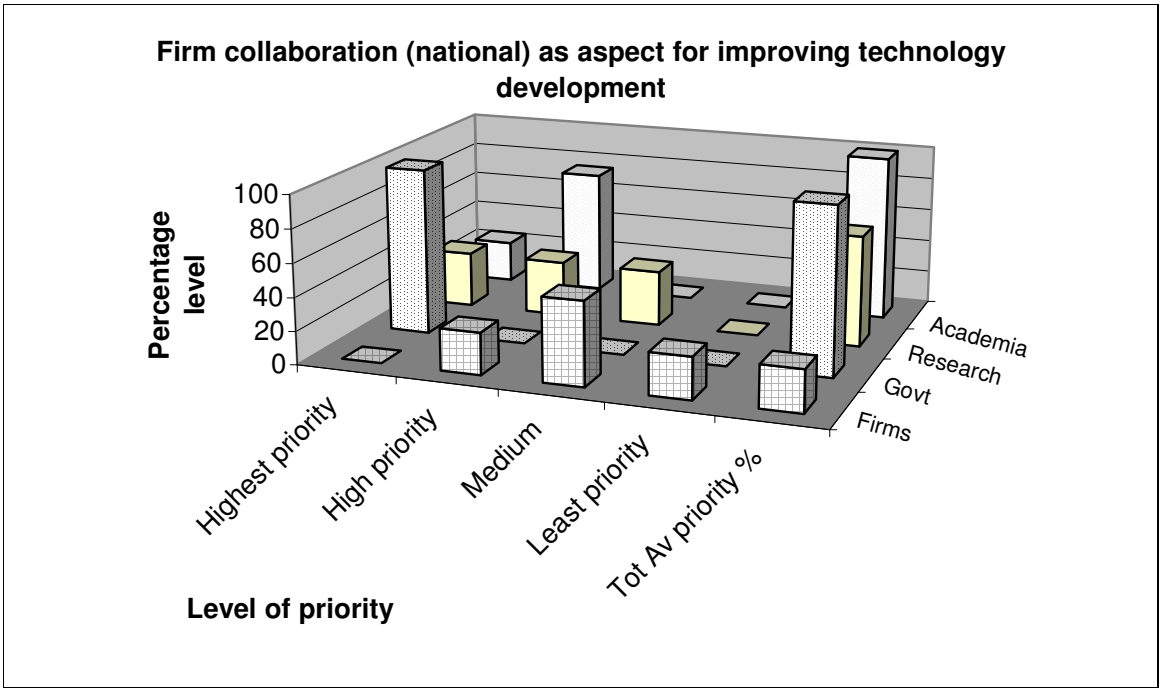

Figure (iv)46 Level of priority of "Firm collaboration (national)" as aspect for improving technology development

c) Firm collaboration (international)

A score of **46%** on *Highest priority* by total respondents was obtained. *Government* had 100% score on *Highest priority*, with *Firms* scoring 75% on same (*Highest priority*).

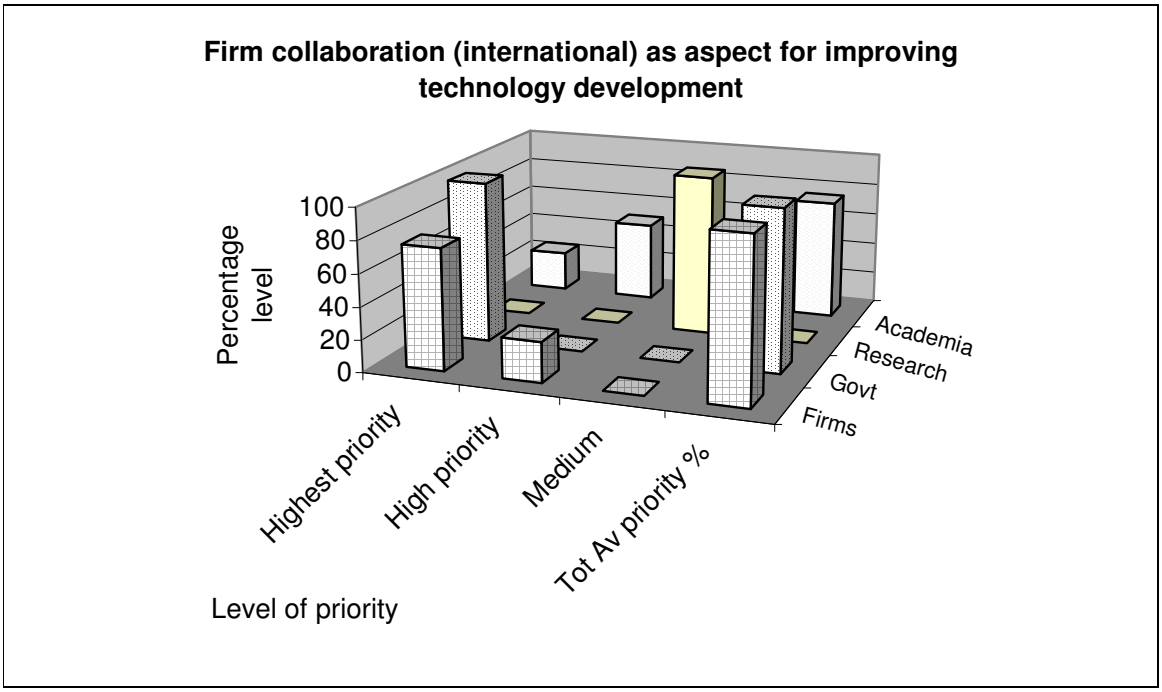

Figure (iv)47 Level of priority of "Firm collaboration (international)" as aspect for improving technology development

d) Aircraft-related research institutes

A score of **54%** on *Highest priority* by total respondents was obtained. Both *Government* and *Academia* had individual scores of 100% each on *Highest priority*. *Firms* found this aspect to be of *Medium priority* (50%).

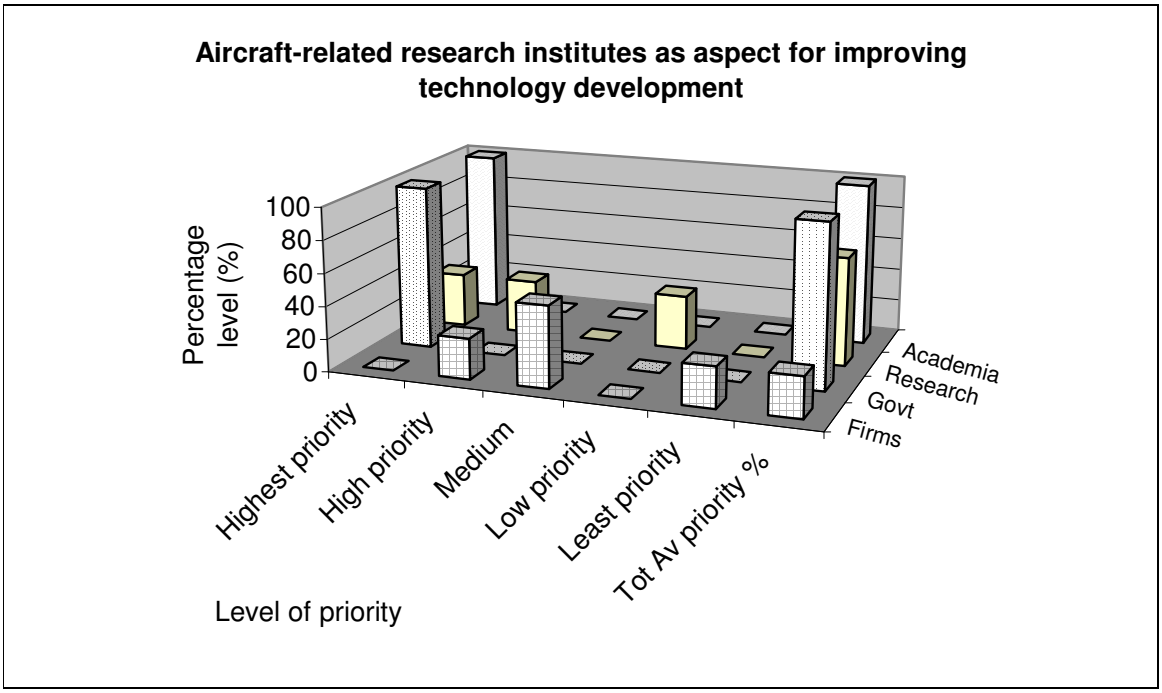

Figure (iv)48 Level of priority of "Aircraft-related research institutes" as aspect for improving technology development

e) Government support/involvement

For this aspect the highest score of **67%** by total respondents was obtained on *Highest priority*. Both *Firms* and *Government* had individual scores of 100% each on the same (*Highest priority*), with *Academia* scoring 75% (*Highest priority*).

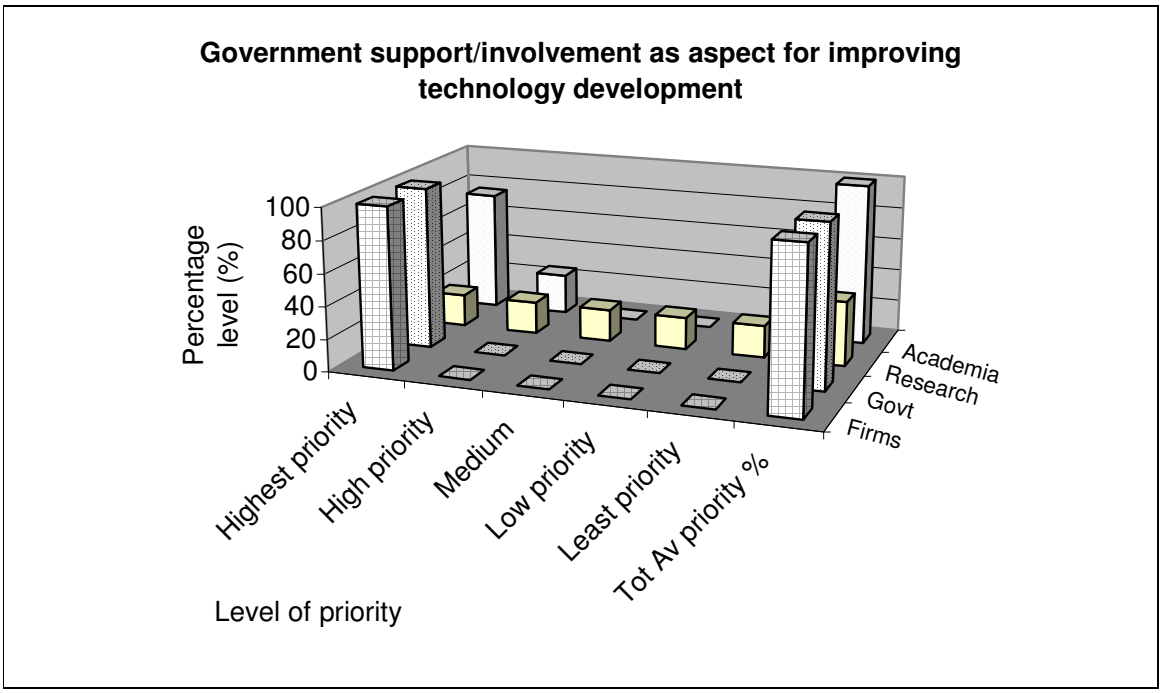

Figure (iv)49 Level of priority of "Government support/involvement" as aspect for improving technology development

f) Market acquisition assistance

The lowest score of **15%** by total respondents was obtained under *Highest priority*, indicating that this aspect is not of priority. *Firms*, *Government* and *Academia* scored 50% on *High priority*.

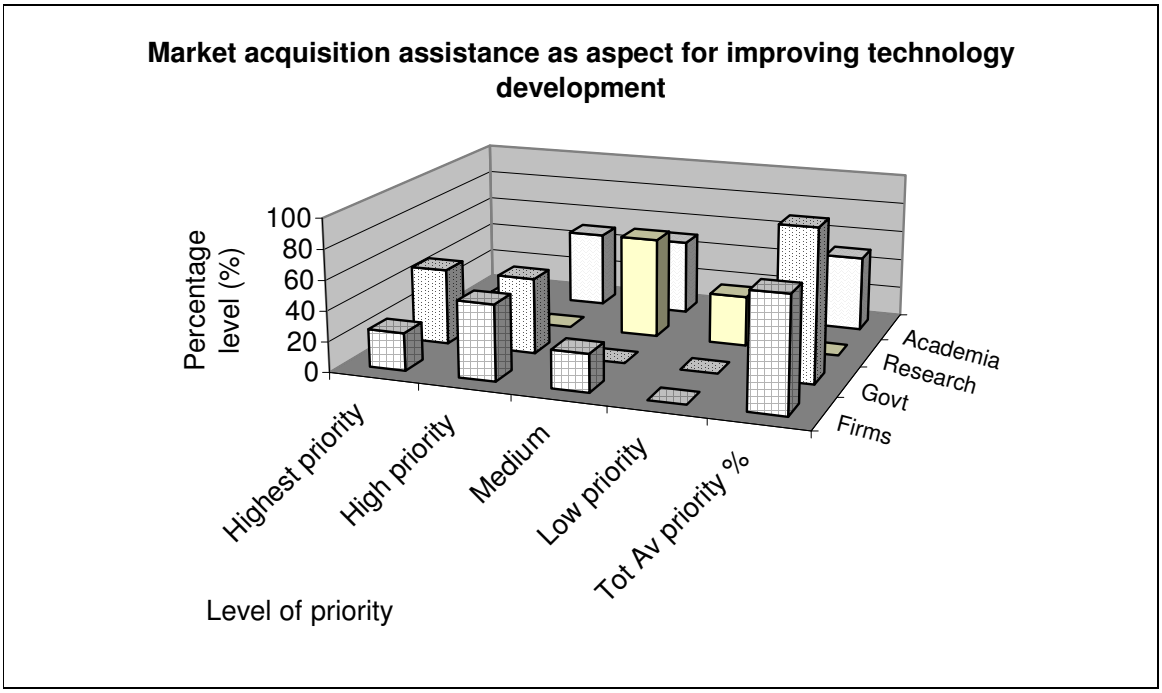

Figure (iv)50 Level of priority of "Market acquisition assistance" as aspect for improving technology development

g) Research collaboration (government, research institutes, academia, firms)

A score of **54%** on *Highest priority* by total respondents was obtained. *Government* had a 100% score (on *Highest priority*), with *Academia* scoring 75% (*Highest priority*). *Firms* found this aspect to be of *High priority* (50%).

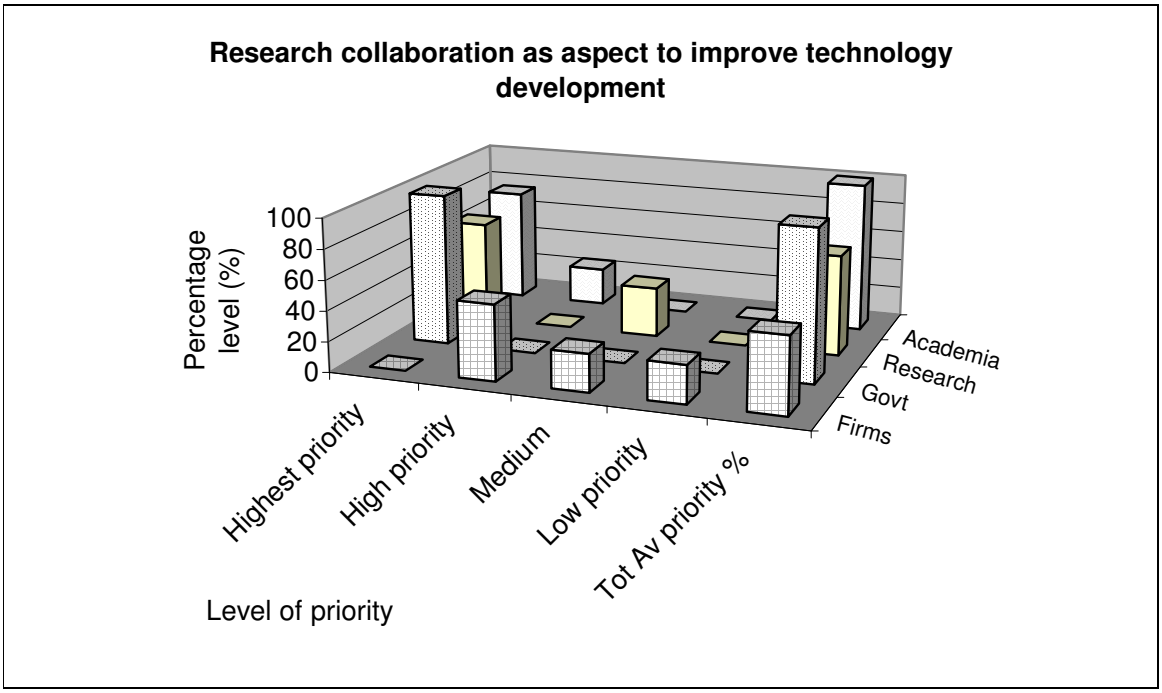

Figure (iv)51 Level of priority of "Research collaboration" as aspect for improving technology development

h) Technology transfer

A score of **50%** by total respondents was obtained under *Highest priority*, with *Government* scoring 100% on same (*Highest priority*). *Firms* found this aspect to be of *High priority* (67%).

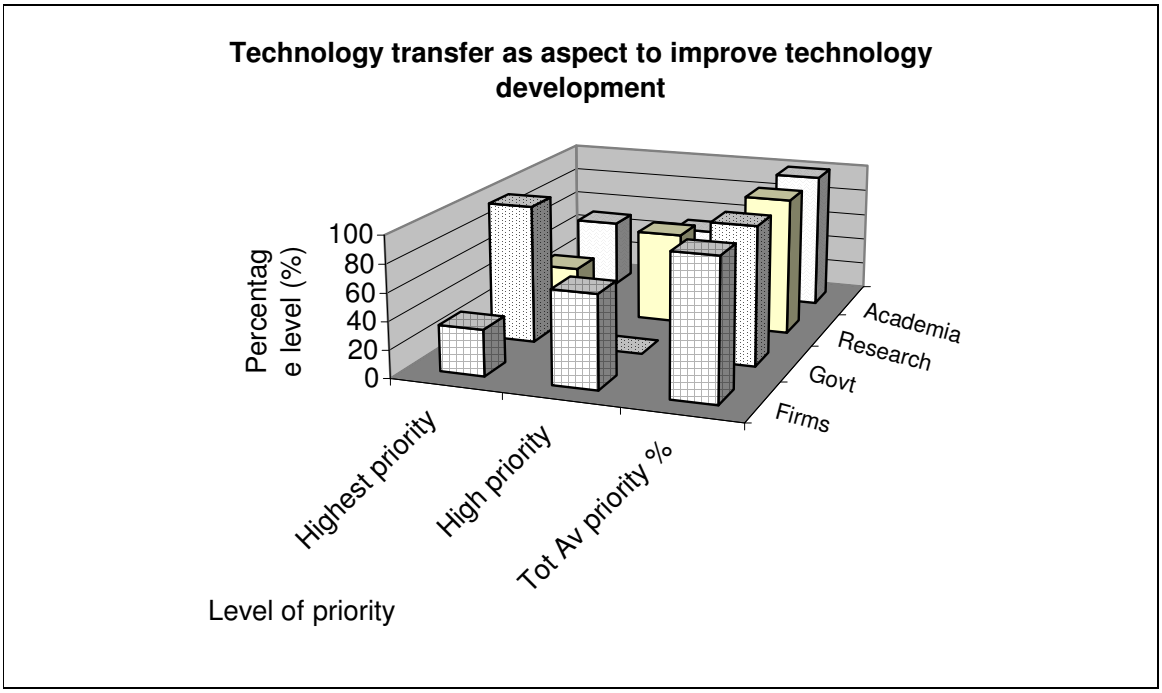

Figure (iv)52 Level of priority of "Technology transfer" as aspect for improving technology development

i) Skills development

A score of **60%** by total respondents was obtained under *Highest priority*, with *Government* scoring 100% (*Highest priority*) and *Academia* 75% (*Highest priority*). *Firms* found the aspect to be of *High priority* (75%).

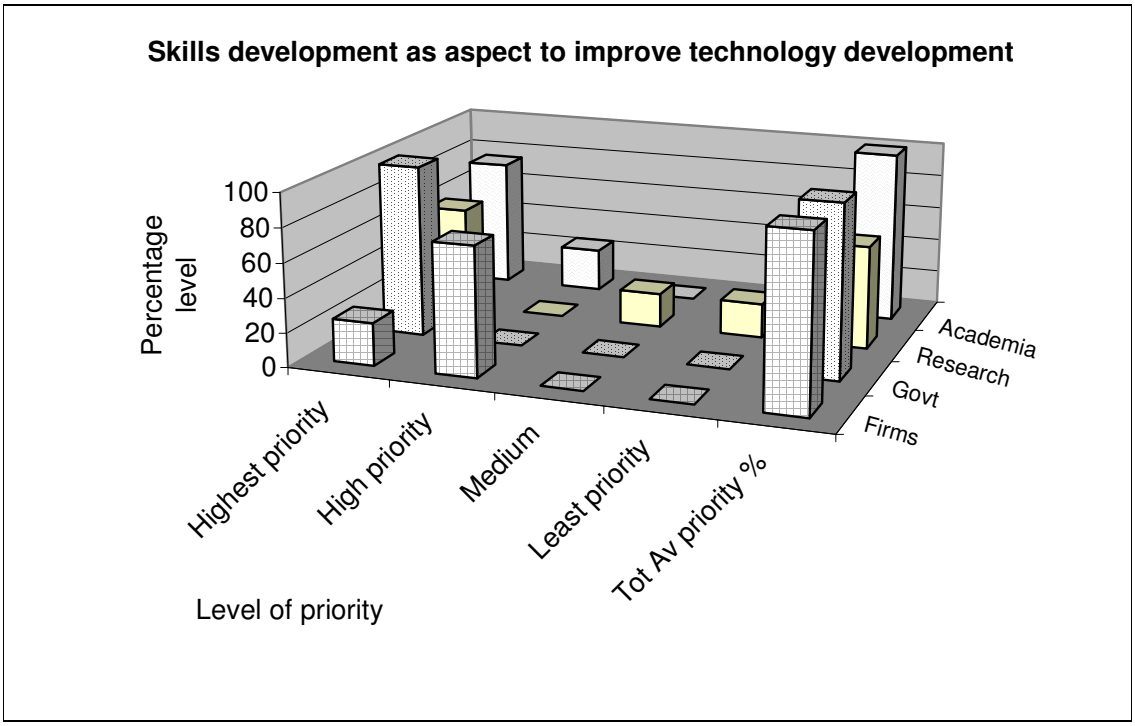

Figure (iv)53 Level of priority of "Skills development" as aspect for improving technology development

When all the factors are grouped together, on total respondents, the factor on *Government support/involvement* had the highest ranking (**67%** *Highest priority*), with *Firms* affirming the ranking with a score of 100% (*Highest priority*). Both factors on *Research and technology development programme* and *Skills development* had the second highest ranking (**60%** *Highest priority*). The difference is that *Firms* scored 50% (*High priority*) and 75% (*High priority*) respectively. The factors of *Research collaboration (government, research institutes, academia, firms)* and *Aircraft-related research institutes* both had the third highest ranking (**54%** *Highest priority*). The difference is also that *Firms* scored 50% (*High priority*) and 25% (*High priority*) respectively. The fourth ranked factor is *Technology transfer*, with **50%** (*Highest priority*), followed by

Firm collaboration (international) that scored **46%** (*Highest priority*), then *Firm collaboration (national)* at **31%** (*Highest priority*), last factor being *Market acquisition assistance* (**15%** *Highest priority*).

15. The following are assumed to be the factors hampering business acquisition and technology capability-building for South African civil aircraft firms:

Responses were obtained on the following list of factors:

A. Highly regulated environment (global & local)
B. Insufficient financial resources
C. Inadequate skilled resources
D. Lack of appropriate technologies
E. Projects too costly
F. Poor strategic alliances or networks
G. Not meeting customers' demands
H. Insufficient government support
I. Insufficient experience in global supply
J. Negative perception by global customers on quality of products

The factor that obtained the highest score on total responses was **C** *(Inadequate skilled resources),* with **40%** (*Strongly agree*). *Firms* also had the highest individual score (75%) on *Strongly agree*. A graphical representation of the scores is illustrated on Figure (iv)54.

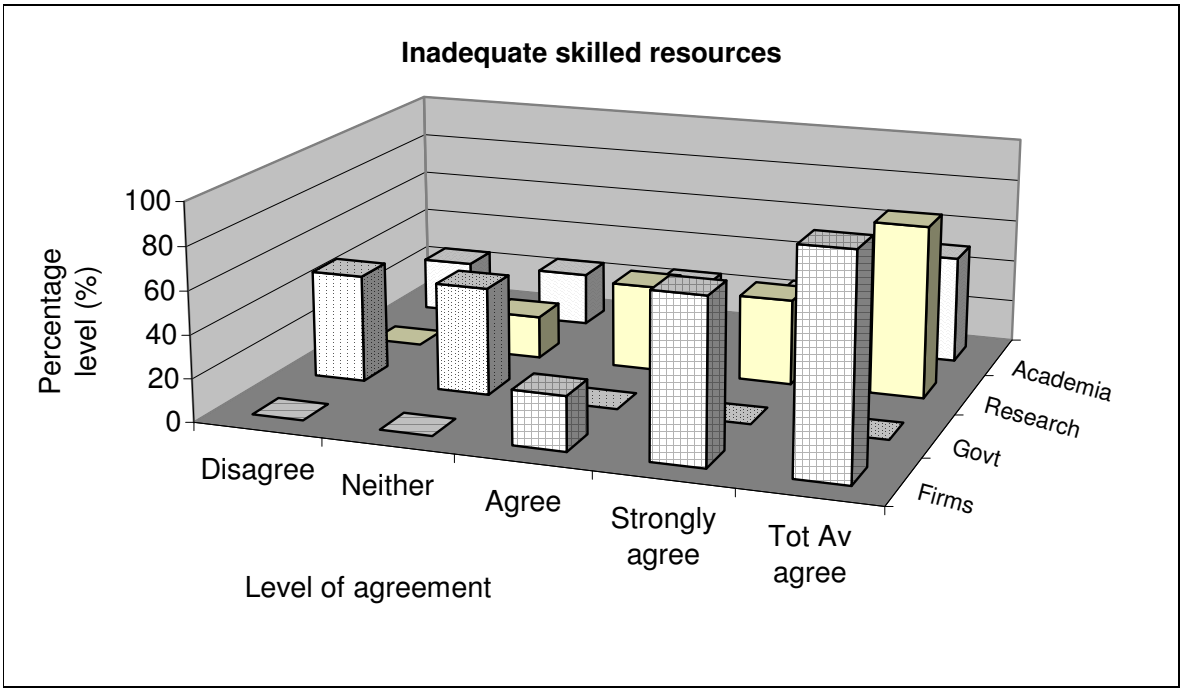

Figure (iv)54 Level of agreement on "Inadequate skilled resources" as a factor hampering business acquisition and technology development

Factors **I** *(Insufficient experience in global supply)* and **A** *(Highly regulated environment – global and local)* obtained the second highest score of **33%** (*Strongly agree*) on total responses. What separates them is that factor I had a further 40% (*Agree*) whereas factor A had 27% (*Agree*). *Firms* also scored 100% (*Agree*) on factor I, with factor A scoring 50% (*Agree*) by *Firms*. Graphical representations of the scores for factors I and A are illustrated on Figures (iv)55 and (iv)56 respectively.

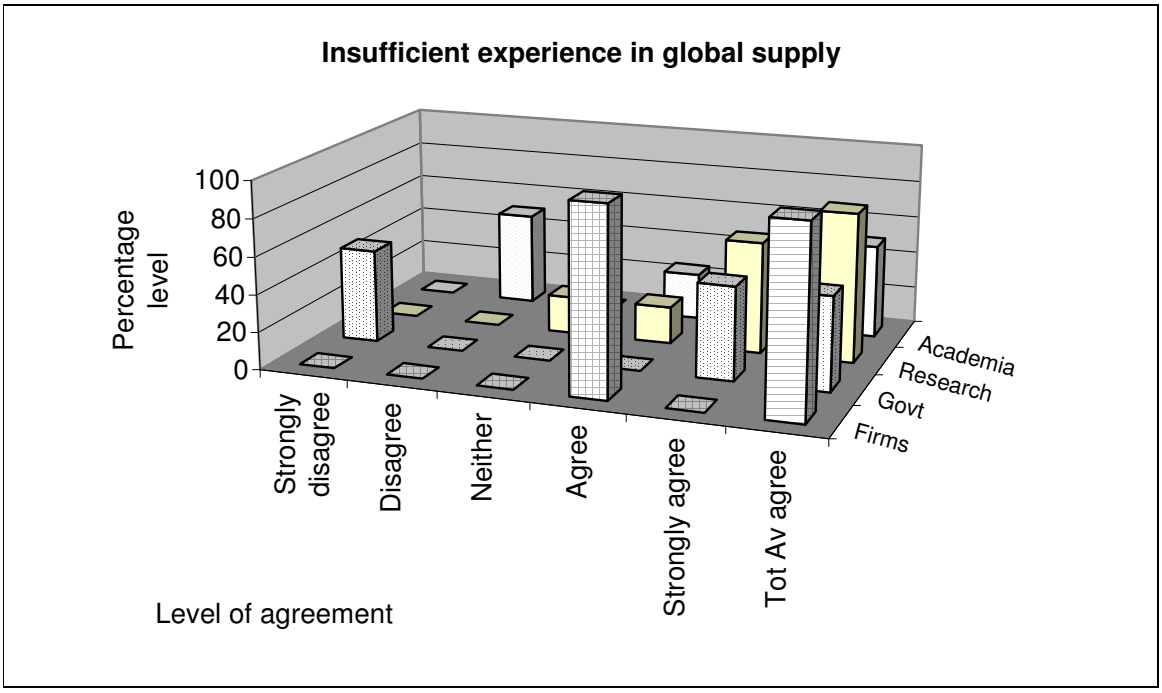

Figure (iv)55 Level of agreement on "Insufficient experience in global supply" as a factor hampering business acquisition and technology development

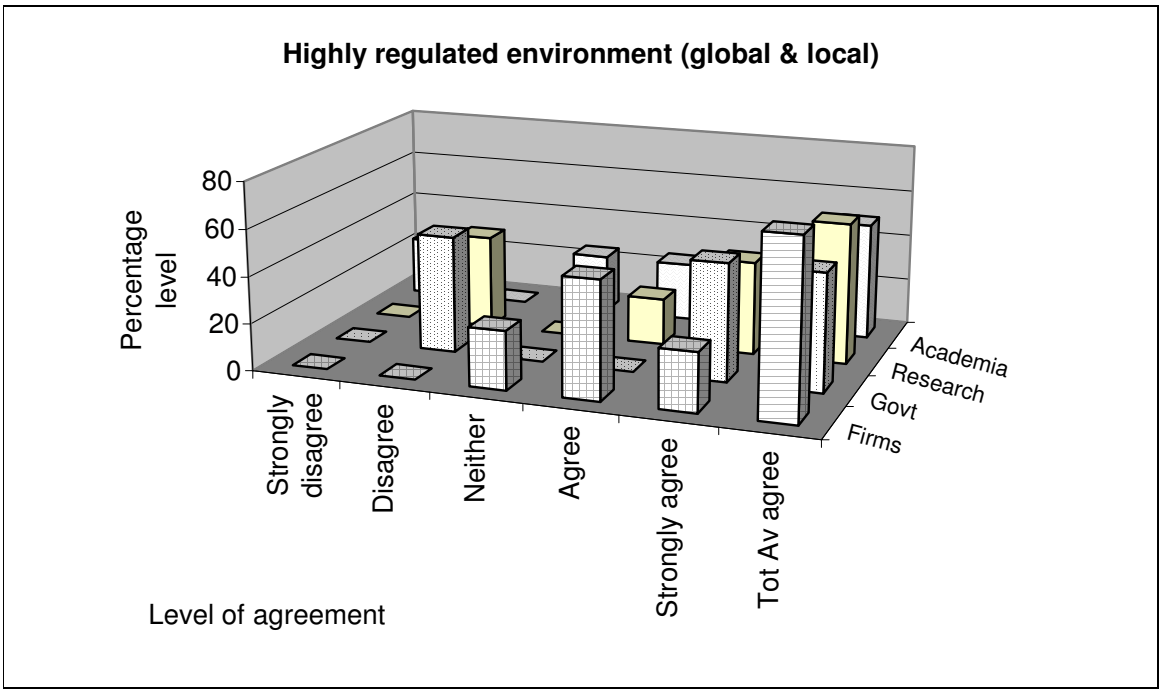

Figure (iv)56 Level of agreement on "Highly regulated environment" as a factor hampering business acquisition and technology development

Third highest score of **27%** (*Strongly agree*) was obtained for both factors **B** (*Insufficient financial resources)* and **F** *(Poor strategic alliances or networks)* on total responses. Factor B had a further 47% (*Agree*) with factor F scoring 33% (*Agree*). For factor B, *Firms* scored 25% (*Strongly agree*) with a further 50% (*Agree*). For factor F, *Firms* scored only 50% (*Agree*), nothing on *Strongly agree*.

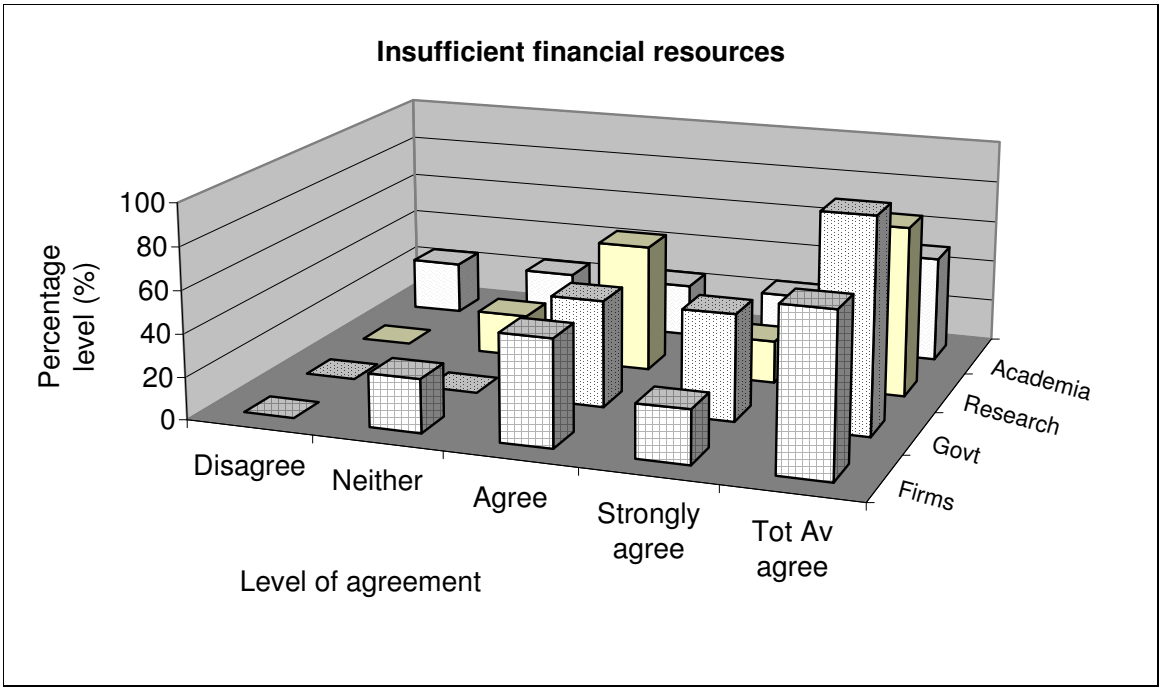

Figure (iv)57 Level of agreement on "Insufficient financial resources" as a factor hampering business acquisition and technology development

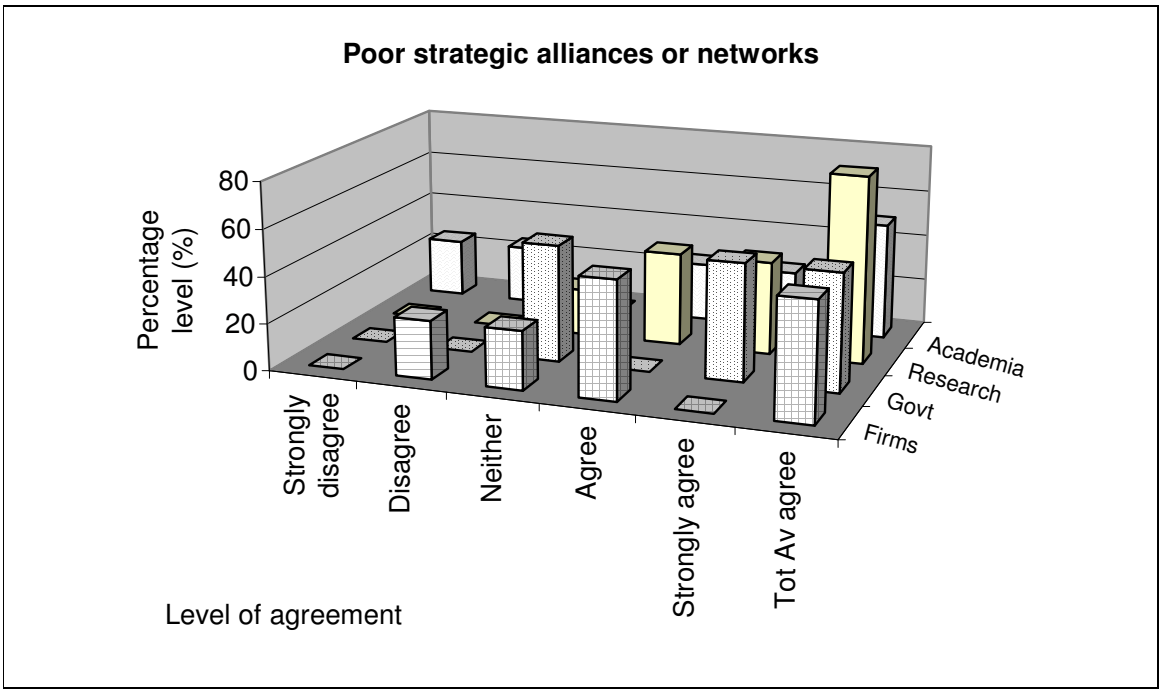

Figure (iv)58 Level of agreement on "Poor strategic alliances or networks" as a factor hampering business acquisition and technology development

Fourth highest score of **13%** (*Strongly agree*) was obtained for factors **E** (*Projects too costly),* **G** (*Not meeting customers' demands*) and **J** (*Negative perception by global customers on quality of products*) on total responses. Both factors E and J had a further 40% (*Agree*) with factor G scoring 27% (*Agree*). For factors E and J, *Firms* scored 75% (*Agree*), whereas for factor F, *Firms* scored only 25% (*Agree*).

Factor **D** (*Lack of appropriate technologies*) followed on total responses with a score of **7%** (*Strongly agree*) and a further 40% (*Agree*). *Firms* had 50% on *Agree*.

Factor **H** (*Insufficient government support*) was last, with nothing on Strongly agree but 40% (*Agree*) for the total responses. *Firms* only had 25% on *Agree*.

16. What are the existing competencies, capabilities, skills and technologies available within the South African aircraft industry?

Responses were obtained on the following list of specialty areas:

A. Aircraft maintenance skills (93% YES)

B. Aircraft conversions and modification skills (80% YES)

C. Manufacture of components and sub-system levels (93% YES)

D. Manufacture of composites, rotor wing propeller blades, gear-boxes (80% YES)

E. Specialists in avionics (80% YES)

F. Capabilities for interior designs (80% YES)

G. Design and manufacturing skills for helicopters (73% YES)

H. Manufacture of military aircraft (47% YES)

The results showed that all the specialty areas as listed above exist within the South African aircraft industry. Specialty Areas **A** *(Aircraft maintenance skills)* and **C** *(Manufacture of components and sub-system levels)* had the highest score of **93%** (YES) by total respondents. In both instances, *Firms*, *Government* and *Research institutions* had individual scores of 100% (YES).

Specialty Areas **B** (*Aircraft conversions and modification skills*), **D** (*Manufacture of composites, rotor wing propeller blades, gear-boxes*), **E** (*Specialists in avionics*) and **F** (*Capabilities for interior designs*) had the second highest score of **80%** (YES). For B, D and F, both *Firms* and *Government* had individual scores of 100% (YES). However, E scored 75% (YES) on responses by *Firms*.

Specialty Area **G** (*Design and manufacturing skills for helicopters*) followed with a **73%** (YES) score by total respondents. *Firms* had an individual score of 75% (YES).

Specialty Area **H** (*Manufacture of military aircraft*) scored **47%** (YES) by total respondents, thereby indicating that such a skill or competency is at very

minimal levels if it does exist within the country. *Government* scored 100% (YES), with *Academia* scoring 75% (YES).

17. What would be the ideal key competencies, capabilities, skills and technologies needed for technology development within the South African civil aircraft industry?

Responses were obtained on the following list of elements:

A. Aircraft maintenance skills

B. Aircraft conversions and modification skills

C. Manufacture of components and sub-system levels

D. Manufacture of composites, rotor wing propeller blades, gear-boxes

E. Design and manufacturing of complete engines

F. Specialists in avionics

G. Capabilities for interior designs

H. Design and manufacturing skills for helicopters

I. Design and manufacturing skills for passenger aircraft

J. Full assembling skills for passenger aircraft

K. Civil-military technology linkages

Element **I** *(Design and manufacturing skills for passenger aircraft)* had the highest score by total respondents, where *Highest priority* obtained **82%.** Both *Government* and *Academia* had individual scores of 100% on *Highest priority*, with *Firms* scoring 75% on the same (*Highest priority*). The graphical representation of the results is shown on Figure (iv)59.

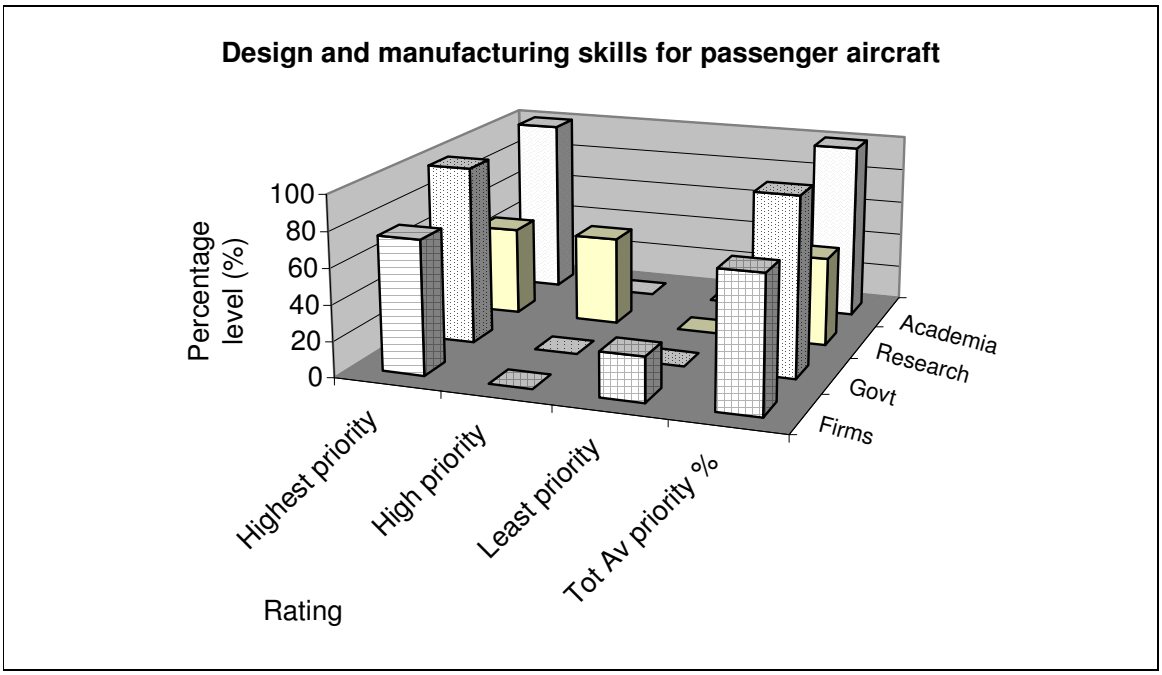

Figure (iv)59 Rating on "Design and manufacturing skills for passenger aircraft" as competency needed for technology development

Element **A** *(Aircraft maintenance skills)* had the second highest score by total respondents, where *Highest priority* obtained **67%**. Both *Firms* and *Government* had individual scores of 100% on *Highest priority*. The graphical representation of the results is shown on Figure (iv)60.

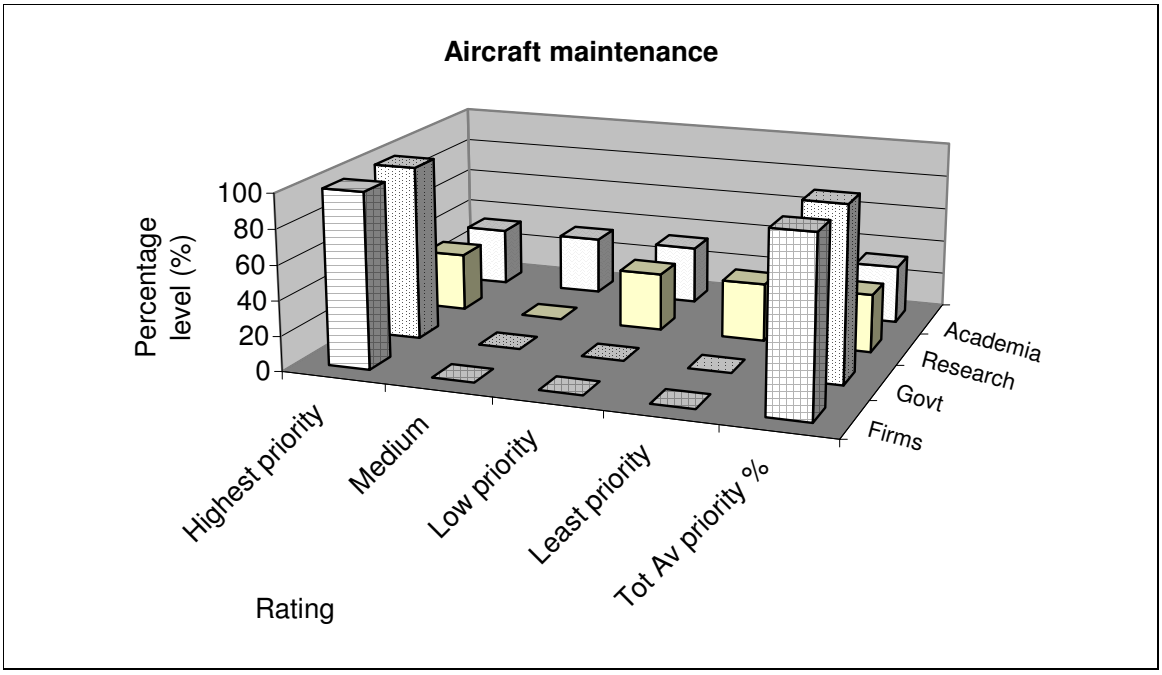

Figure (iv)60 Rating on "Aircraft maintenance" as competency needed for technology development

Element **C** (*Manufacture of components and sub-system levels)* followed with a score of **64%** on *Highest priority* by total respondents. Again, *Government* had a 100% score on *Highest priority*, with *Research institutions* scoring 80% (*Highest priority*) and *Firms* 50% (*Highest priority*). The graphical representation of the results is shown on Figure (iv)61.

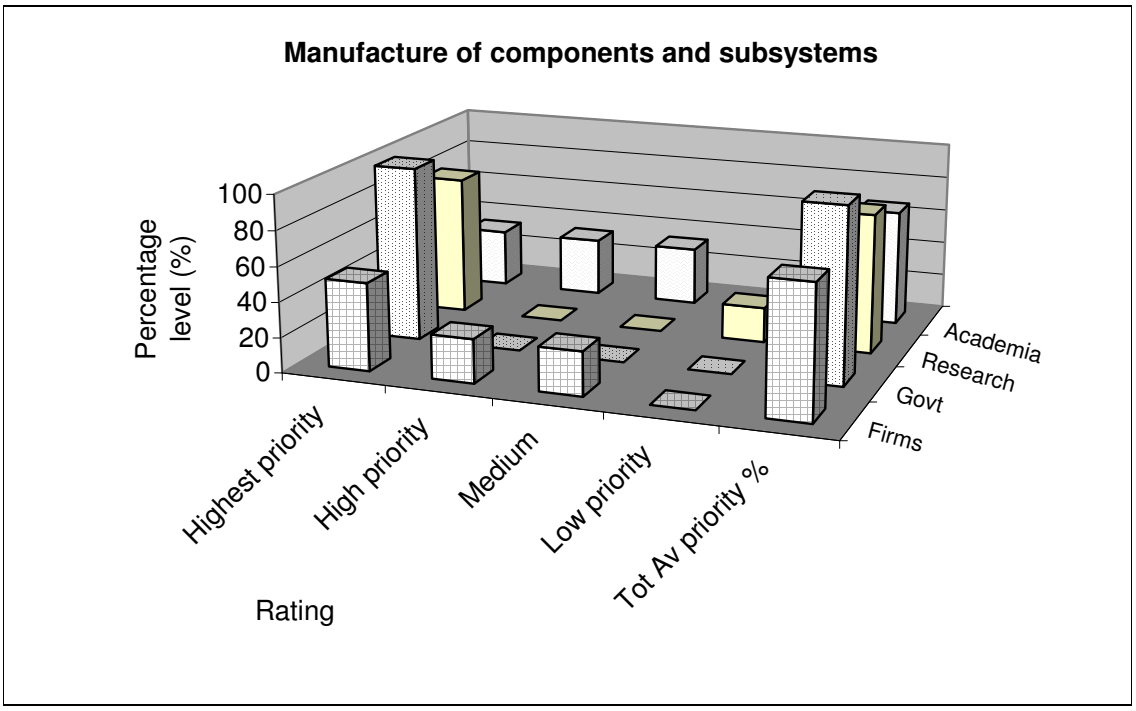

Figure (iv)61 Rating on "Manufacture of components and subsystems" as competency needed for technology development

Both Elements **K** (*Civil-military technology linkages)* and **J** (*Full assembling skills for passenger aircraft)* had the same score of **60%** *Highest priority* by total respondents. However, Element K had a further 40% score on *High priority* whereas Element J had 20% on same (*High priority*). For both Elements K and J, *Government* and *Research* had individual scores of 100% on *Highest priority*. The graphical representation of the results for both elements is shown on Figures (iv)62 and (iv)63.

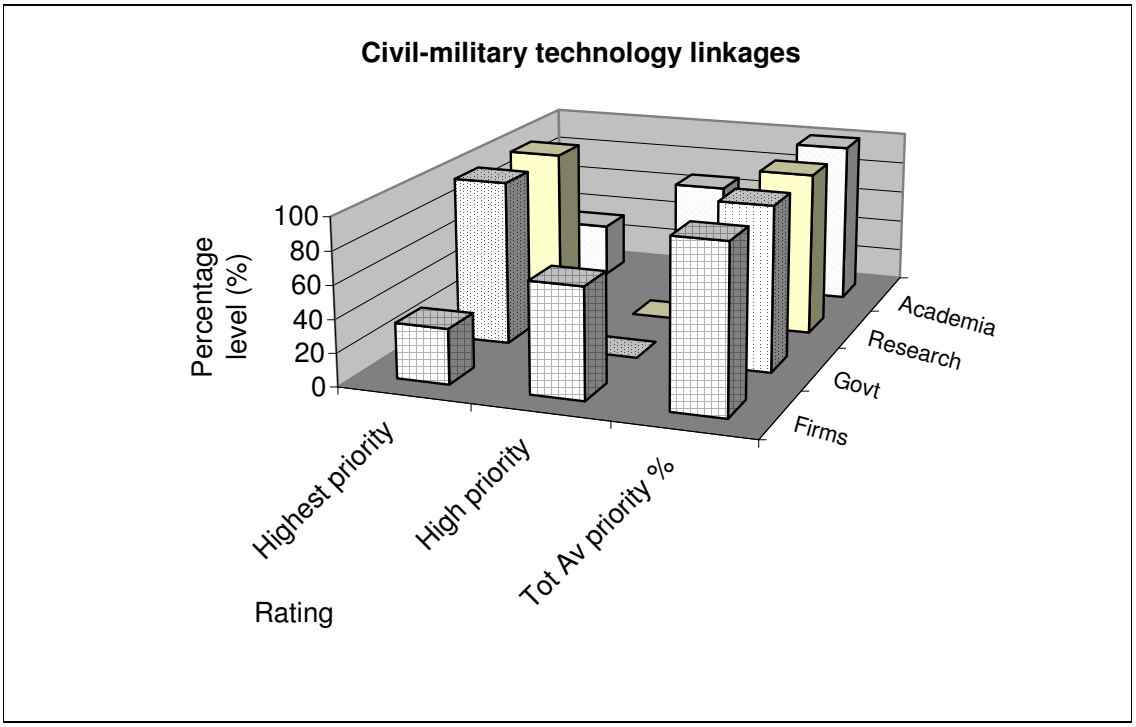

Figure (iv)62 Rating on "Civil-military technology linkages" as skill needed for technology development

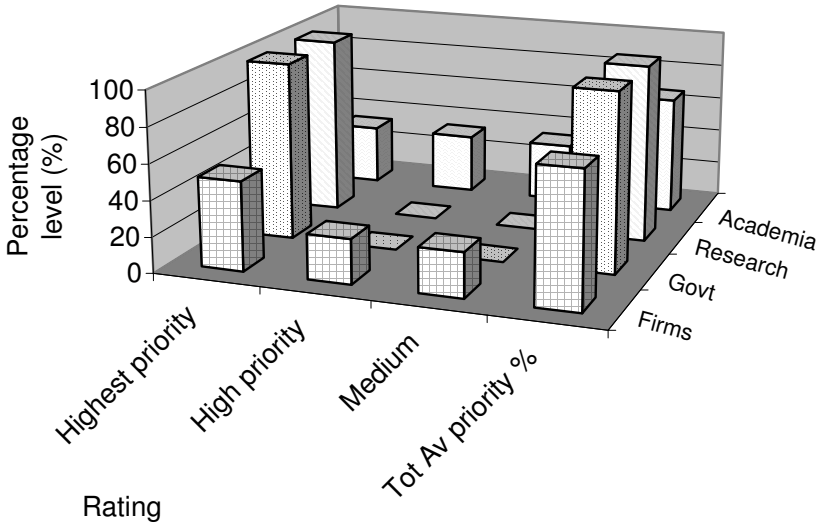

Figure (iv)63 Rating on "Full assembling skills for passenger aircraft" as skill needed for technology development

Element **F** (*Specialists in avionics*) had a score of **46%** on *Highest priority* by total respondents. Both Elements **B** (*Aircraft conversions and modification skills*) and **H** (*Design and manufacturing skills for helicopters*) scored **42%** on *Highest priority* by total respondents. They also had a further score of 17% each on *High priority*. Element **E** (*Design and manufacturing of complete engines*) had a score of **40%**, followed by Element **D** (*Manufacture of composites, rotor wing propeller blades, gear-boxes*) with **37%** (*Highest priority*). The last Element was **G** (*Capabilities for interior designs*) with **33%** on *Highest priority*.

18. How would you rate the current level of innovation in South Africa as compared to that of other successful organisations/institutions/firms in developing countries (South Korea, Japan, Brazil, etc) within the civil aircraft industry?

Score by total respondents on ***Poor*** is **57%**, indicating that the level of innovation in South Africa is poor when compared to other developing countries. 35% was scored on *Moderate*, and only 7% on *Strong*. *Firms* had a score of 75% on *Poor*.

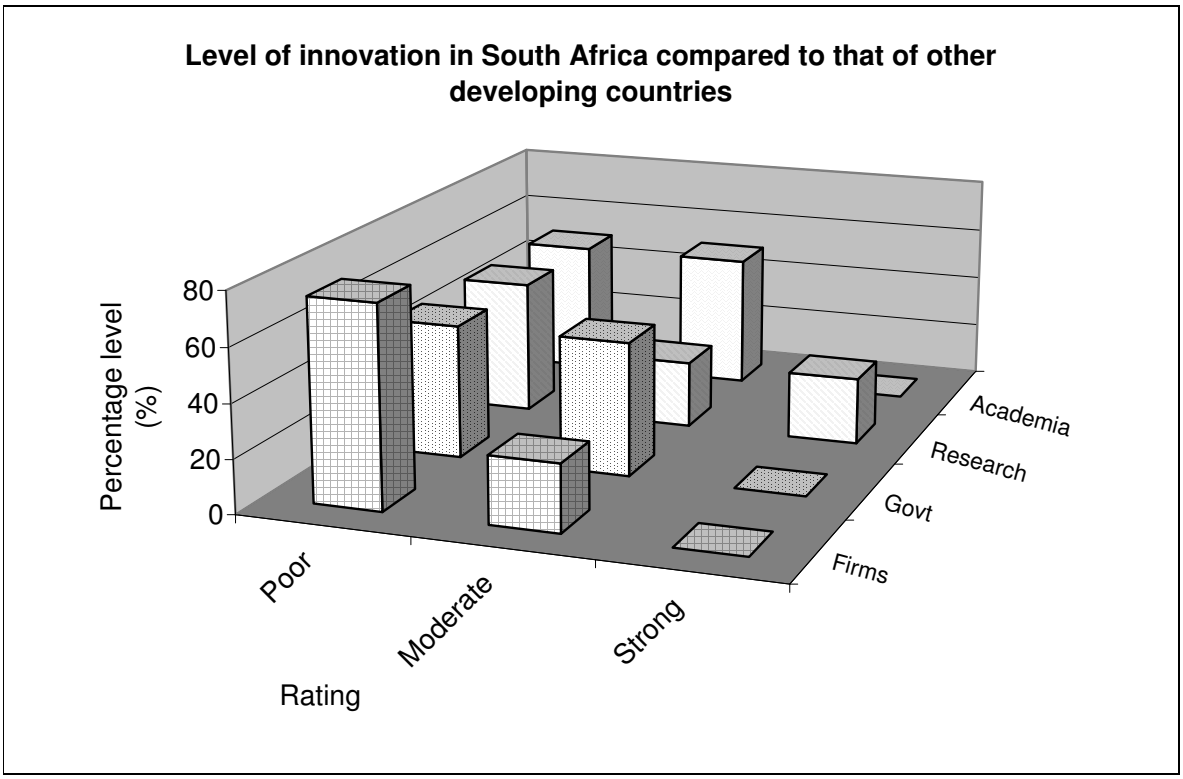

Figure (iv)64 Rating on level of innovation in South Africa compared to that of other developing countries

Respondents were further asked to state the percentage level of investment in innovation (R&D) by their institutions towards technological development within the civil aircraft industry.

Only 22% of the total responses indicated a 70% investment in innovation. *Research institutions* had the highest score of 50% showing the 70% investment, with 25% indicating a 50% investment. 25% of *Firms* indicated a 10% investment in innovation. Academia indicated 0% investment in innovation. Figure (iv)65 illustrates the results.

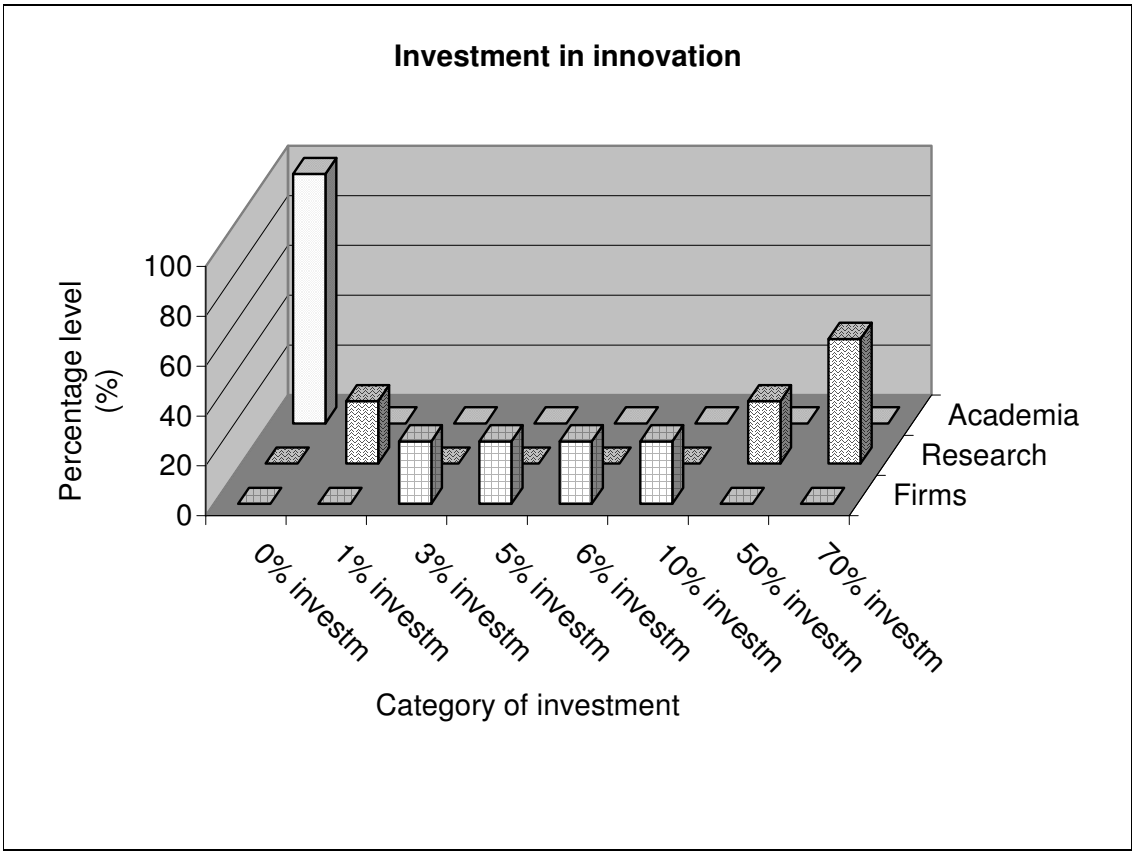

Figure (iv)65 Rating on level of investment in innovation in various categories

Appendix V: Discussion on data collected from international experts

On the **Research questionnaire for international experts**, responses were gathered from respondents as illustrated on figures (v)1 and (v)2:

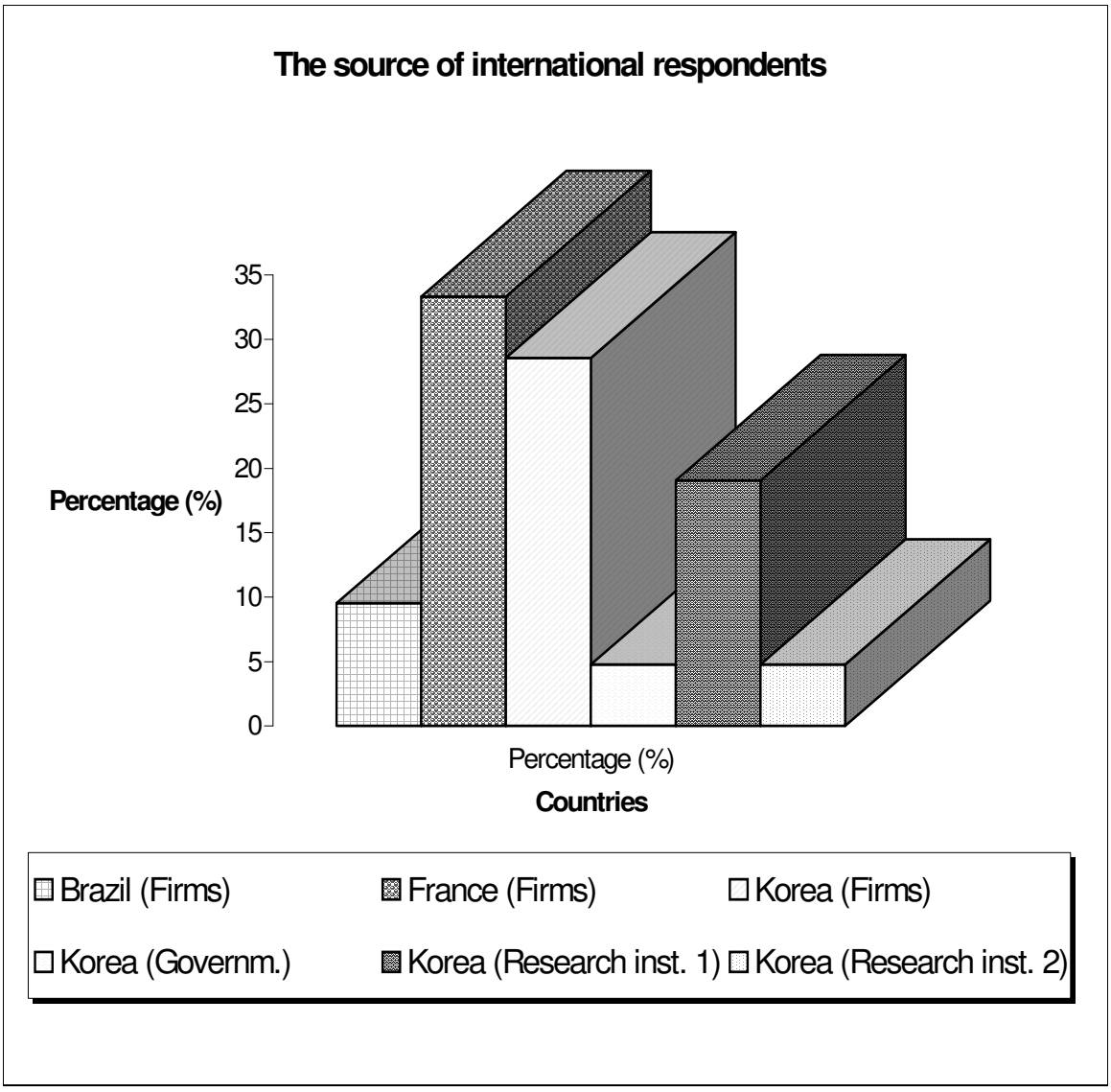

Figure (v)1 The source of international respondents (a)

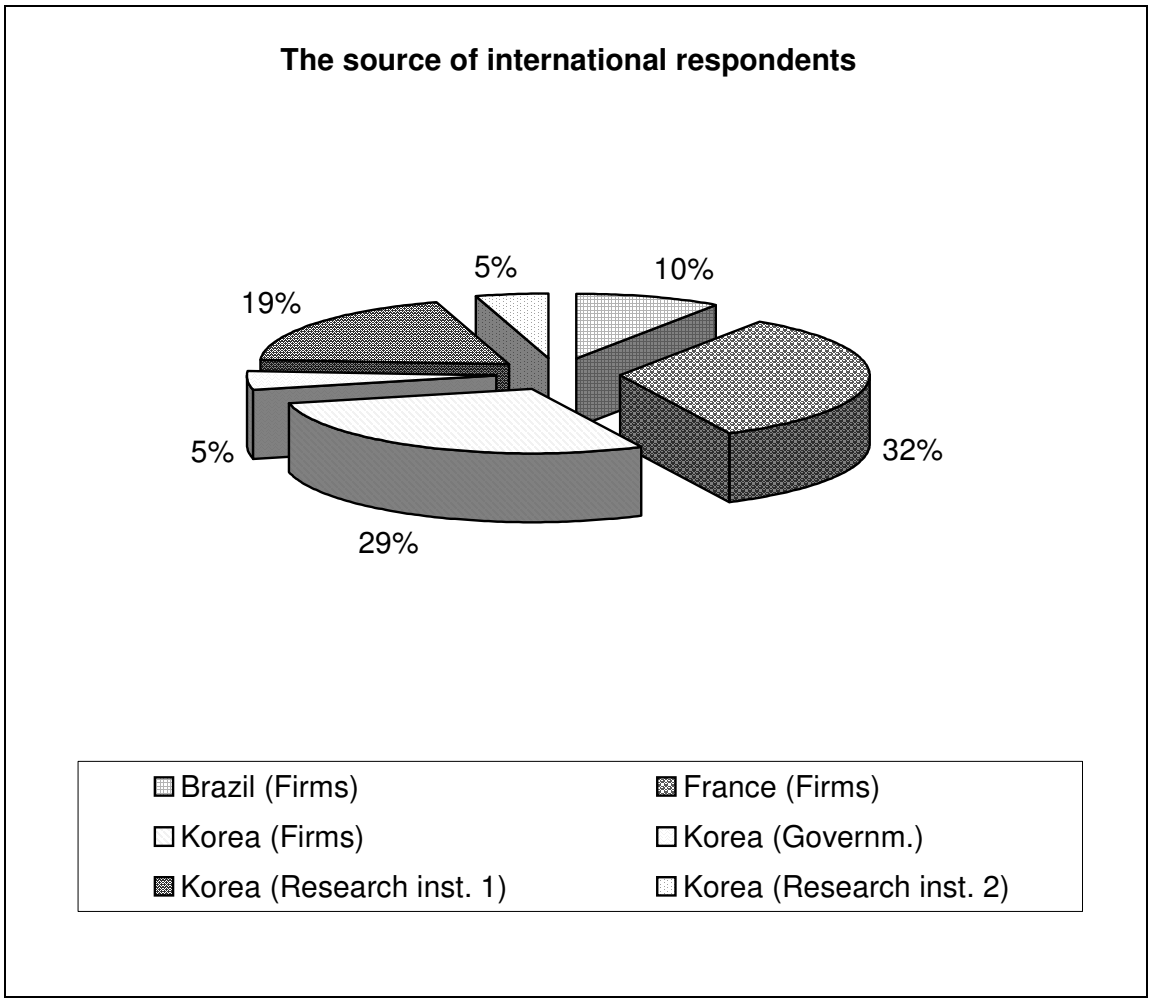

Figure (v)2 The source of international respondents (b)

Three (3) questions were asked under **Personal background** as follows:

1. Please indicate your field of expertise below

The results showed that the majority of respondents were experts within the *'engineering'* field (70%). The analysis would mean that the aircraft industry is dominated by engineers because of the technicality and complexity of it. The graphical representation of such results is illustrated on figures (v)3 and (v)4.

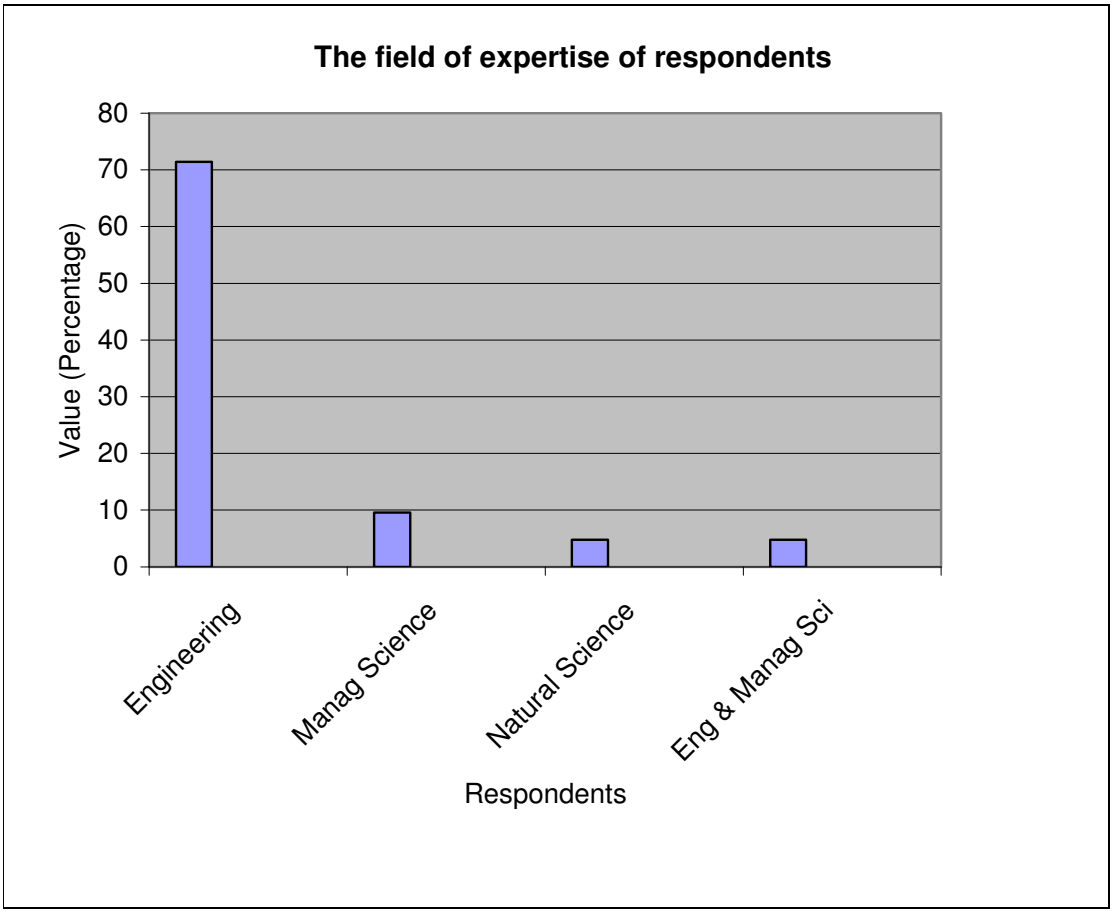

Figure (v)3 The field of expertise of respondents (a)

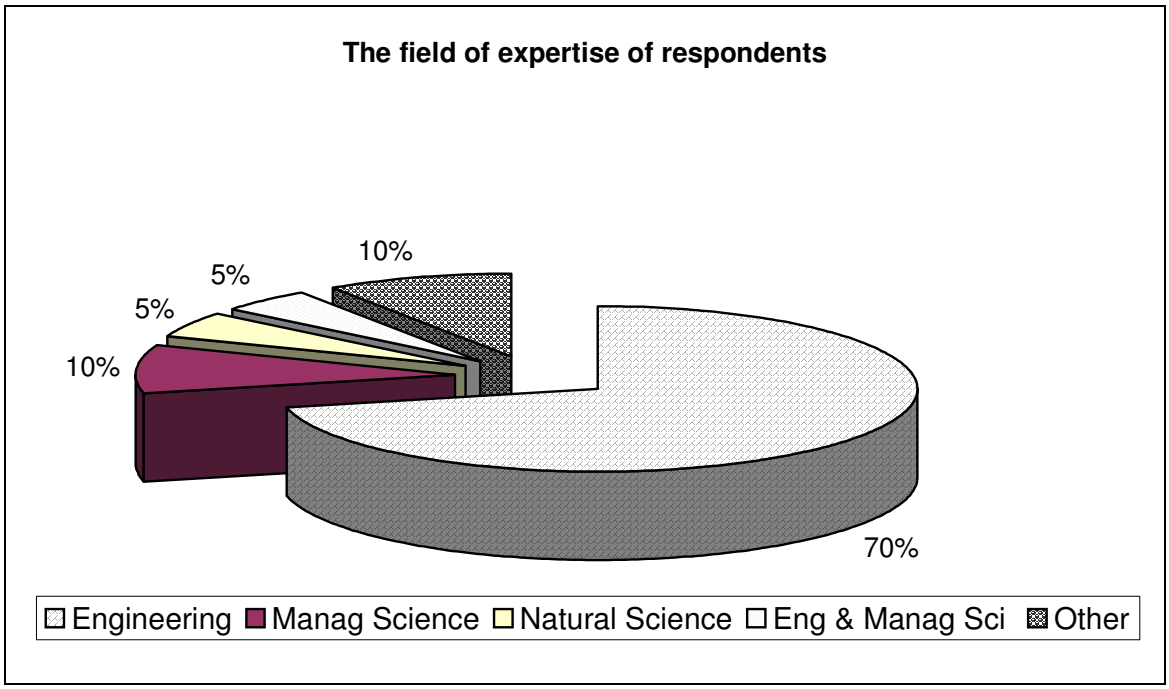

Figure (v)4 The field of expertise of respondents (b)

2. Please indicate your field of work within the organisation

The distribution showed a score of 38% on '*Other*', which is either the combination of fields within '*manufacturing*, '*technical production'*, '*sales'* and '*marketing*', or other fields that were not listed. '*Manufacturing'* had a score of 29%, '*sales*' and '*marketing*' (19%), followed by '*technical production'* with 14%. The analysis would mean that most of the top personnel within the aircraft industry were not directly involved in the listed fields, possibly because they were in top management positions. They would therefore fall under the field named '*Other*', which could also include '*management'* field. Figure (v)5 illustrates the distribution.

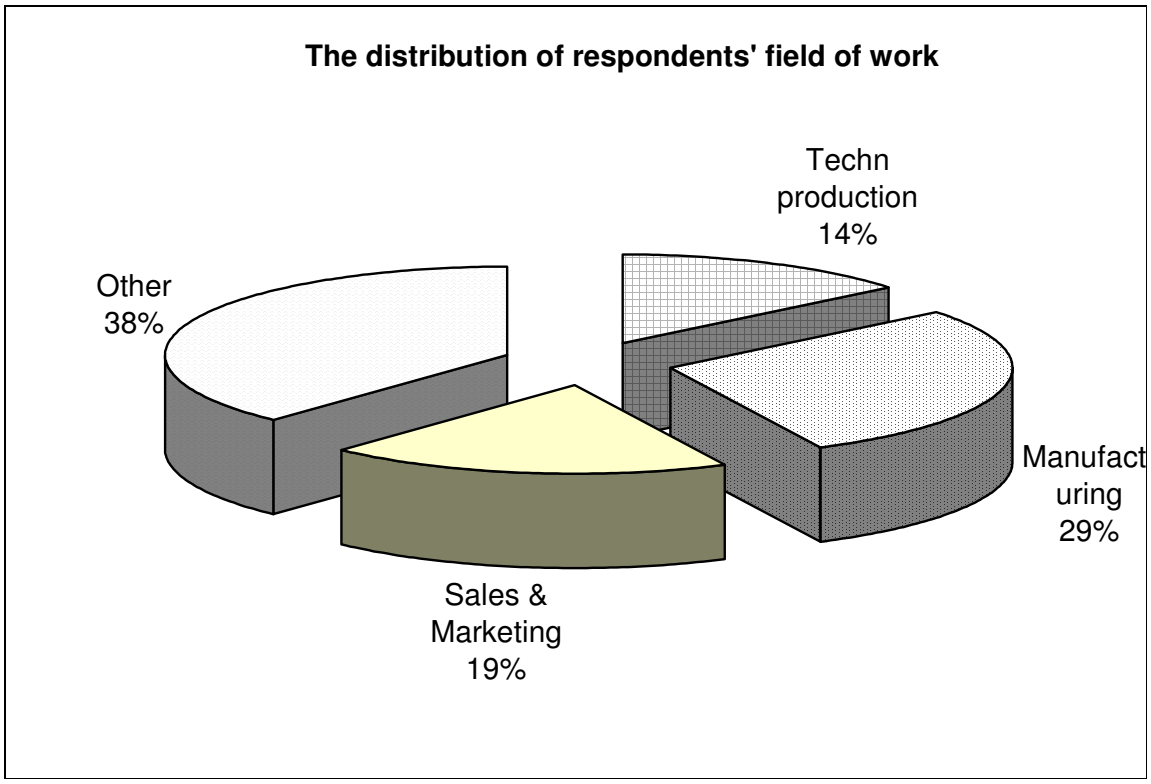

Figure (v)5 The distribution of respondents' field of work

3. Please indicate your work experience within the aircraft industry or within aircraft-related policy development

The results showed that the majority of respondents (85%) had work experience of over 5 years. Only 5% of the respondents had work experience of between 6 and 12 months. 10% ('*Other*') did not respond to this question. Figure (v)6 illustrates the distribution.

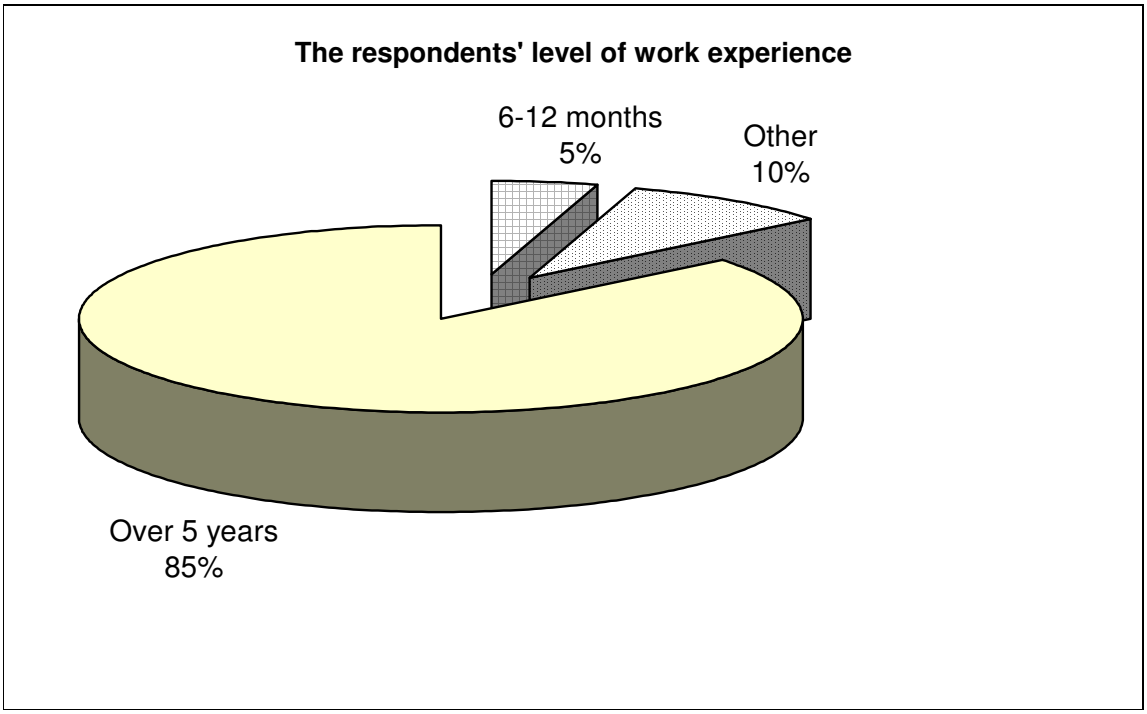

Figure (v)6 The respondents' level of work experience

On the **main research questions** there were two sections, Part I and II.

Part I looked at the technological innovation related background in the form of activities (both current and previous) that firms have embarked on, so as to compare the successful countries' pattern of technology development to the current gaps by South African firms. This was in line with the theory on technological competence and capability building paths followed by most of the successful countries studied (Chapter 2). It also looked at the current and future positioning of firms in relation to the aircraft industry structure.

Responses to **Part I** questions were received as follows:

1. Does your firm have or had any joint ventures with other aircraft firms/institutions/organisations outside your country?

48% of the respondents agreed (YES) to have had joint ventures with institutions outside their country, whereas 47% responded with a NO. 5% ('*Other*') did not respond.

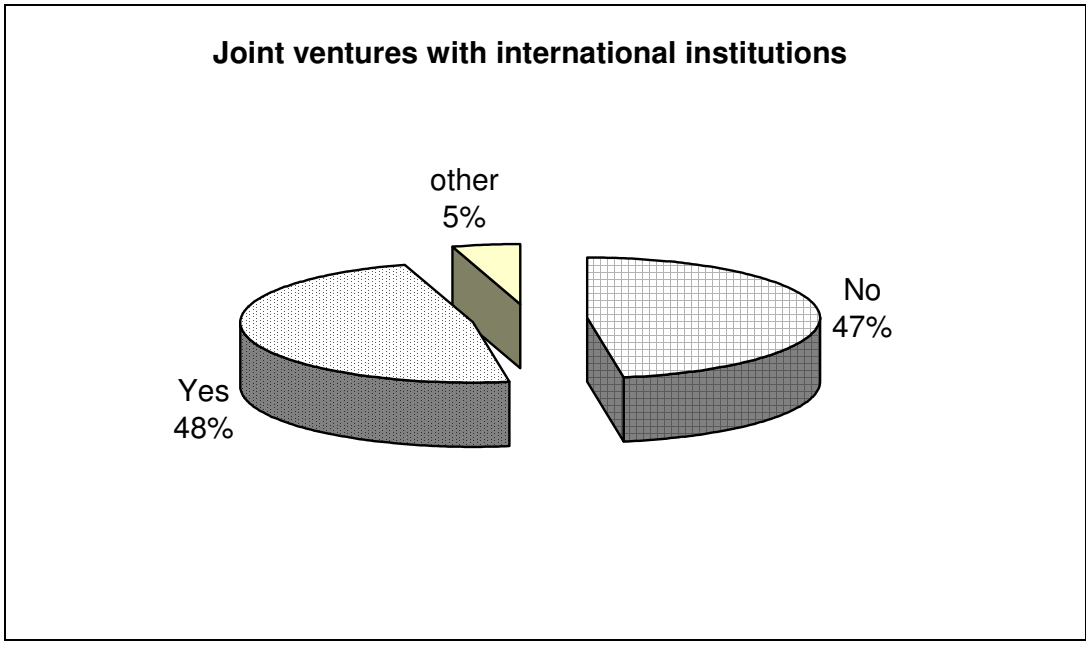

Figure (v)7 If respondents have had joint ventures with international institutions

2. Has your firm been involved in any form of collaboration with other local firms/institutions/organisations?

Majority of respondents agreed (YES 90%) to have been involved in collaboration activities with local institutions. 5% ('*Other*') did not respond, whereas 5% (NO) denied having had any collaborative activities.

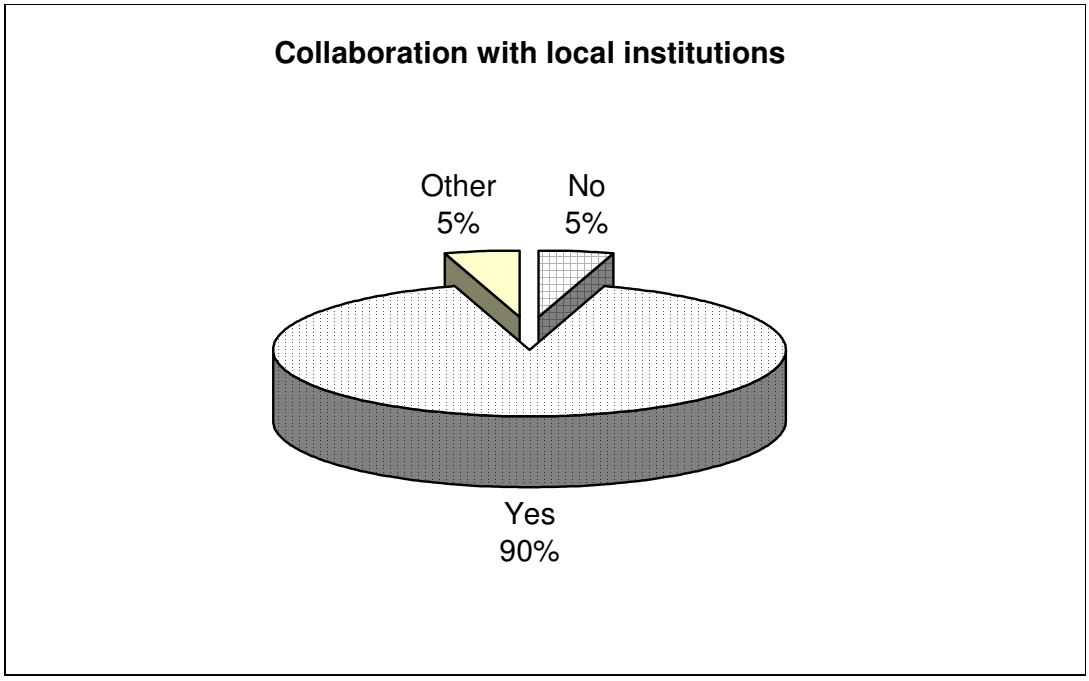

Figure (v)8 If respondents collaborate with local institutions

3. Is your firm subcontracting some of its work to firms/institutions/organisations outside your country?

About 66% (YES) of the respondents indicated that they subcontract some of their work to institutions outside their country. 29% (NO) responded that they do not subcontract to institutions outside their country, with only 5% (‘*Other*’) not responding.

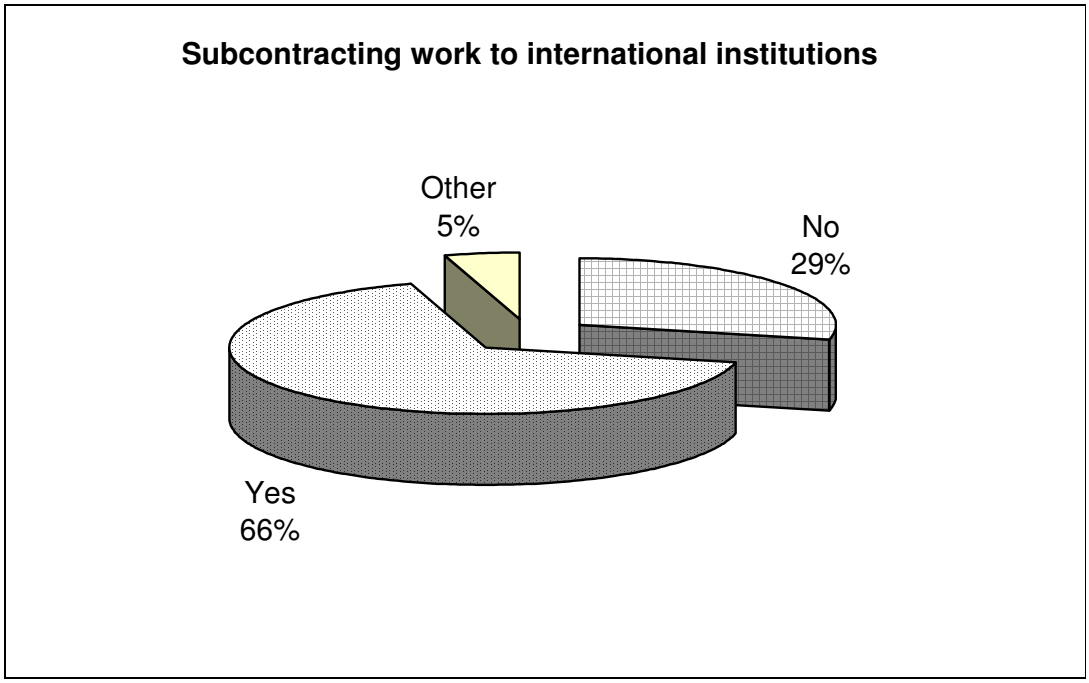

Figure (v)9 If respondents subcontract work to institutions outside their country

The respondents that agreed to be subcontracting work to institutions outside their country have further responded as follows with regard to percentage contribution by such work to the sales of their institution:

23% stated that the contribution of such work to their sales is 40%.

5% stated that the contribution of such work to their sales is 50%.

Another 5% stated that the contribution of such work to their sales is 0%.

About 66% of the respondents did not state the percentage contribution of such work to their sales.

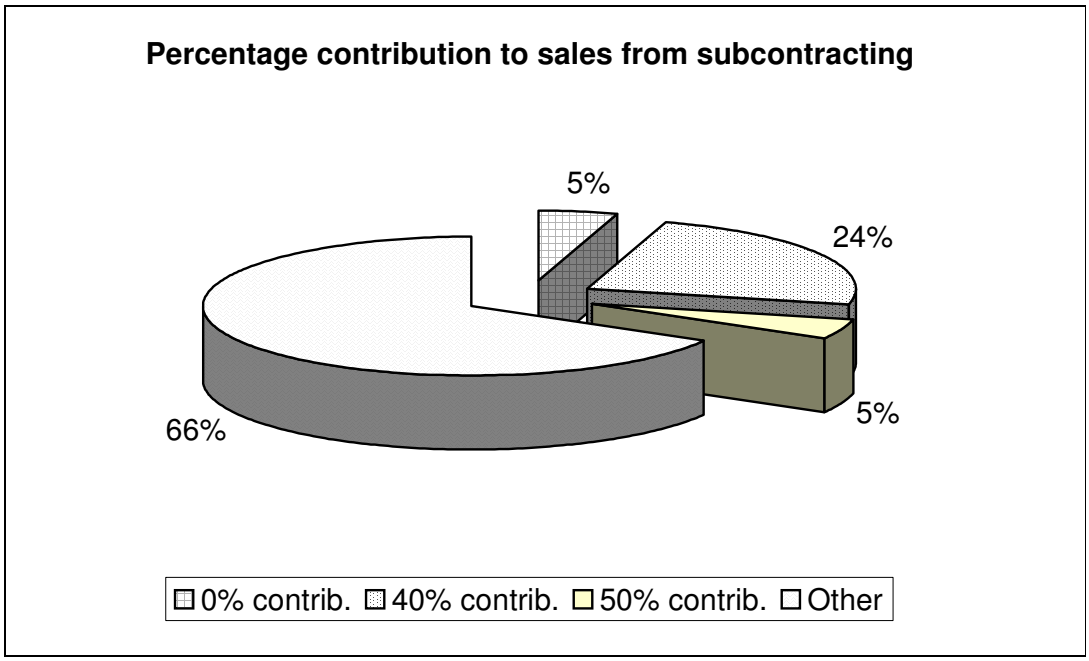

Figure (v)10 The percentage contribution to sales from subcontracting

4. Has your firm/institution/organisation been involved in aircraft projects for an international contractor?

66% (YES) of the respondents indicated that they have been involved in aircraft projects for an international contractor. 29% indicated that they have not been involved (NO), with only 5% ('*Other*') not responding to the question.

Figure (v)11 If respondents have been involved in projects for an international contractor

Those that agreed to have been involved have further responded as follows with regard to the percentage contribution of such work to the sales of their institutions:

29% stated that the contribution of such work to their sales is 20%.

14% stated that the contribution of such work to their sales is 1%.

5% stated that the contribution of such work to their sales is 0%.

About 52% of the respondents did not state the percentage contribution of such work to their sales.

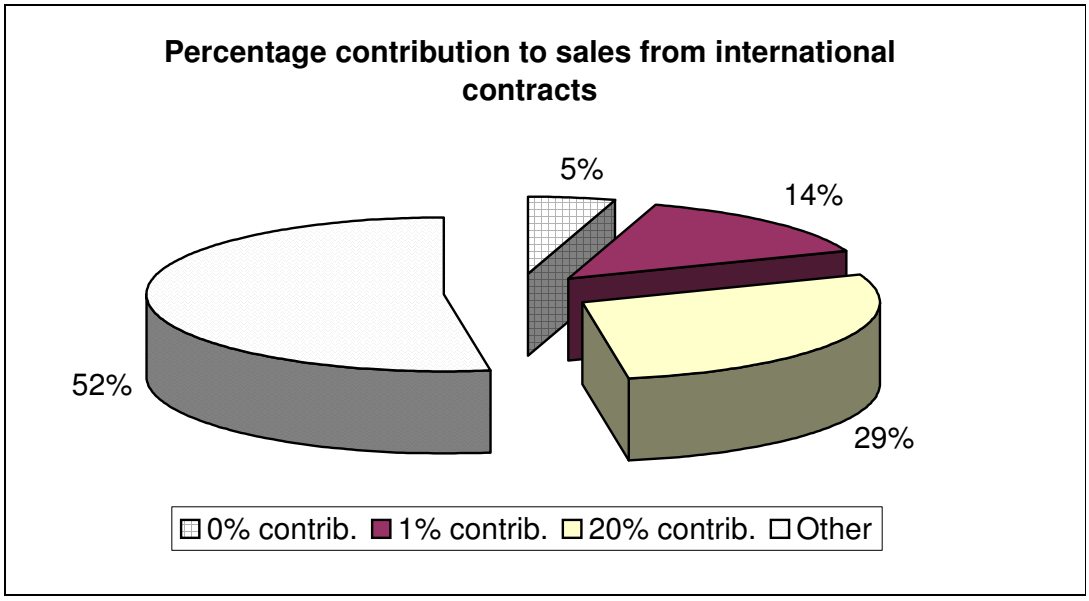

Figure (v)12 The percentage contribution to sales from international contracts

5. Has your firm/institution/organisation been involved in any form of technological innovation or improvement within the aircraft industry?

95% of the respondents agreed that they have been involved in some form of technological innovation or improvement within the aircraft industry. 5% did not respond to the question.

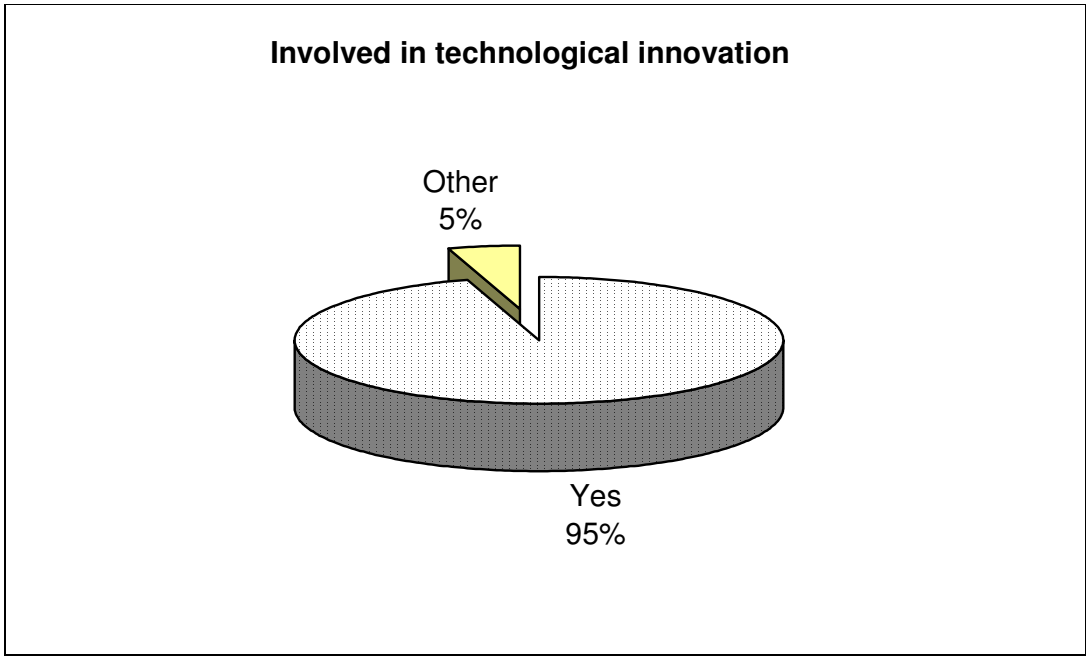

Figure (v)13 The level of involvement by respondents in technological innovation

6. Did your firm/institution/organisation acquire some business contracts through government assistance in the past, where without their involvement it might have been difficult if not impossible to attain such business?

52% of the respondents indicated that they have acquired some business contracts through the assistance of government. 43% indicated that they never acquired business contracts through the intervention of government. 5% did not respond to the question.

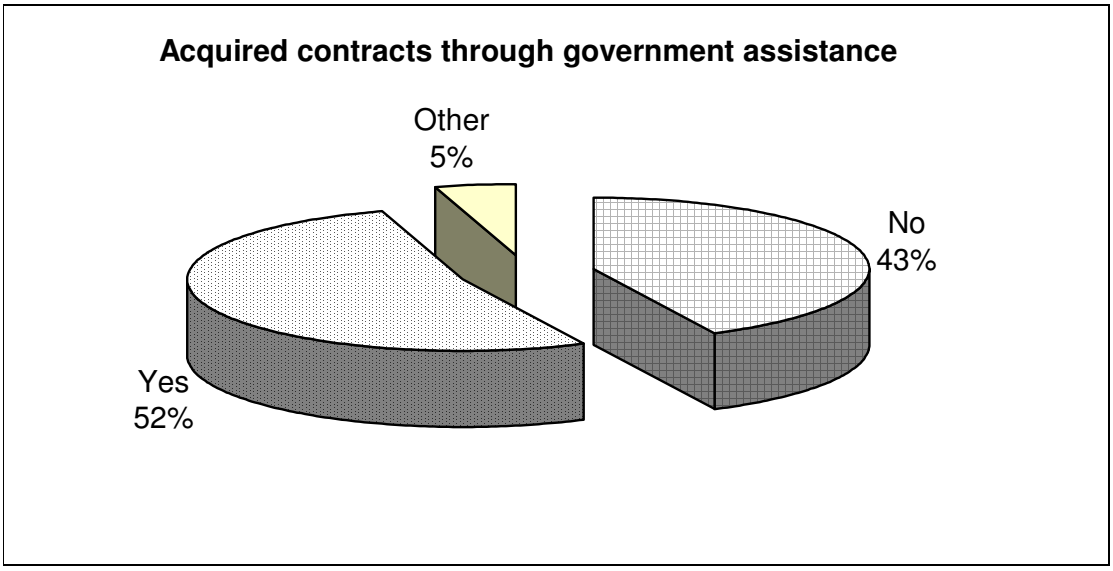

Figure (v)14 If respondents acquired contracts through government assistance

7. Has your firm/institution/organisation been involved in any form of aircraft-related technology transfer with global firms/institutions?

48% (YES) indicated that they have been involved in aircraft-related technology transfer with global institutions, whereas 47% (NO) said they have not been involved. 5% ('*Other*') did not respond to the question.

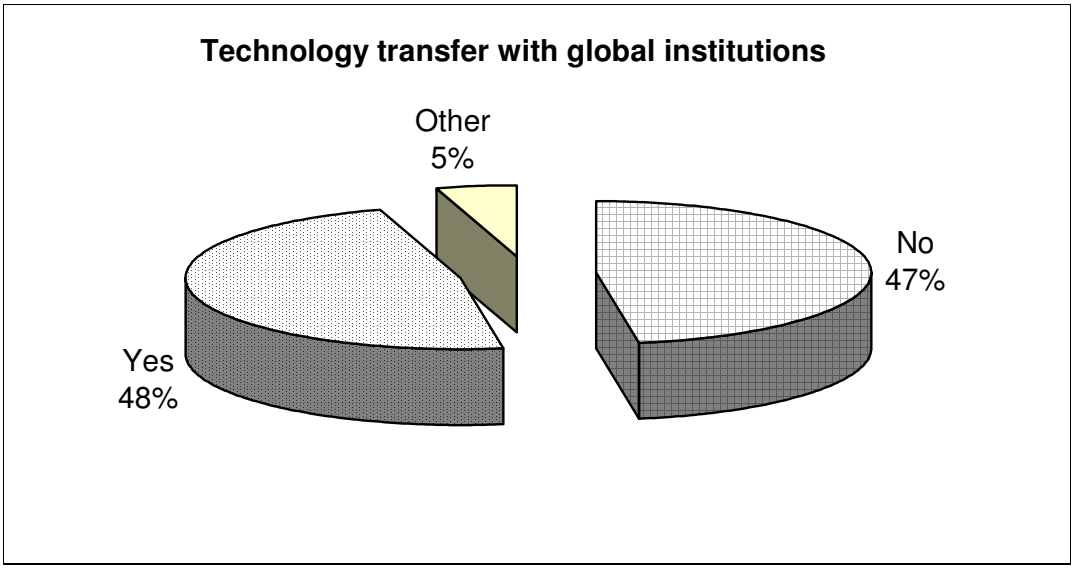

Figure (v)15 Respondents' involvement in technology transfer with global institutions

If yes, please state the country where technology is transferred from and the area of application of such technology.
Brazil did not indicate their source countries for technology transfer. However, it is more likely that it was from US, looking at the volumes of technology business interaction between the two countries.
Korea indicated US and Europe (area of application being on aircraft design & system integration).
France indicated China and Europe (area of application not indicated).

8. In what area of the aircraft industry structure is your firm/institution making a major contribution?

On average respondents indicated that they make a major contribution on **second tier** level (Major sub-system supply) of the aircraft industry structure, where the score was **67%**. The second highest score (**62%**) was for both **first tier** and **fourth tier**, where respondents also indicated that they make a major contribution in those aspects. **Third tier** followed with a **48%** score, the last being **fifth tier** with an indication of **5%** major contribution. The findings are illustrated on figure (v)16.

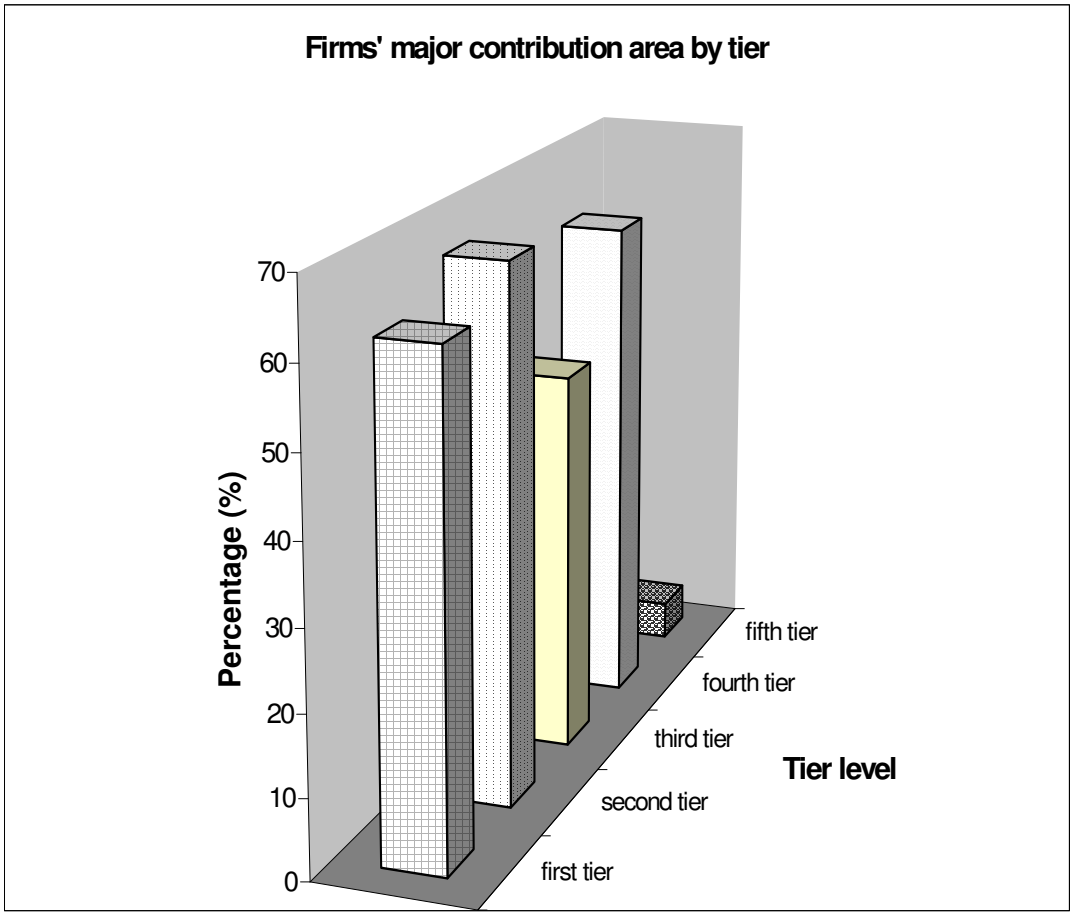

Figure (v)16 Firms' major contribution on various tiers of the aircraft industry structure

Part II looked at the trends on the factors and interventions believed to be key in building technological competencies within the aircraft industry. Data would be compared to that gathered from local respondents so as to establish the existence of a pattern on the technological capability building paths followed by various countries.

For **Part II**, responses were received on the questions as follows:

9. It is the role of government to promote national technological competence through interventions such as these.

Responses were received on the following list of interventions:

A. Support R&D programmes

B. Support infrastructure development

C. Stimulate local and international partnerships

D. Provide safety and regulatory environment guidelines

E. Oversee establishment of enabling or governing structures

F. Support skills development

Intervention **A** (*Support R&D programmes*) had the highest score of **86%** on *Strongly agree*, indicating that government should use such intervention as a tool to promote national technological competence within the aircraft industry. The graphical representation of the results is shown on figure (v)17.

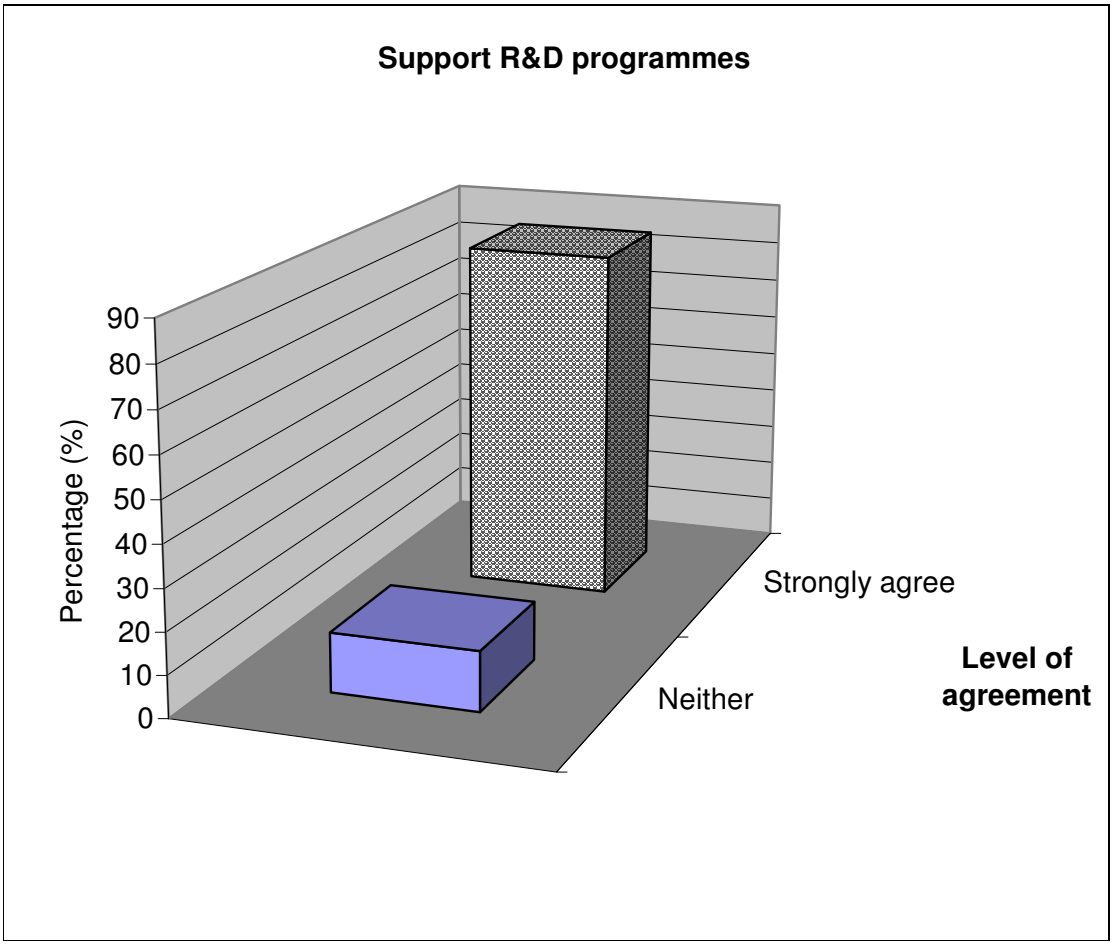

Figure (v)17 The level of agreement by respondents on the intervention to "Support R&D programmes"

Intervention **B** (*Support infrastructure development*) had the second highest score of **67%** on *Strongly agree*. The graphical representation of the results is shown on figure (v)18.

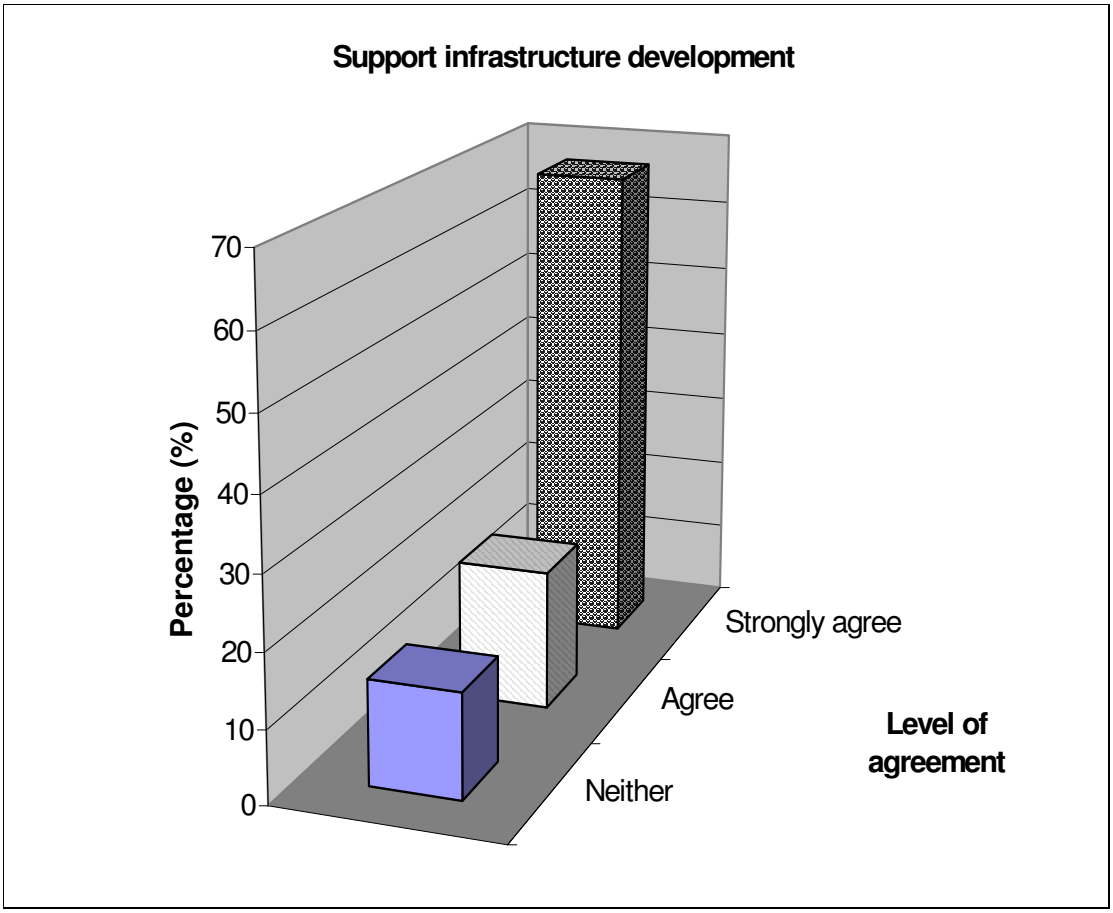

Figure (v)18 The level of agreement by respondents on the intervention to "Support infrastructure development"

Intervention **F** (*Support skills development*) obtained the third highest score of **38%** on *Strongly agree*. A graphical representation of the results is illustrated on figure (v)19.

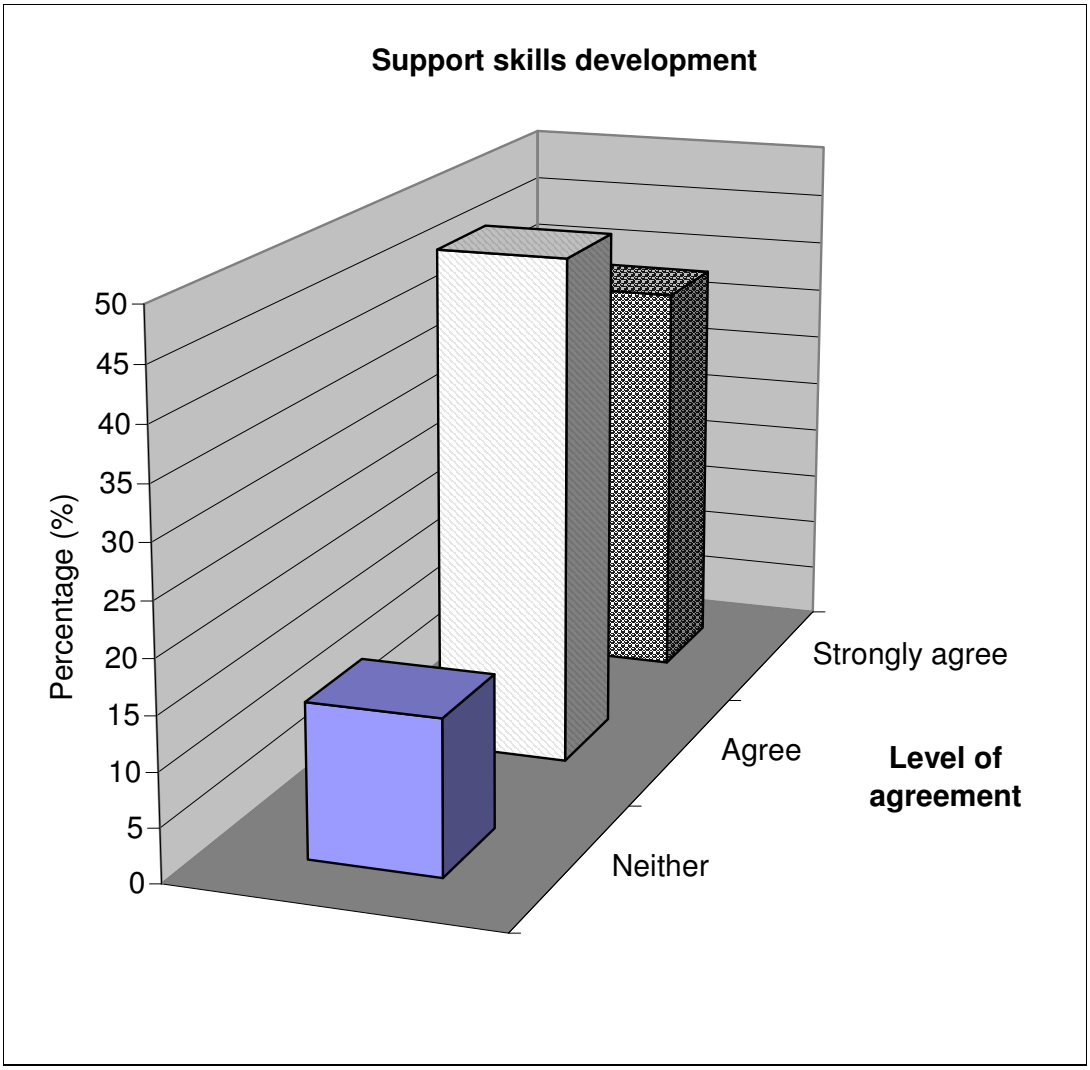

Figure (v)19 The level of agreement by respondents on the intervention to "Support skills development"

Intervention **D** (*Provide safety and regulatory environment guidelines*) followed with **33%** score on *Strongly agree*. A graphical representation of the results is illustrated on figure (v)20.

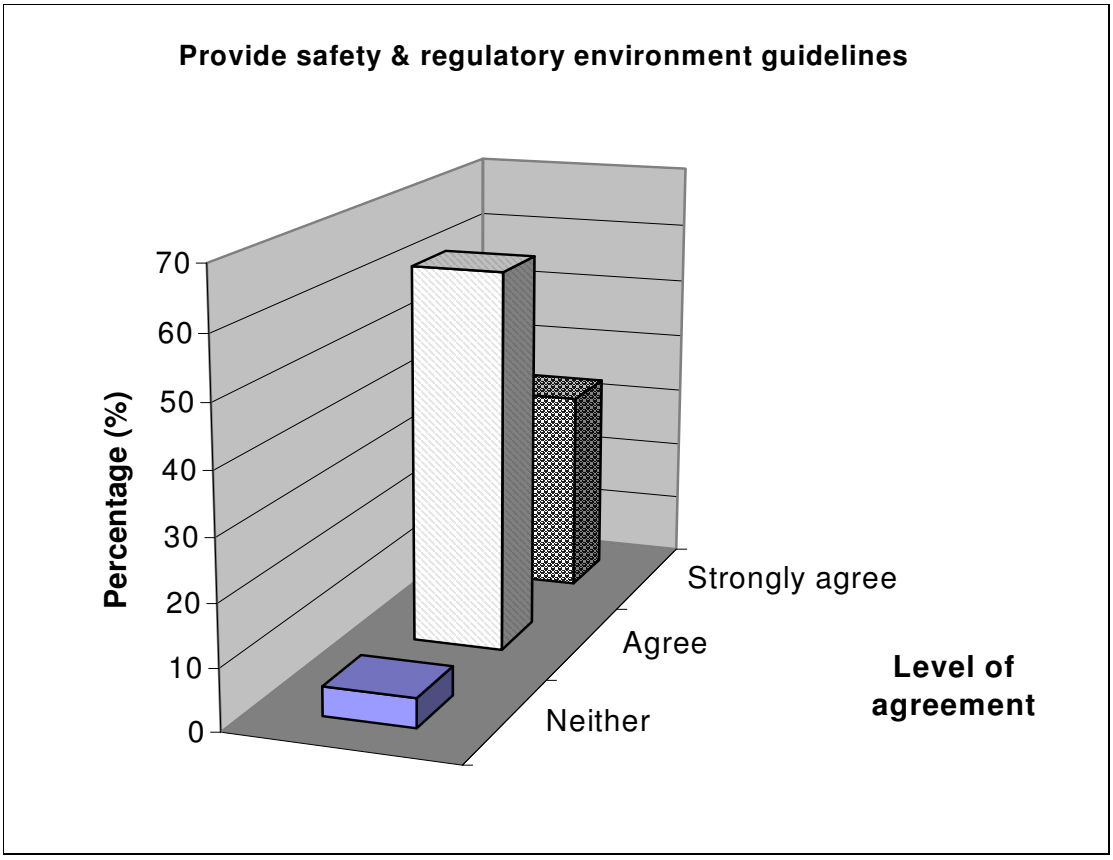

Figure (v)20 The level of agreement by respondents on the intervention to "Provide safety & regulatory environment guidelines"

Both interventions **C** (*Stimulate local and international partnerships*) and **E** (*Oversee establishment of enabling or governing structures*) followed last with a score of **14%** on *Strongly agree*, but with 81% and 62% respectively on *Agree*.

10. The following are essential interventions for successful technology capability-building or technological competitiveness within the aircraft industry. (Show the extent that you agree or disagree with the statements).

A. *Inter-firm collaboration can enhance technology capability development within aircraft firms through skills transfer, joined investment and learning from each other.*
B. *Government interventions are essential for fostering proper structures necessary for building technology competence.*
C. *Large investment on R&D could improve technology competence within firms thereby enhancing technological competitiveness of the national aircraft industry.*
D. *Technology transfer would be key towards development of technology capabilities, improved innovation and competitiveness of aircraft industry.*
E. *Firms should form joint ventures or strategic alliances with global firms to have improved technology development capabilities, as well as better market accessibility.*
F. *Government should collaborate with governments from other countries on major projects so as improve technology competence and global market access for aircraft firms.*
G. *Collaborative efforts from academia, research institutions, firms and government are essential for enhancing innovation and technology development within the aircraft industry.*
H. *User-producer kind of linkages should be maintained to foster inter-firm learning and proper understanding of technology development requirements.*
I. *Government should invest in developing future engineers at all levels of training, so as to build a strong technology development skilled nation.*

Statement **G** (*Collaborative efforts from academia, research institutions, firms and government are essential for enhancing innovation and technology development within the aircraft industry*) had the highest score of **81%** on *Strongly agree*, with a further 19% on *Agree*. The graphical representation of the results is illustrated on figure (v)21.

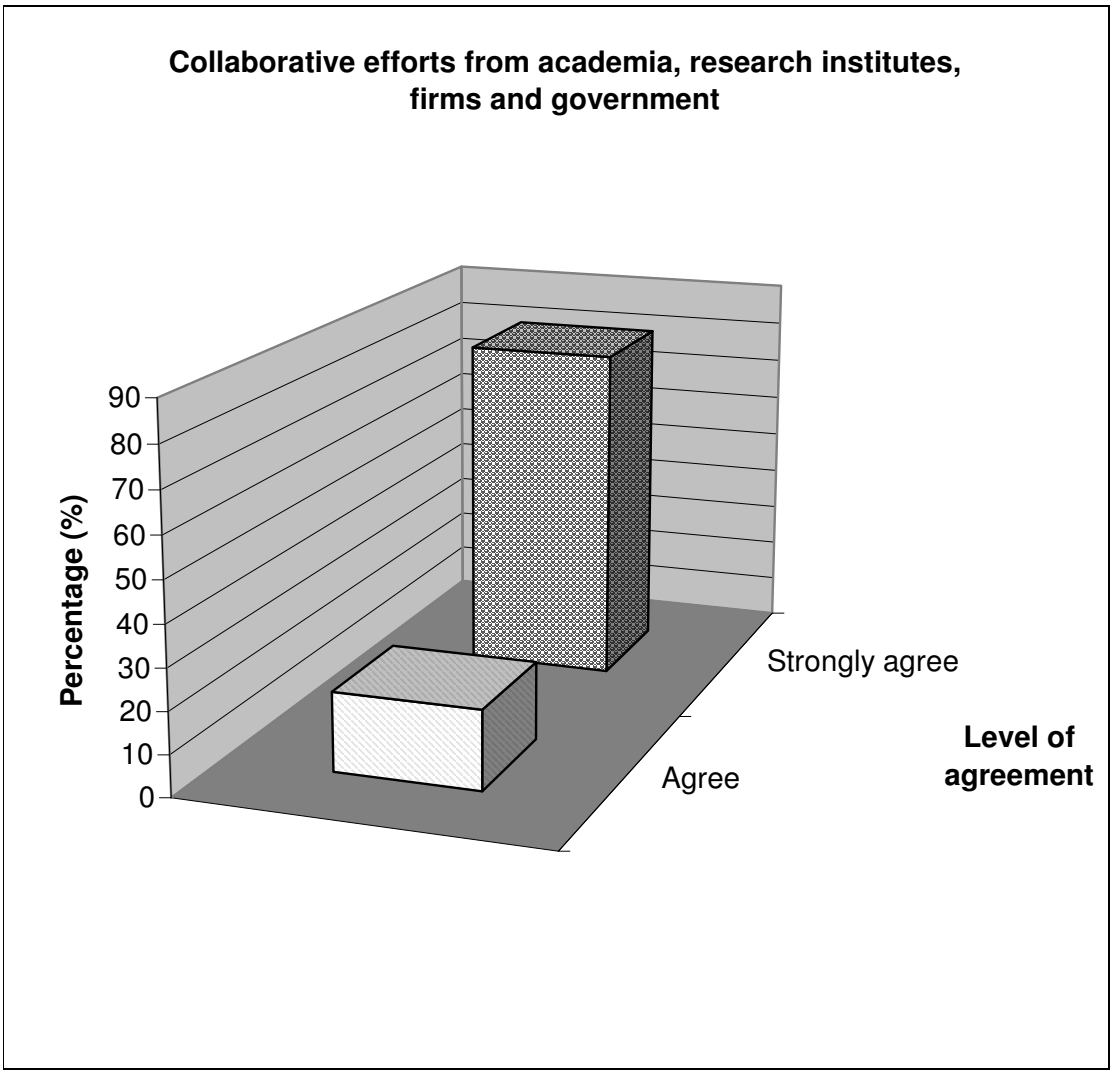

Figure (v)21 The level of agreement on Statement G

Statement **I** (*Government should invest in developing future engineers at all levels of training, so as to build a strong technology development skilled nation)* had the second highest score of **76%** on *Strongly agree*, with a further 24% on *Agree*. The graphical representation of the results is illustrated on figure (v)22.

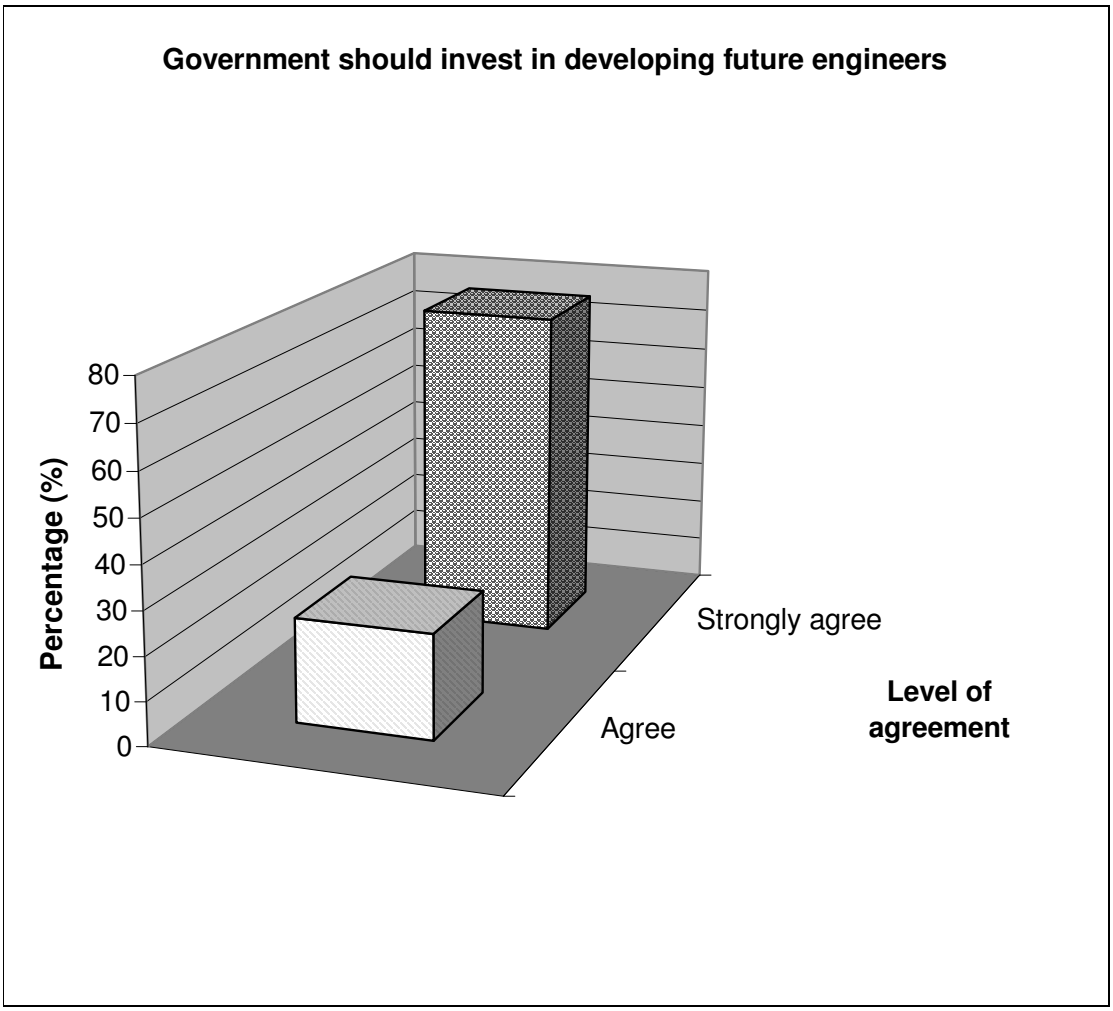

Figure (v) The level of agreement on Statement I

Statement **A** (*Inter-firm collaboration can enhance technology capability development within aircraft firms through skills transfer, joined investment and learning from each other)* had the third highest score of **67%** on *Strongly agree*, with a further 29% on *Agree*. The graphical representation of the results is illustrated on figure (v)23.

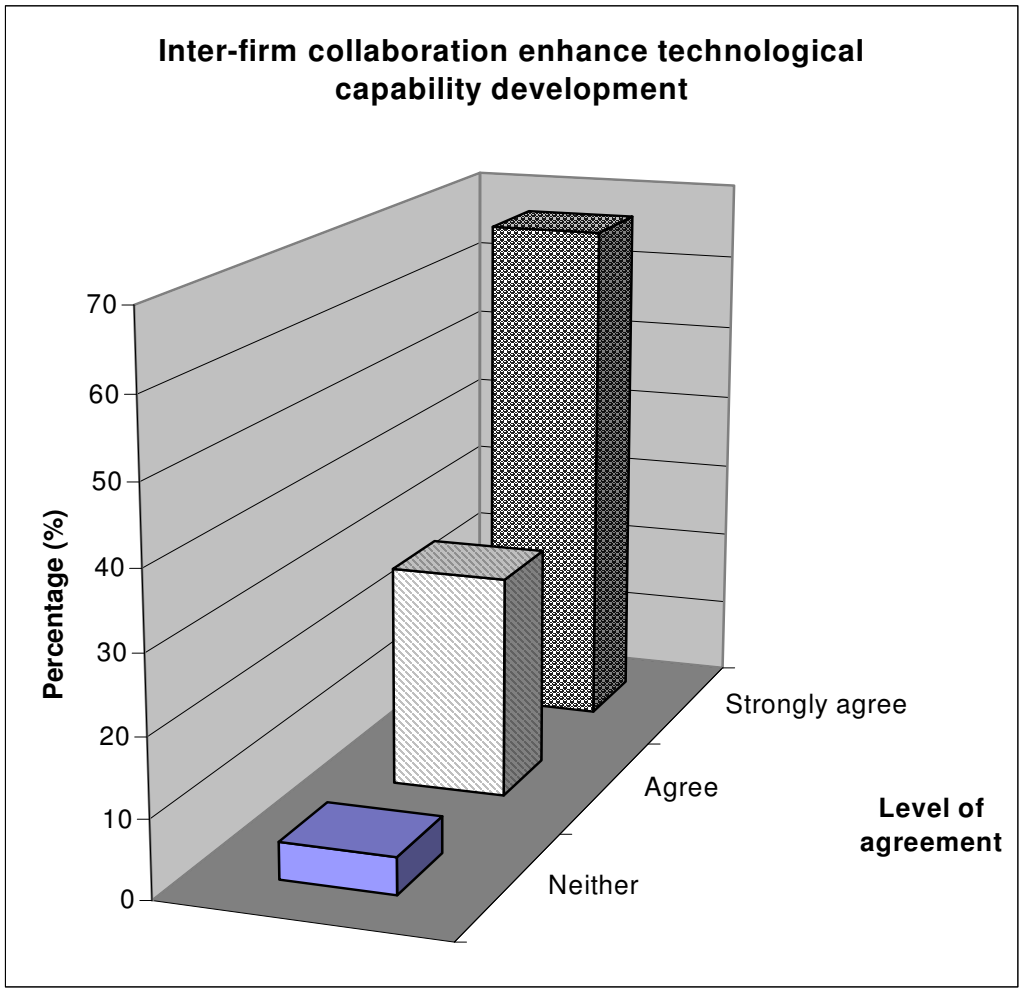

Figure (v)23 The level of agreement on Statement A

Statement **C** (*Large investment on R&D could improve technology competence within firms thereby enhancing technological competitiveness of the national aircraft industry*) followed with a score of **62%** on *Strongly agree*, with a further 38% on *Agree*. The graphical representation of the results is illustrated on figure (v)24.

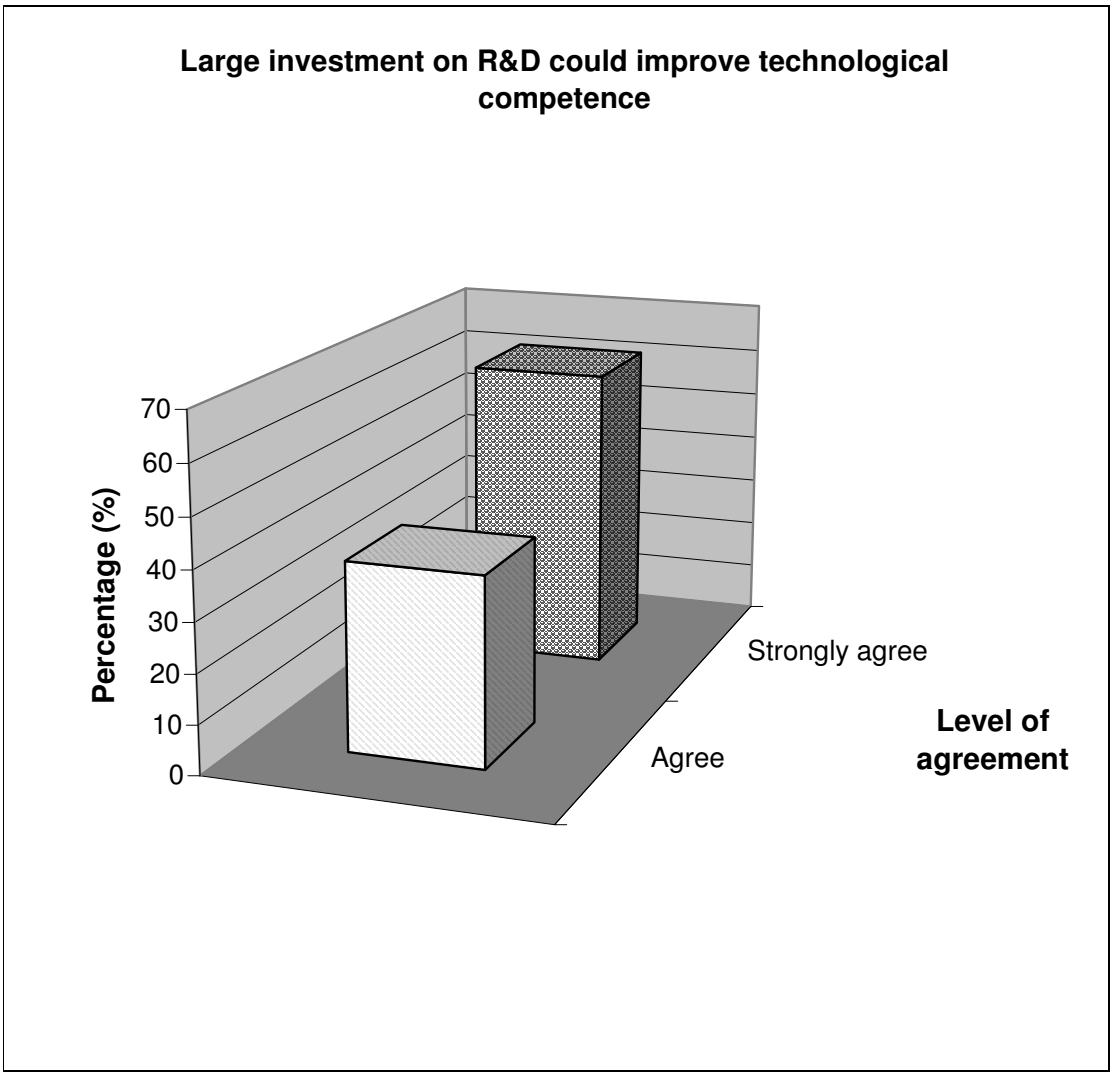

Figure (v)24 The level of agreement on Statement C

Statements **B** (*Government interventions are essential for fostering proper structures necessary for building technology competence)* and **E** (*Firms should form joint ventures or strategic alliances with global firms to have improved technology development capabilities, as well as better market accessibility)* both scored **29%** on *Strongly agree*, with a further 62% and 57% respectively on *Agree*. The graphical representations of both B and E are illustrated on figures (v)25 and (v)26 respectively.

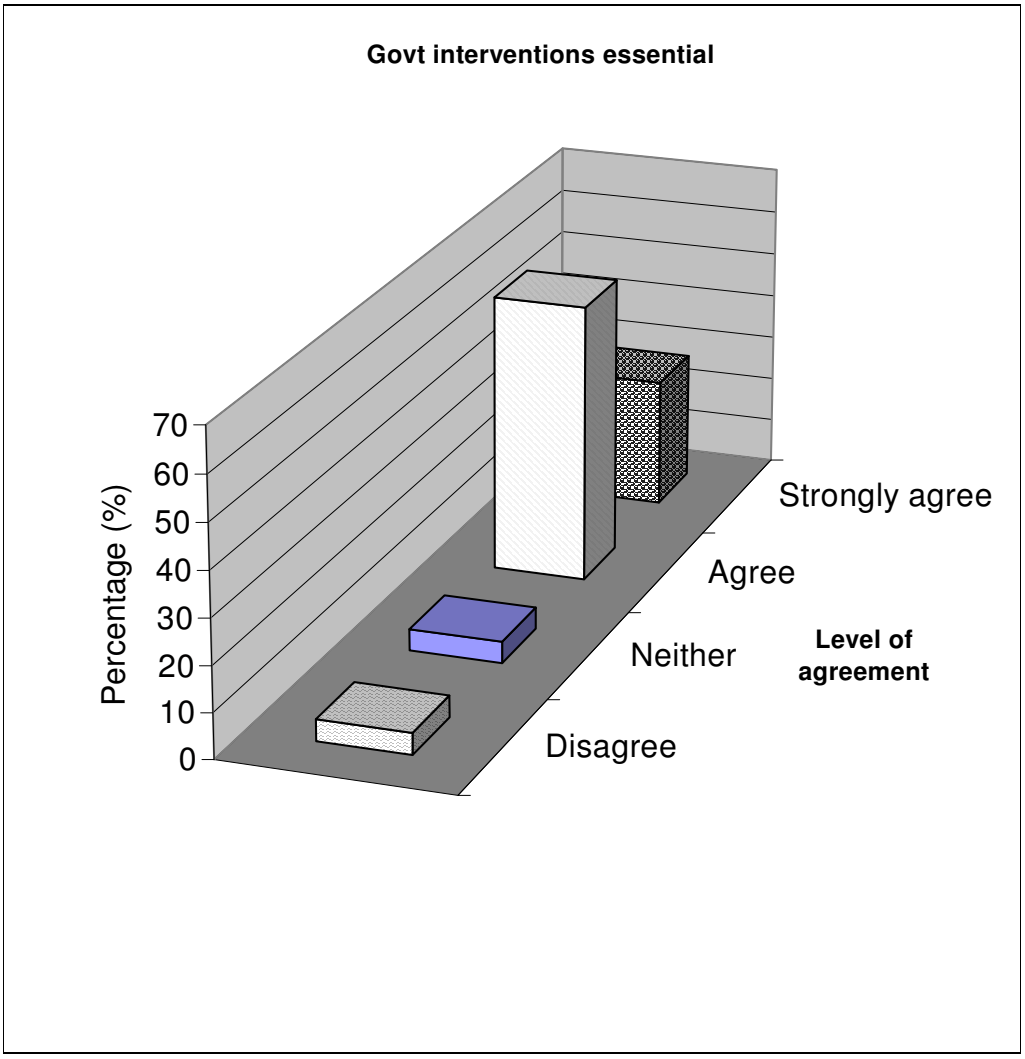

Figure (v)25 The level of agreement on Statement B

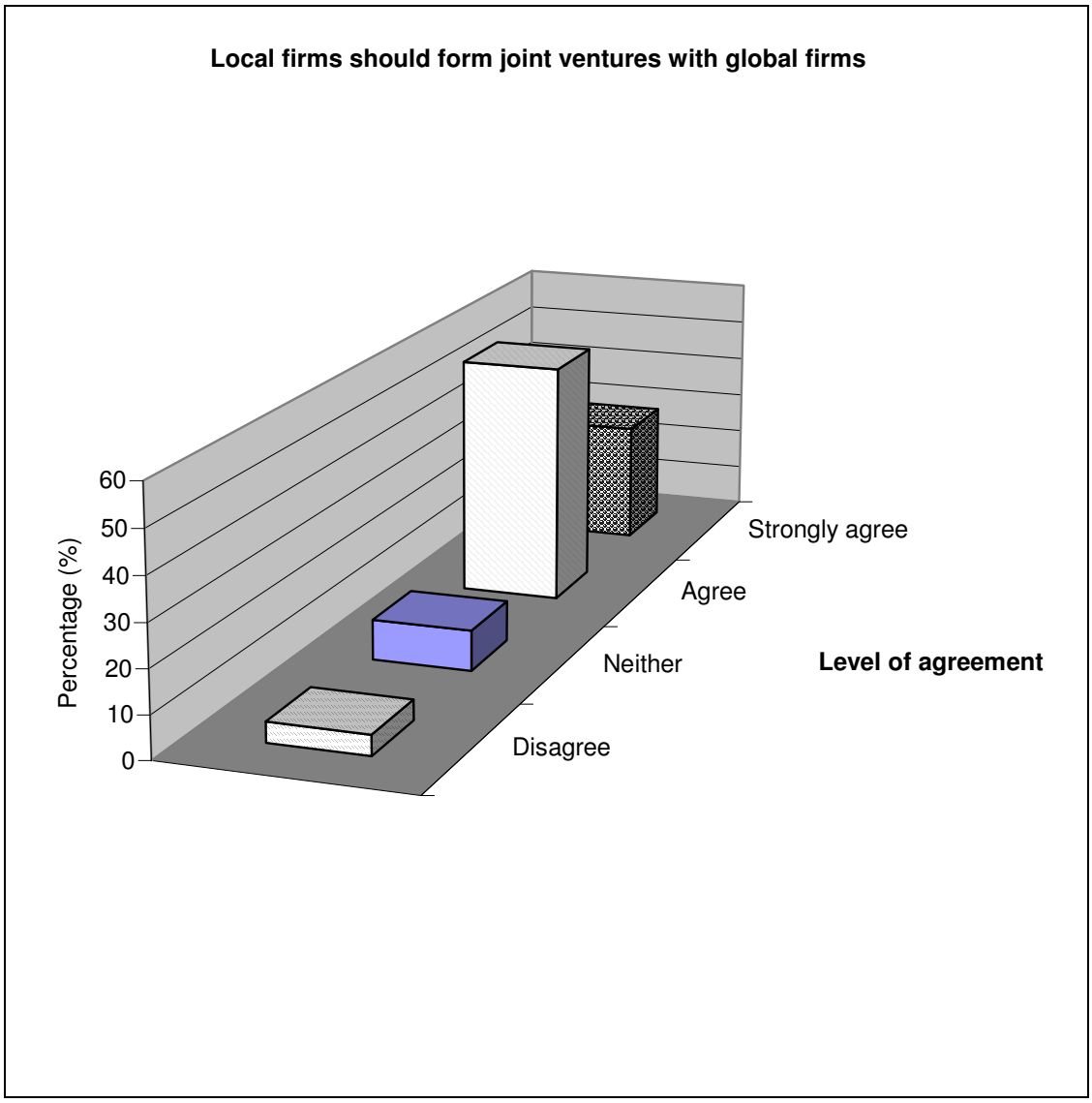

Figure (v)26 The level of agreement on Statement E

Statements H *(User-producer kind of linkages should be maintained to foster inter-firm learning and proper understanding of technology development requirements)*, F (*Government should collaborate with governments from other countries on major projects so as improve technology competence and global market access for aircraft firms)* and D (*Technology transfer would be key towards development of technology capabilities, improved innovation and competitiveness of aircraft industry)* had lower scores. Both **H** and **F** scored **24%** on *Strongly agree*, but with a further 72% and 43% respectively on *Agree*. **D** scored **14%** on *Strongly agree* and 52% on *Agree*.

11. To develop the aircraft industry towards national technological competitiveness, the following should be established:

Responses were obtained on the following list of elements:

A. Research and technology development programme

B. Firm collaboration (national)

C. Firm collaboration (international)

D. Aircraft-related research institutes

E. Government support for technological innovation

F. Market acquisition assistance

G. Research collaboration (government, research institutes, academia, firms)

H. Technology transfer

I. Skills development programme

J. Good governance structures

K. Well-supported higher education & research institutions

L. Appropriate infrastructure

Element **A** (*Research and technology development programme*) had the highest score of **95%** on *Highest priority*, indicating that this element is quite critical when developing or improving national technological competencies within the aircraft industry. The graphical representation of the results is illustrated on figure (v)27.

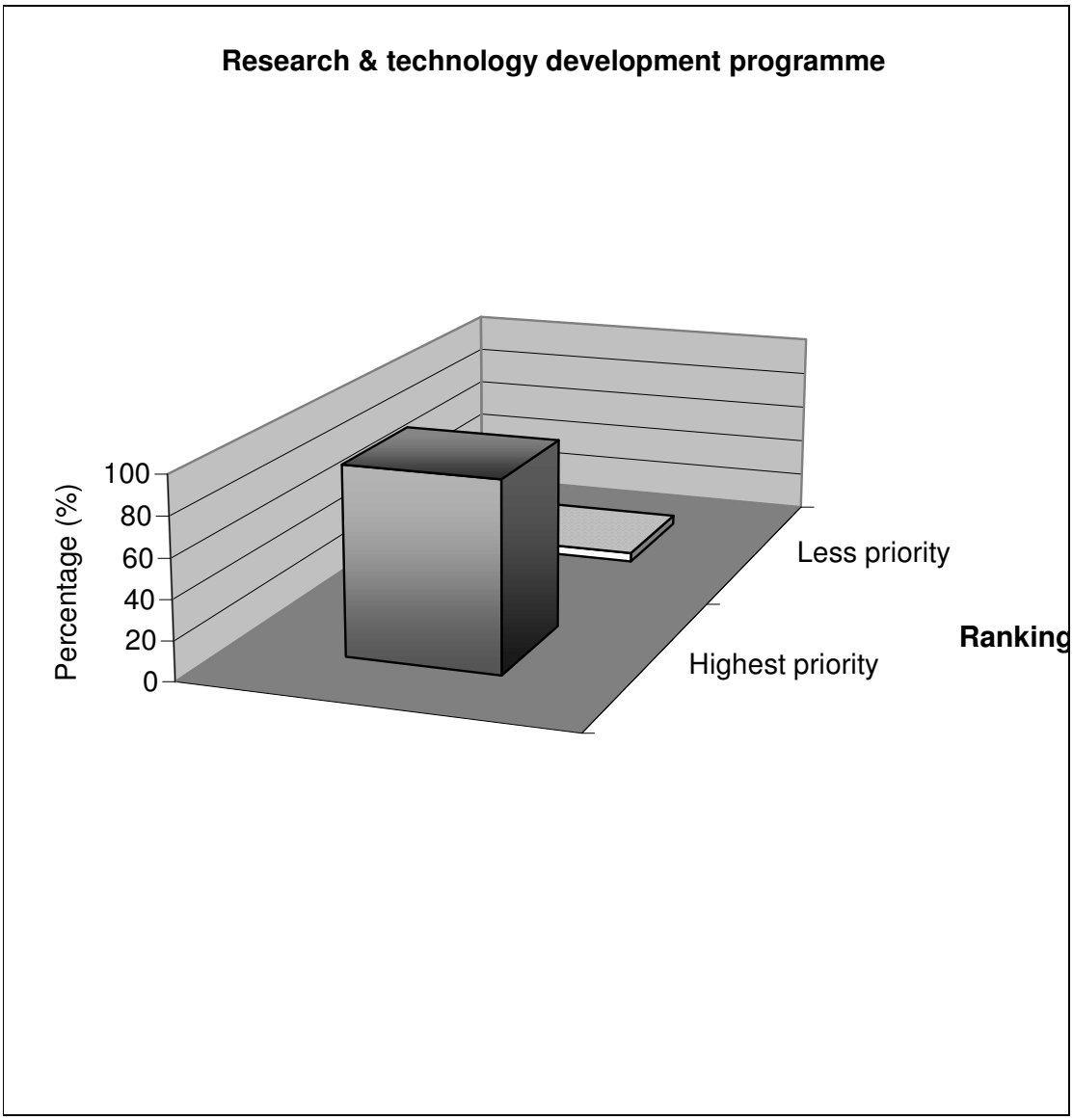

Figure (v)27 Ranking on "Research & technology development programme" as an element for developing/improving technological competence

Element **D** (*Aircraft-related research institutes*) had the second highest score of **43%** on *Highest priority*.

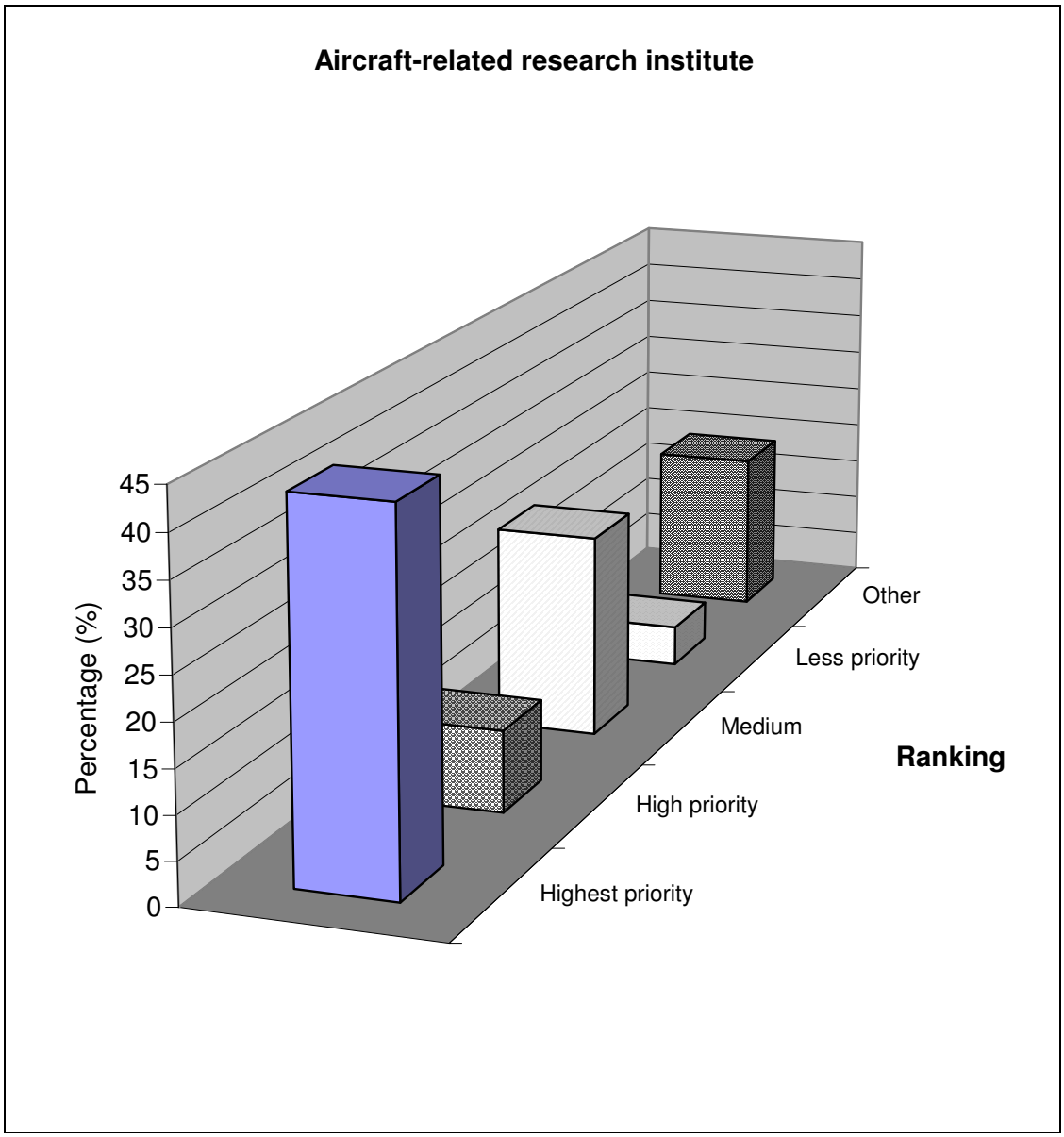

Figure (v)28 Ranking on "Aircraft-related research institute" as an element for developing/improving technological competence

Both Elements **E** (*Government support for technological innovation*) and **G** (*Research collaboration - government, research institutes, academia, firms*) had the third highest score of **38%** on *Highest priority*, with a further 29% on *High priority* in both instances. The graphical representations on the results for both (E and G) are illustrated on figures (v)29 and (v)30 respectively.

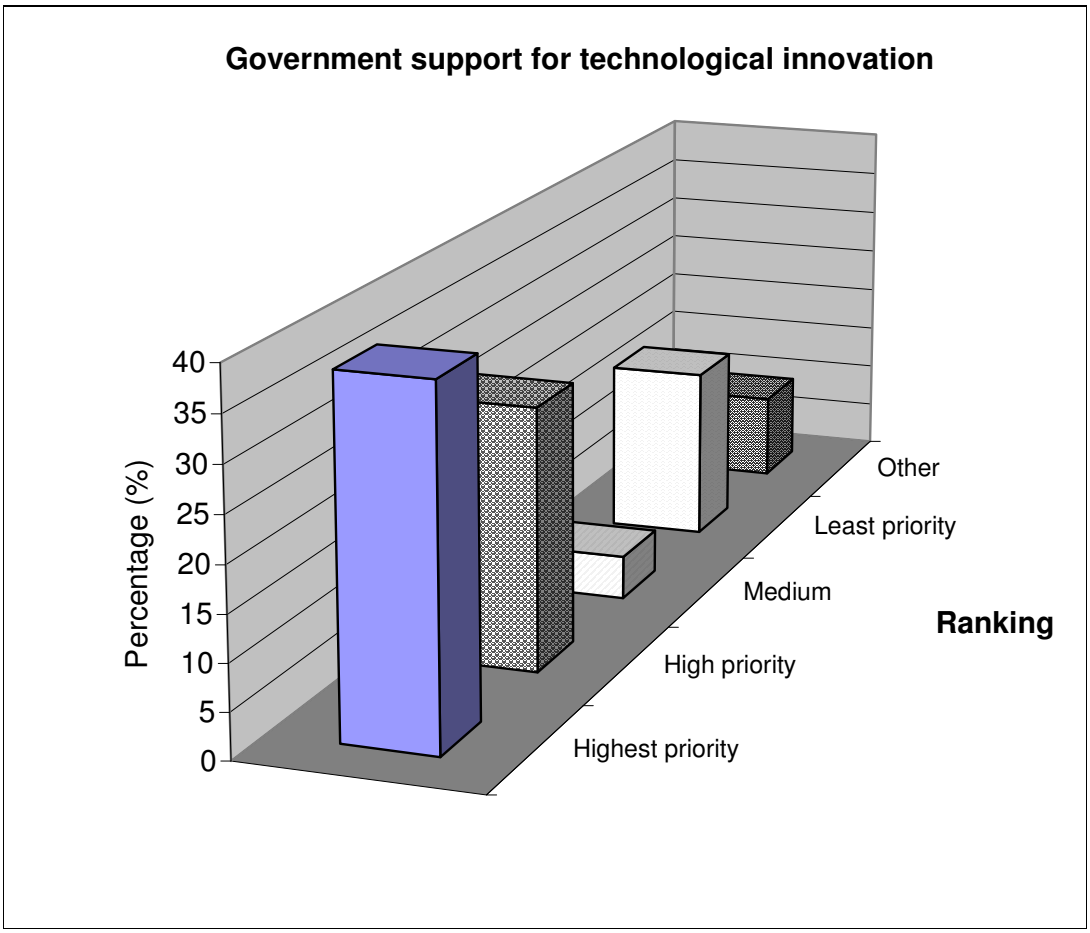

Figure (v)29 Ranking on "Government support for technological innovation" as an element for developing/improving technological competence

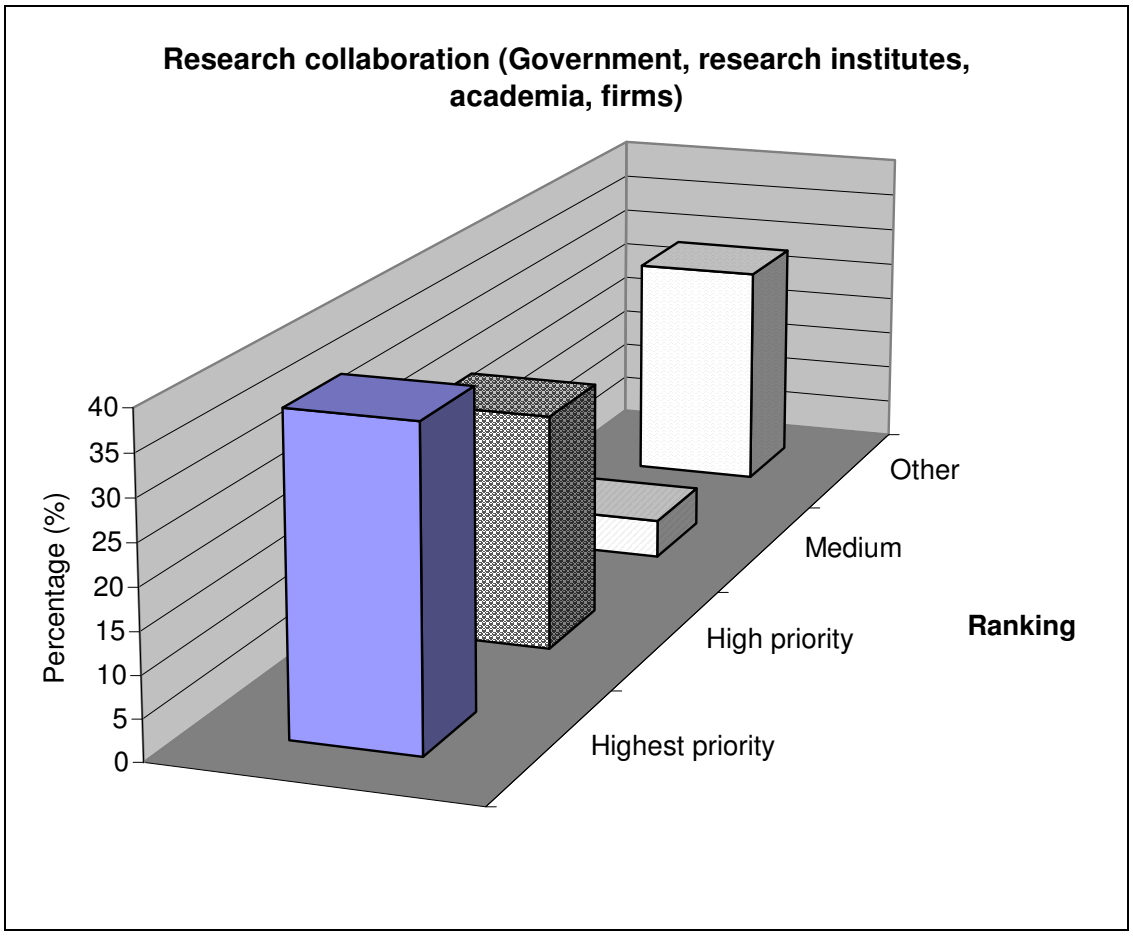

Figure (v)30 Ranking on "Research collaboration" as an element for developing/improving technological competence

Elements **L** (*Appropriate infrastructure*) and **K** (*Well-supported higher education and research institutions*) followed with a score of **33%** on *Highest priority*. Element L had a further 14% on *High priority*, with K scoring 5% on *High priority*. Graphical representations of both results are shown of figures (v)31 and (v)32 respectively.

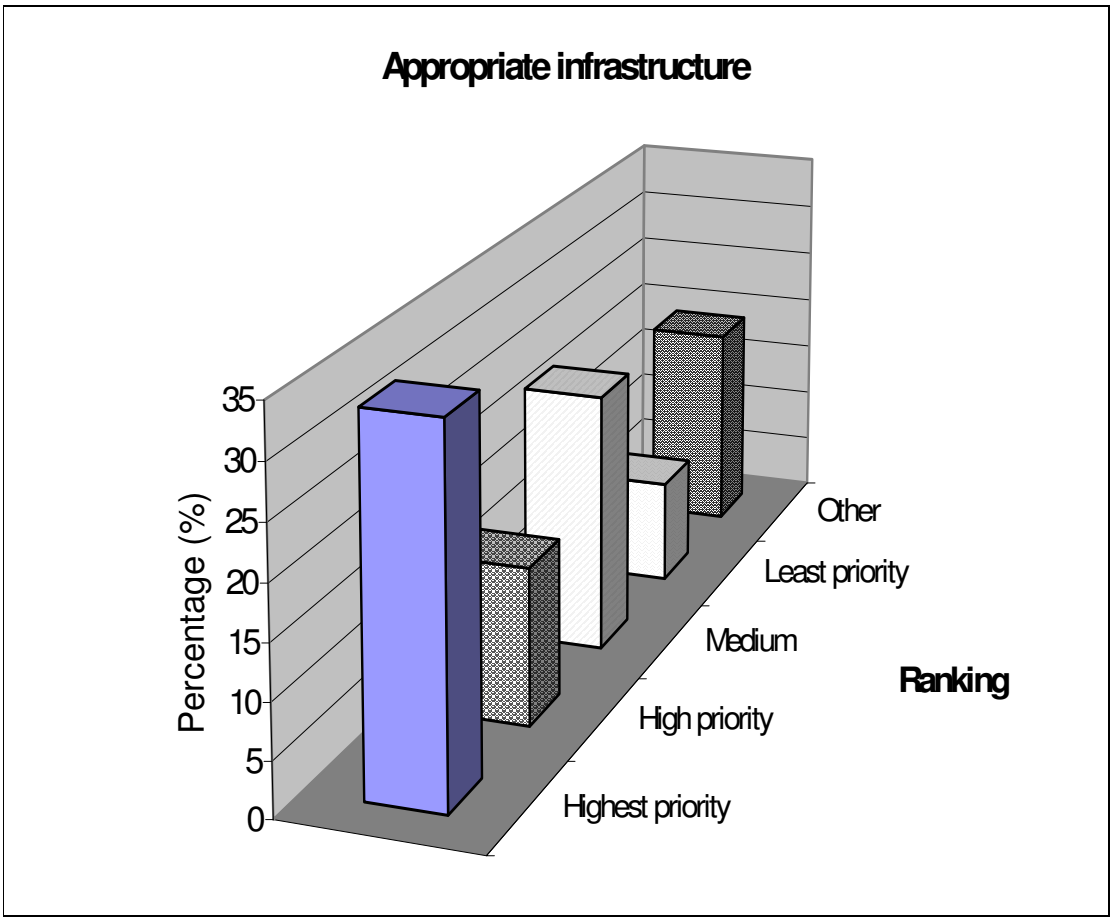

Figure (v)31 Ranking on "Appropriate infrastructure" as an element for developing/improving technological competence

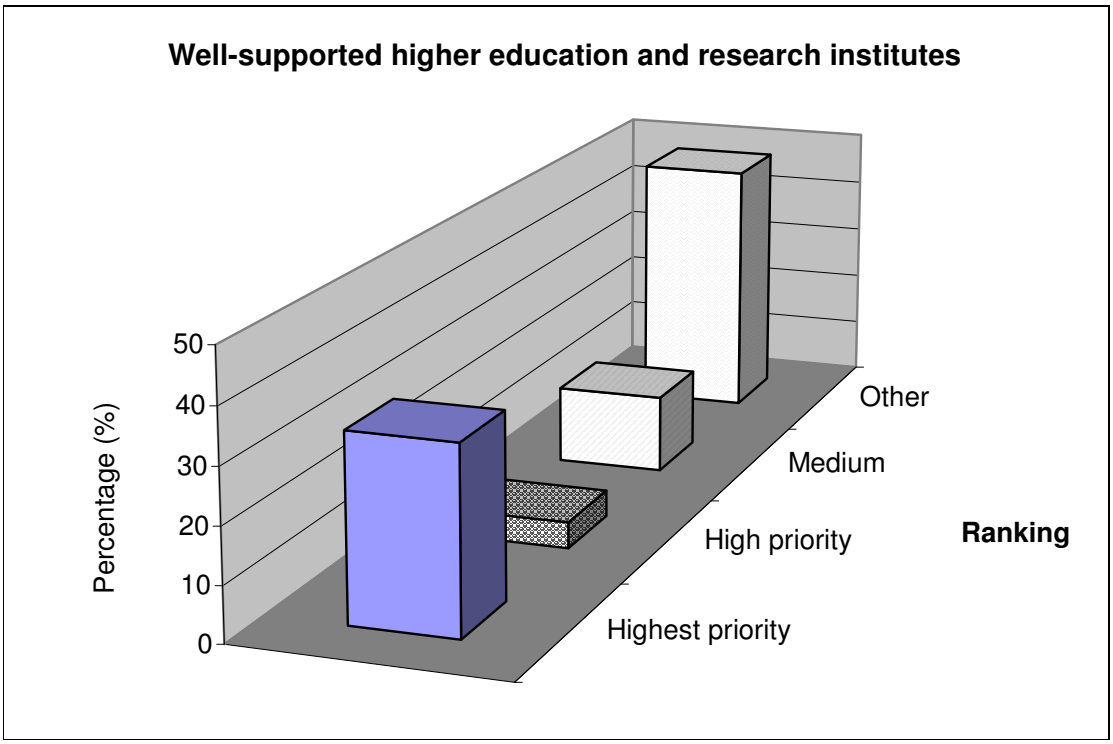

Figure (v)32 Ranking on "Well-supported higher education and research institutes" as an element for developing/improving technological competence

The other Elements that followed with a score of **10%** on *Highest priority* were **I** (*Skills development programme*), **B** (*Firm Collaboration - national*), **J** (*Good governance structures*), and **F** (*Market acquisition assistance*). Element I had a further 67% on *High priority*, B with 48% (*High priority*), J with 29% (*High priority*) and F scoring 10% (*High priority*).

Element H (*Technology transfer*) followed with only 62% on *High priority*, the last being C (*Firm collaboration - international*) with 52% (*High priority*).

12. The following are the most well known aspects that impact on the technological competitiveness of firms within the civil aircraft industry.

Responses were obtained on the following list of elements:

A. Insufficient in-house technological capability

B. Under-developed national systems of innovation

C. Lack of firm collaboration

D. Poorly developed aircraft Infrastructure

E. Insufficient skilled resources

F. Under-developed technological capabilities

G. Insufficient R&D investment

H. Insufficient skills development programme

I. Insufficient strategic alliances with global firms

J. Lack of skills transfer/knowledge transfer programme

K. Poor levels of innovation

L. Poor external environment (e.g government policy, demand, firm rivalry)

M. Poor governing structures to oversee the industry

Element **E** (*Insufficient skilled resources*) had **86%** score on *Strongly agree*, leading to the indication that the aspect has an impact on technological competitiveness of firms. The graphical representation on the results is illustrated on figure (v)33.

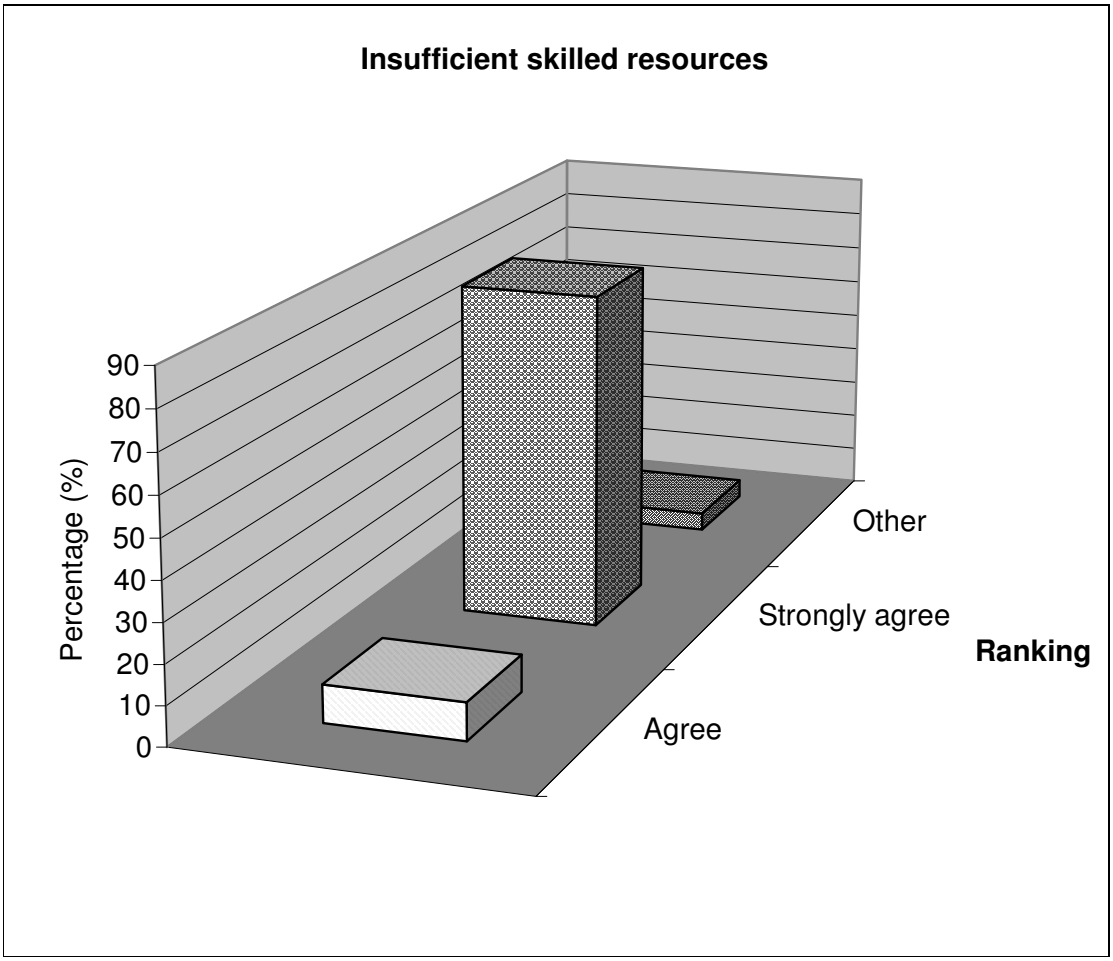

Figure (v)33 Level of agreement on "Insufficient skilled resources" as an element impacting on technological competence

Element **A** (*Insufficient in-house technology capability*) had the second highest score of **62%** on *Strongly agree*, with a further 33% on *Agree*. The graphical representation is illustrated on figure (v)34.

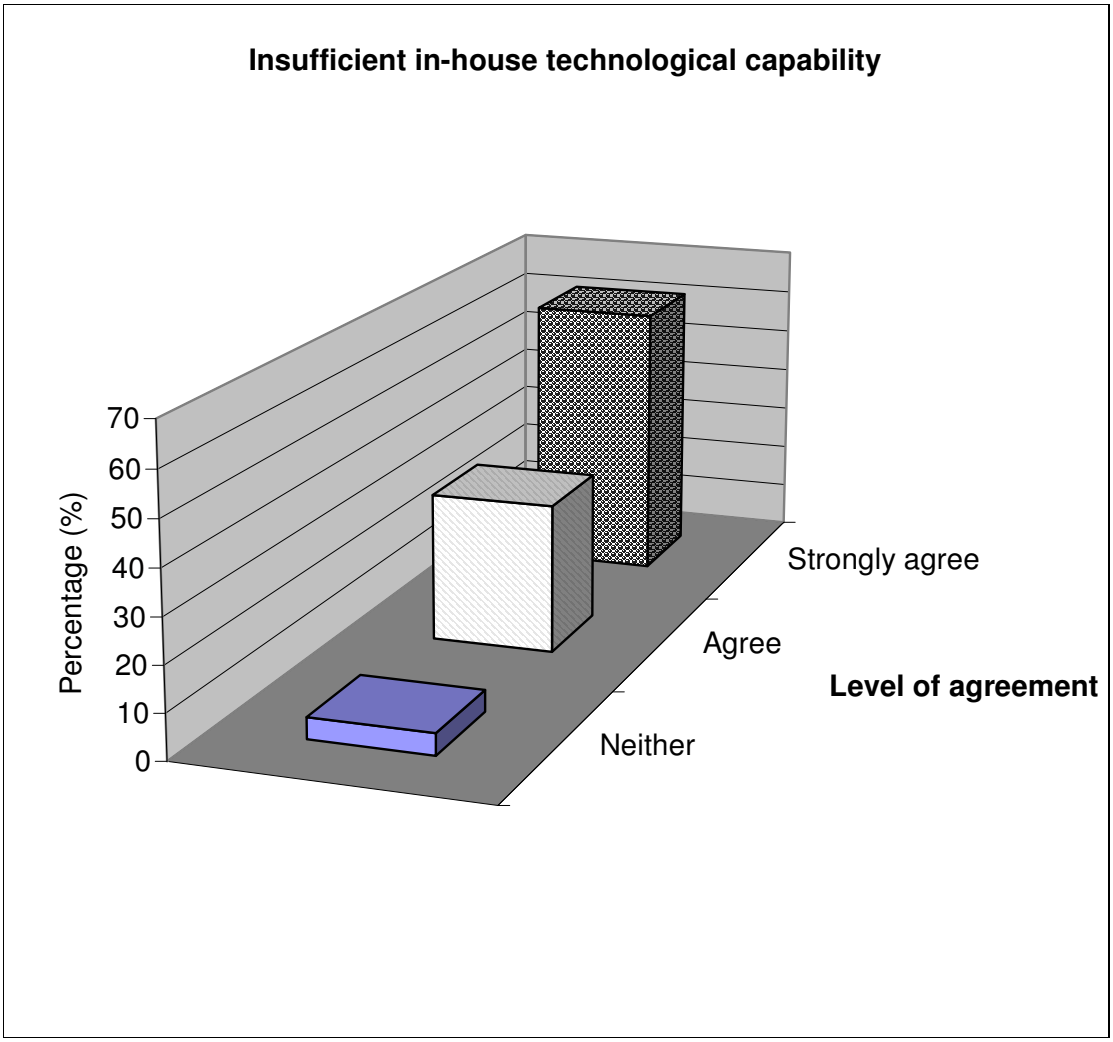

Figure (v)34 Level of agreement on "Insufficient in-house technological capability" as an element impacting on technological competence

Both Elements **F** (*Under-developed technological capabilities*) and **G** (*Insufficient R&D investment*) had the third highest score of **57%** on *Strongly agree*. They further had 38% score under *Agree* on both sides. The graphical representation of results for both elements is illustrated on figures (v)35 and (v)36 respectively.

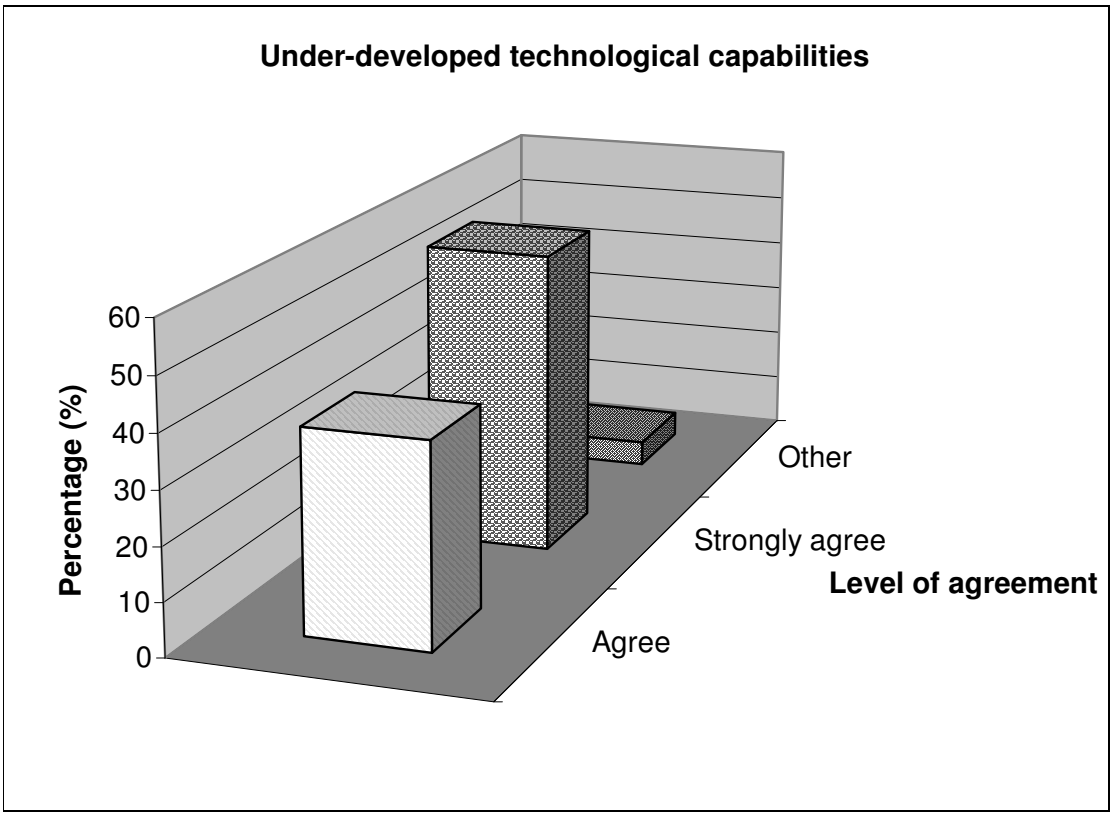

Figure (v)35 Level of agreement on "Under-developed technological capabilities" as an element impacting on technological competence

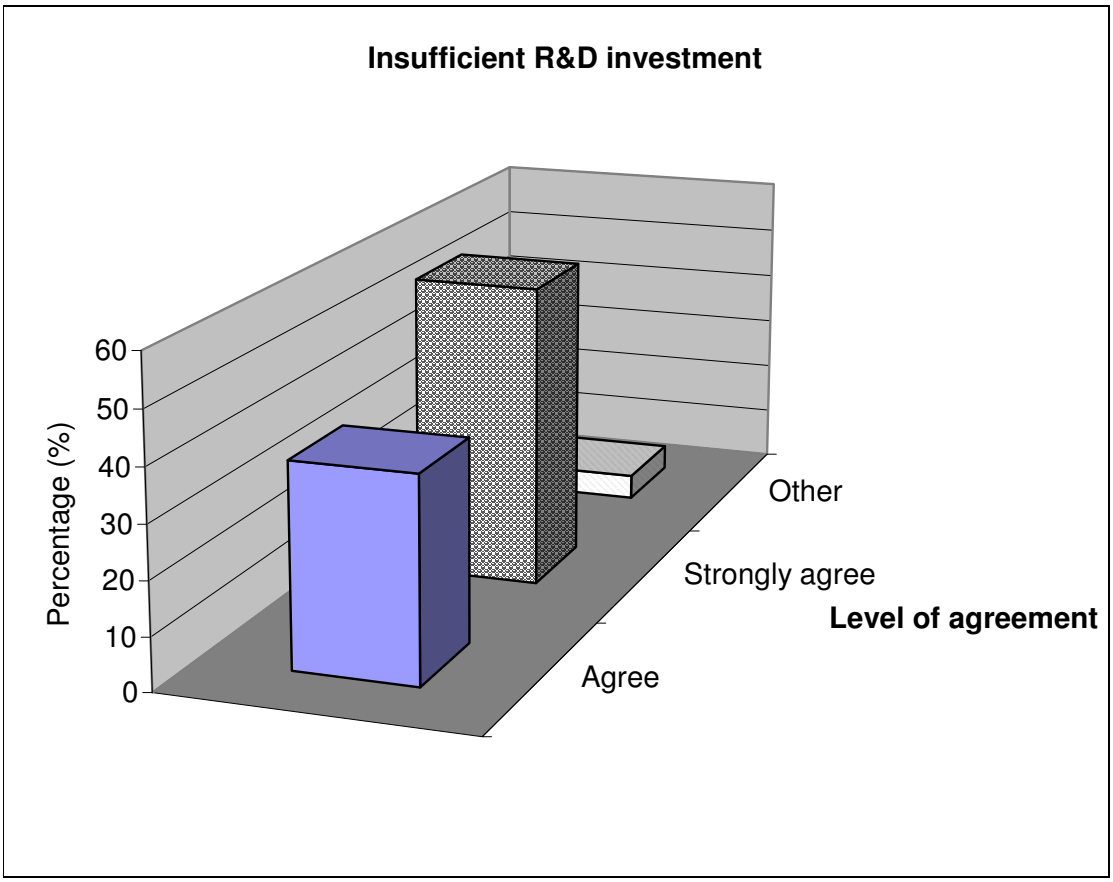

Figure (v)36 Level of agreement on "Insufficient R&D investment" as an element impacting on technological competence

Element **L** (*Poor external environment*) followed with a score of **48%** on *Strongly agree* with a further 43% on *Agree*. Figure (v)37 illustrates the results.

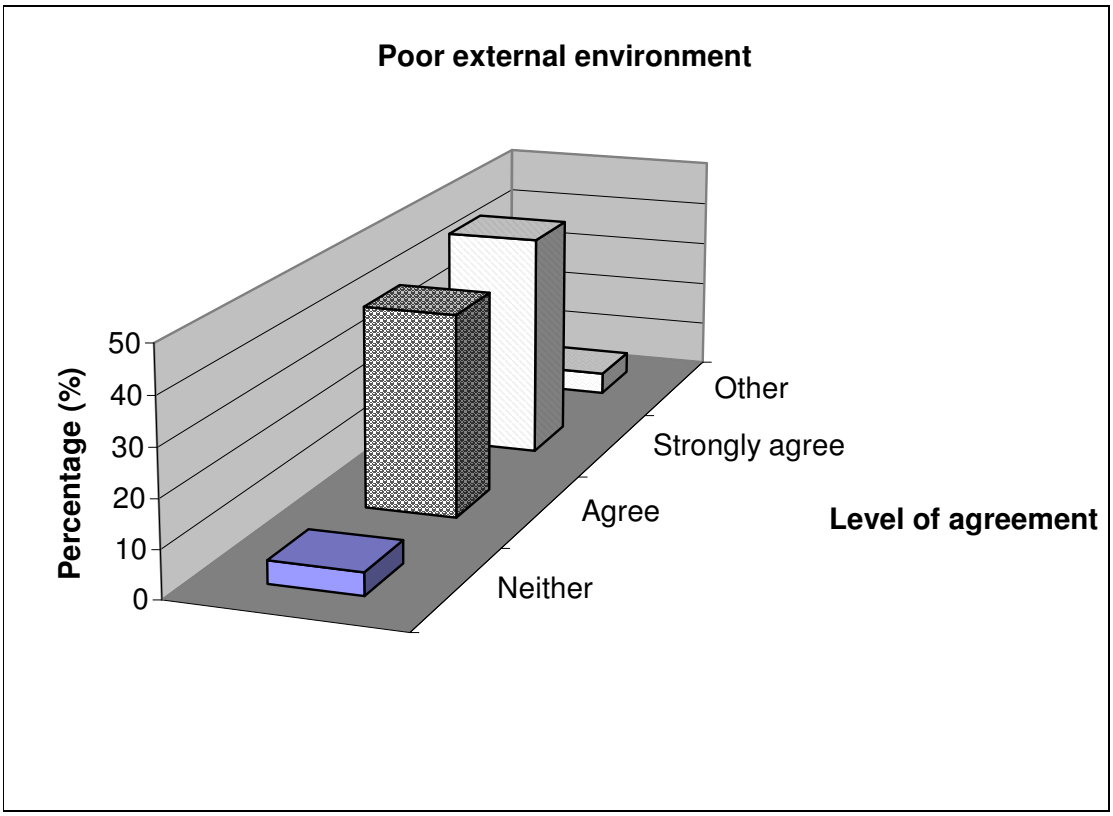

Figure (v)37 Level of agreement on "Poor external environment" as an element impacting on technological competence

Elements **H** (*Insufficient skills development programme*), **K** (*Poor levels of innovation*) and **I** (*Insufficient strategic alliances with global firms*) followed with a common score of **38%** on *Strongly agree*. However, H had a further 62% on *Agree*, whereas K had 52% (*Agree*) and I with 57% (*Agree*).

Element **B** (*Under-developed national systems of innovation*) scored **33%** on *Strongly agree*, with a further 57% on *Agree*. Both Elements **M** (*Poor governing structures to oversee the industry*) and **D** (*Poorly developed aircraft Infrastructure*) scored **29%** on *Strongly agree*, with a further 67% (*Agree*) and 43% (*Agree*) respectively. Element **J** (*Lack of skills transfer/knowledge transfer programme*) followed with **24%** on *Strongly agree* and 67% *Agree*. Element **C** (*Lack of firm collaboration*) had the least score of **10%** on *Strongly agree*, and

71% on *Agree*.

13. What form of interventions should firms do in relation to human resource development to enhance in-house technological capabilities?

Responses were received on the following list of interventions:

A. In-house skills development programme

B. Inter-firm skills exchange program (national)

C. Inter-firm skills exchange program (international)

D. Knowledge transfer during technology transfer

E. Inter-firm research collaboration (national)

F. Inter-firm research collaboration (international)

Intervention **A** (In-house skills development programme) had the highest score of **33%** on *Highest priority*. Intervention **F** (Inter-firm research collaboration – international) had the second highest score (**29%**) on *Highest priority*. Intervention **E** (Inter-firm Research collaboration – national) followed with a score of **19%** on *Highest priority*. Intervention **D** (Knowledge transfer during technology transfer) had a score of **5%** on *Highest priority*. Both interventions B (Inter-firm skills exchange program – national) and C (Inter-firm skills exchange program – international) were not scored for *Highest priority*, but had 33% and 19% respectively on *High priority*. The graphical representation of the findings is illustrated on figure (v)38.

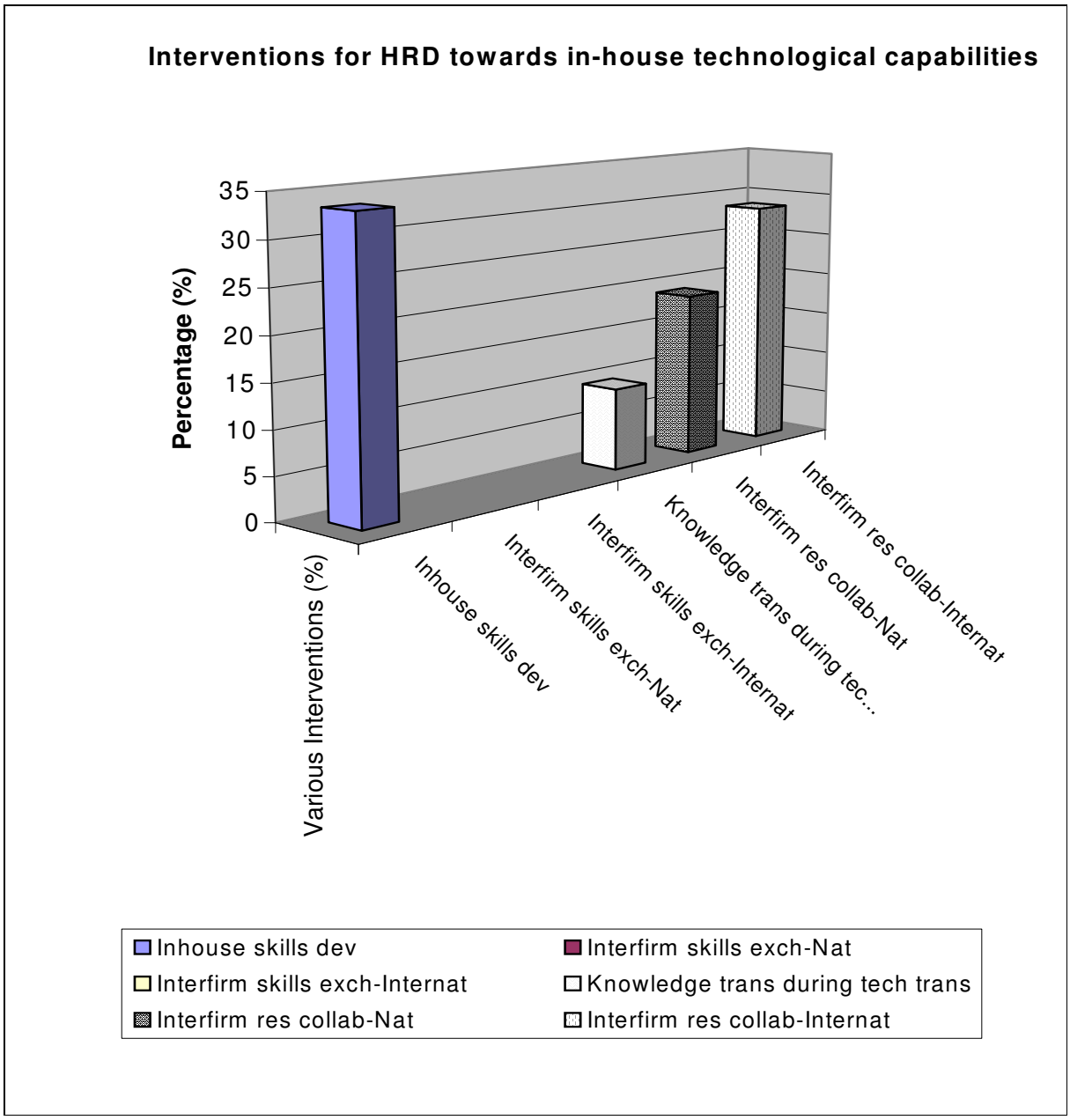

Figure (v)38 Ranking of various interventions for HRD to enhance in-house technological capabilities

14. The following are assumed to be the factors hampering global business acquisition and the technology capability-building needed for enhancing technology development within the civil aircraft firms:

Responses were received on the following list of factors:

A. Highly regulated environment (global and local)

B. Insufficient financial resources

C. Inadequate skilled resources

D. Lack of appropriate technologies

E. Projects too costly

F. Poor strategic alliances or networks

G. Not meeting customers' demands

H. Insufficient government support

I. Insufficient experience in global supply

J. Negative perception by global customers on quality of products

Factor **B** (*Insufficient financial resources*) had the highest score of **57%** on *Strongly agree*, indicating that respondents strongly feel that this is one of the key factors hampering global business acquisition and technology capability-building. The graphical representation of the results is illustrated on figure (v)39.

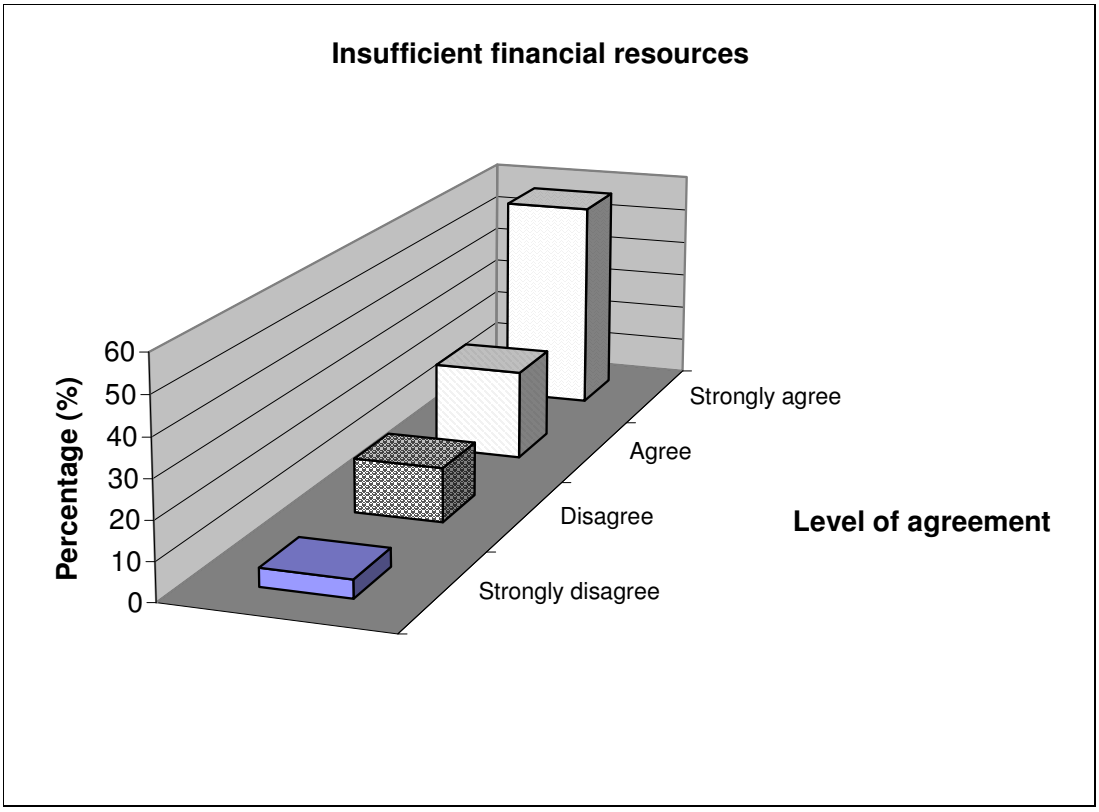

Figure (v)39 Level of agreement on "Insufficient financial resources" as a factor hampering global business acquisition and the technology capability-building process

Factor **E** (*Projects too costly*) had the second highest score of **52%** on *Strongly agree.*

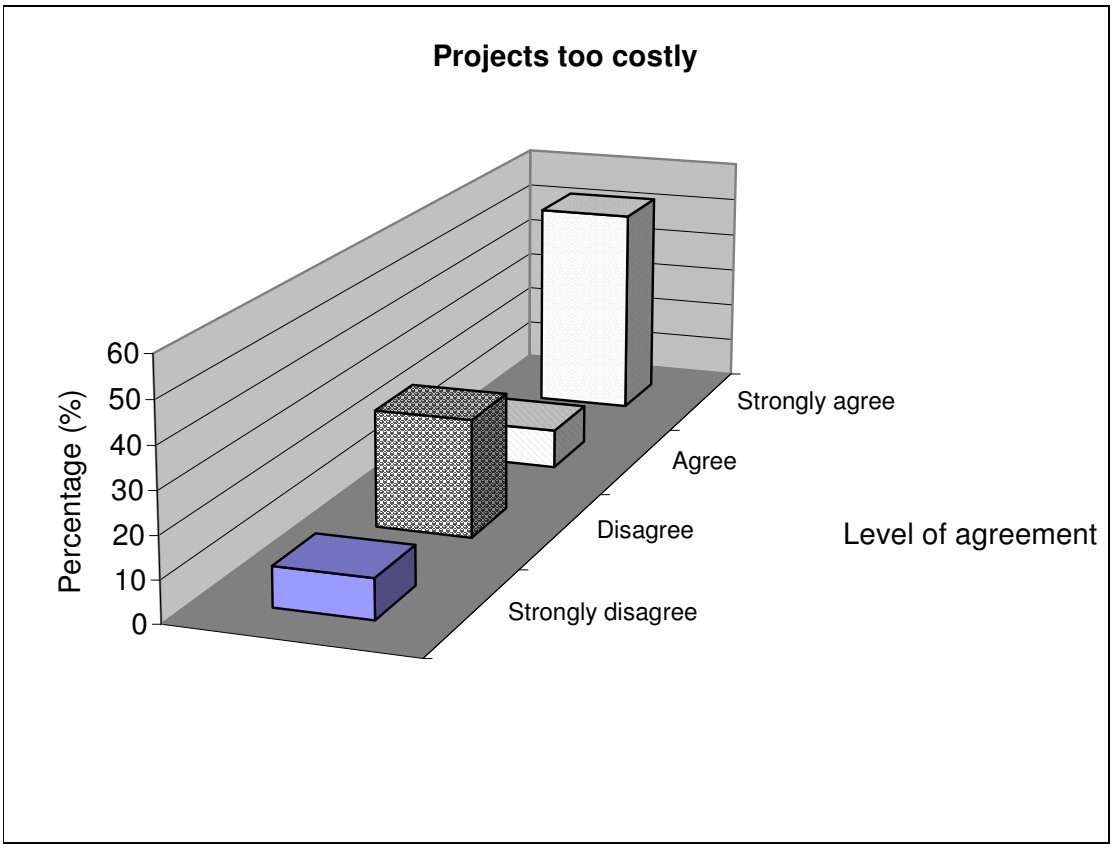

Figure (v)40 Level of agreement on "Projects too costly" as a factor hampering global business acquisition and the technology capability-building process

Factor **G** (Not meeting customers' demand) obtained the third highest score of **43%** on *Strongly agree*, with a further 33% on *Agree*.

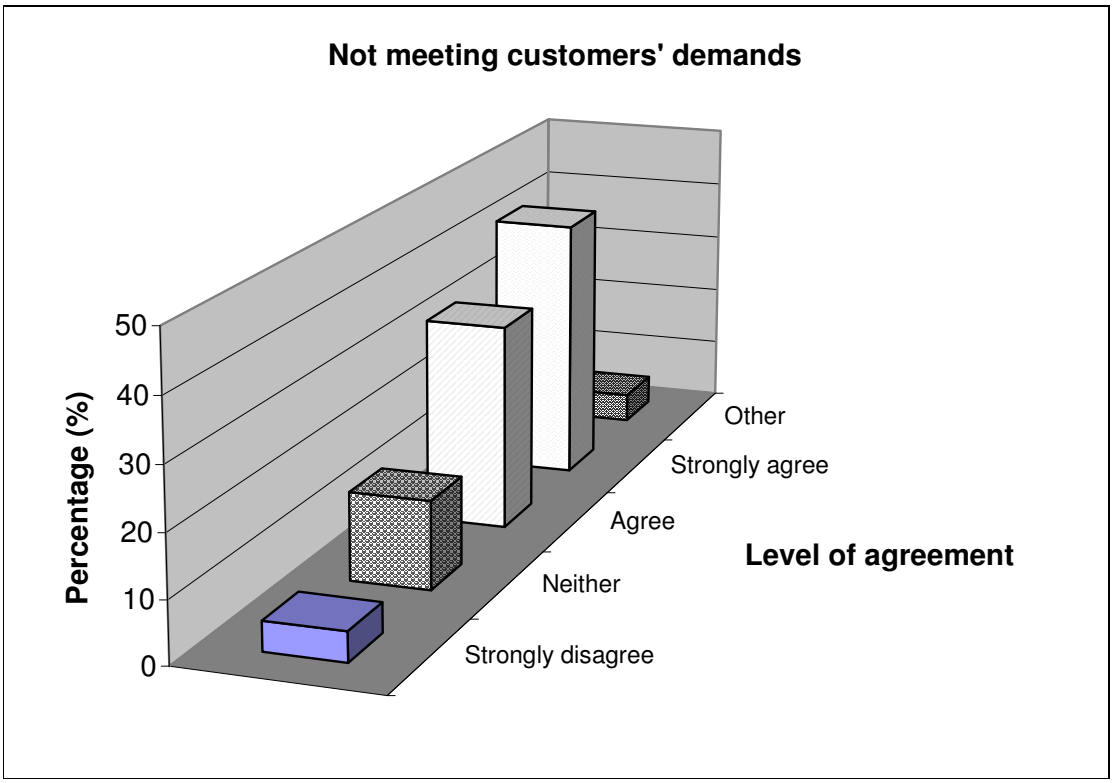

Figure (v)41 Level of agreement on "Not meeting customers' demands" as a factor hampering global business acquisition and the technology capability-building process

Factors **D** (*Lack of appropriate technologies)* and **F** (*Poor strategic alliances or networks)* followed with a common score of **24%** on *Strongly agree*. D had a further 62% on *Agree*, with F scoring 38% (*Agree*). The graphical representations of both are illustrated on figures (v)42 and (v)43 respectively.

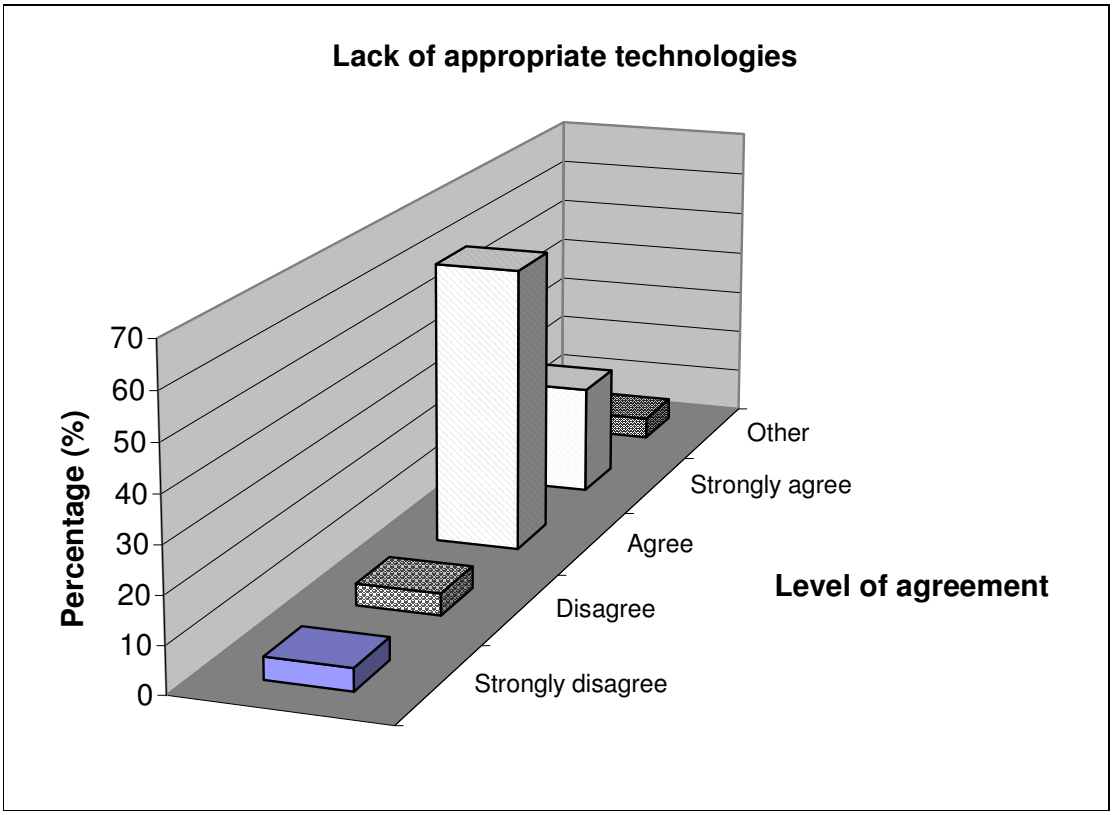

Figure (v)42 Level of agreement on "Lack of appropriate technologies" as a factor hampering global business acquisition and the technology capability-building process

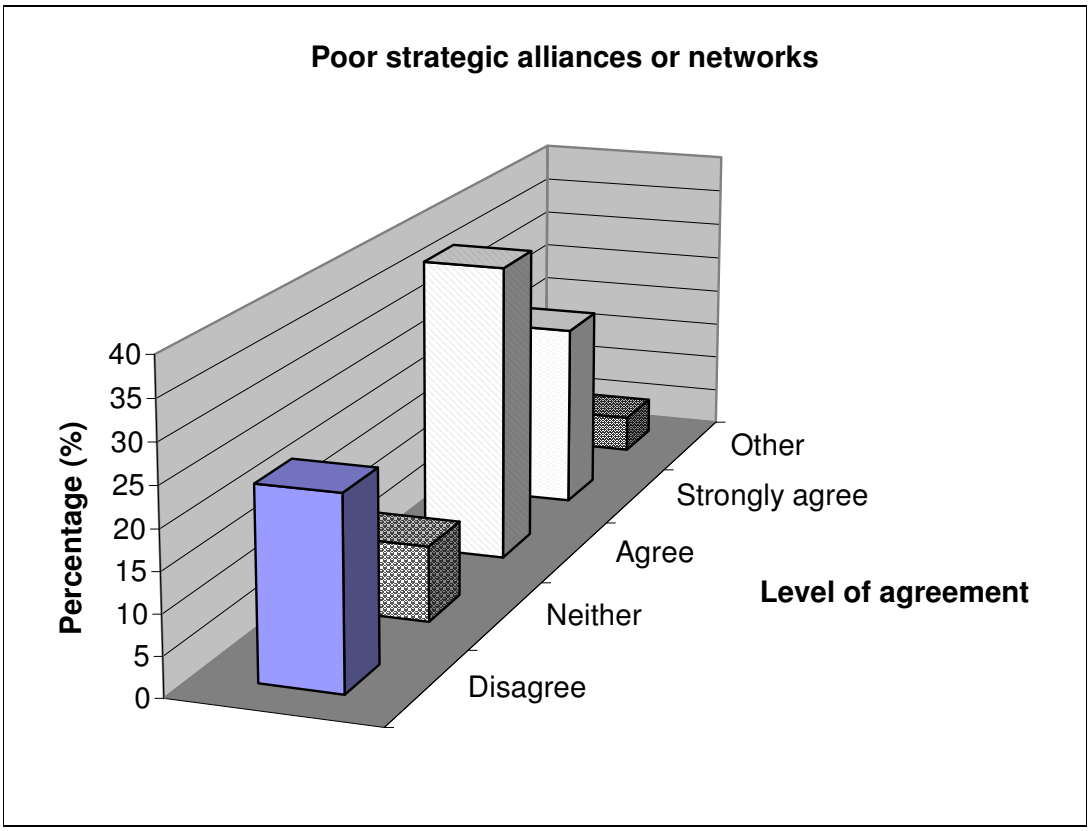

Figure (v)43 Level of agreement on "Poor strategic alliances or networks" as a factor hampering global business acquisition and the technology capability-building process

Factors **H** (*Insufficient government support)* and **I** (*Insufficient experience in global supply)* followed with a common score of **19%** on *Strongly agree*. H had a further 43% on *Agree* with I scoring 23% (*Agree*).

Factor **C** *(Inadequate skilled resources)* then followed with a score of **14%** on *Strongly agree*, and a further 71% on *Agree*.

Factor **J** (*Negative perception by global customers on quality of products)* had **10%** on *Strongly agree*, with 48% on *Agree*.

Factor **A** (*Highly regulated environment - global and local)* had **5%** on *Strongly agree*, and 33% *Agree*.

15. What would be the ideal key competencies, capabilities, skills and technologies needed for the civil aircraft technology development by developing economies?

Responses were obtained on the following list of elements:

A. Aircraft maintenance skills

B. Aircraft conversions and modification skills

C. Manufacture of components and sub-system levels

D. Manufacture of composites, rotor wing propeller blades, gear-boxes

E. Design and manufacturing of complete engines

F. Specialists in avionics

G. Capabilities for interior designs

H. Design and manufacturing skills for helicopters

I. Design and manufacturing skills for passenger aircraft

J. Full assembling skills for passenger aircraft

K. Civil-military technology linkages

Element **K** (*Civil-military technology linkages*) had the highest score of **67%** on *Highest priority*, indicating that this would be the crucial capability required by developing economies for the civil aircraft technology development. A graphical representation on findings is illustrated on figure (v)44.

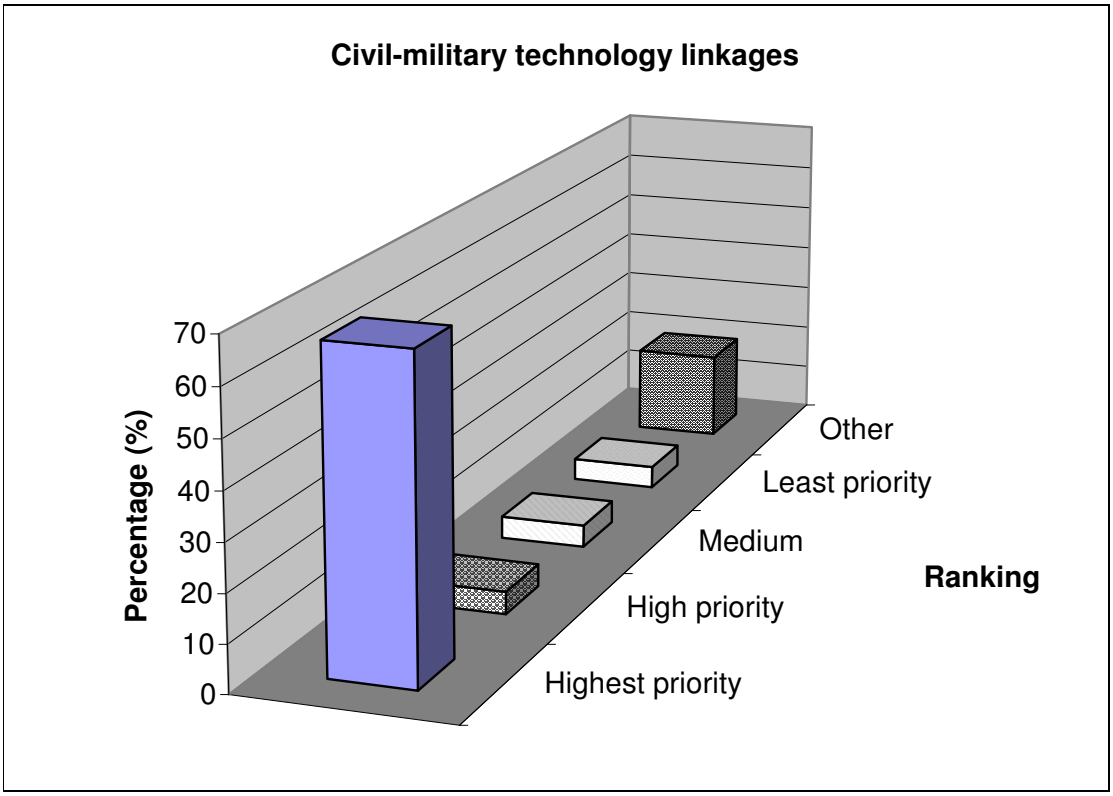

Figure (v)44 Ranking on "Civil-military technology linkages" as a competency/capability/skill needed by developing economies for the civil aircraft technology capability-building process

Element **A** (*Aircraft maintenance skills*) had the second highest score of **52%** on *Highest priority*, with a further 33% on *High priority*. A graphical representation on findings is illustrated on figure (v)45.

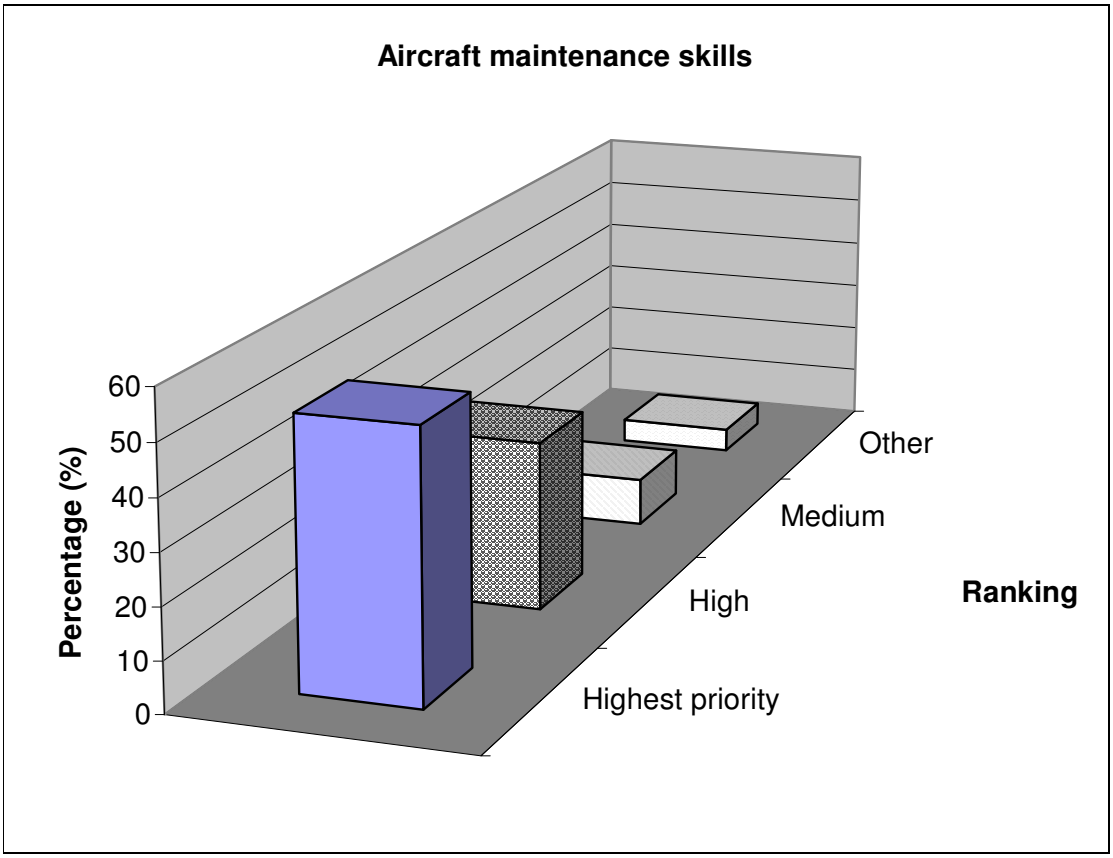

Figure (v)45 Ranking on "Aircraft maintenance skills" as a competency/capability/skill needed by developing economies for the civil aircraft technology capability-building process

Elements **B** (*Aircraft conversions and modification skills*) and **D** (*Manufacture of composites, rotor wing propeller blades, gear-boxes*) both had the third highest score of **38%** on *Highest priority*. B had a further 52% on *High priority*, with D scoring 10% (*High priority*). Graphical representations of both results are illustrated on figures (v)46 and (v)47.

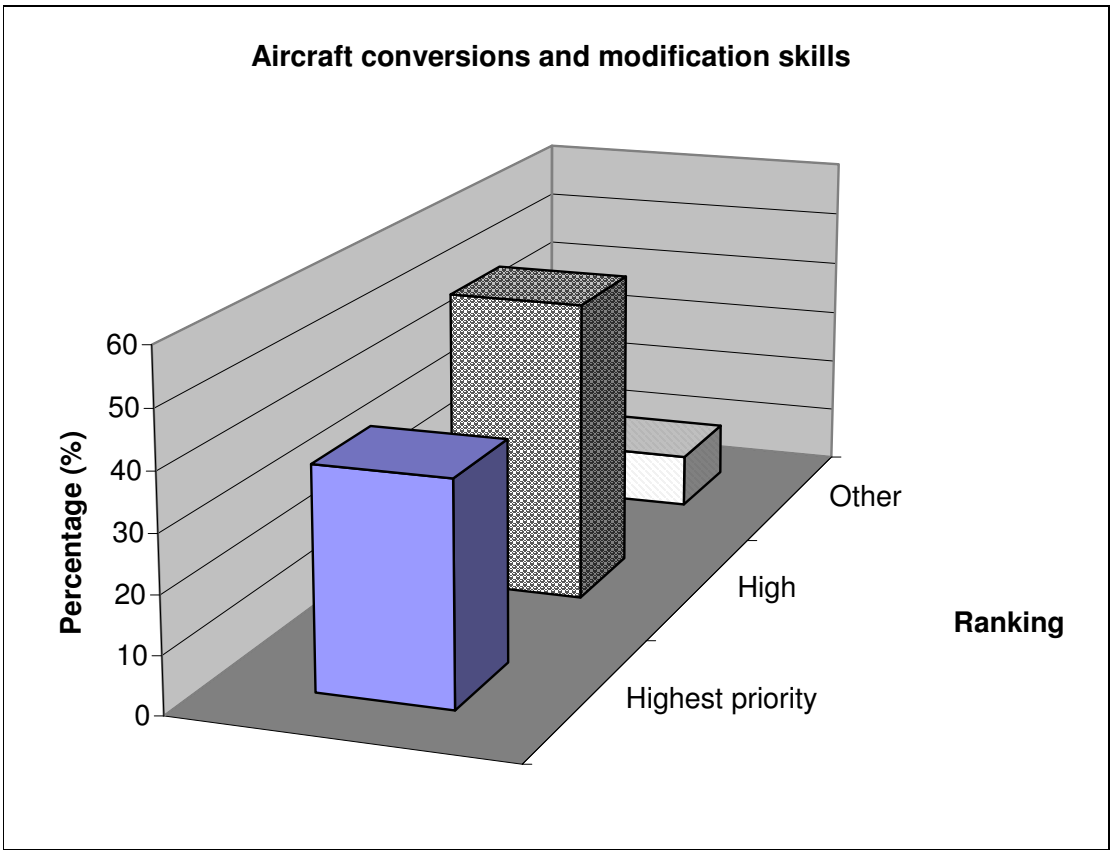

Figure (v)46 Ranking on "Aircraft conversions and modification skills" as a competency/capability/skill needed by developing economies for the civil aircraft technology capability-building process

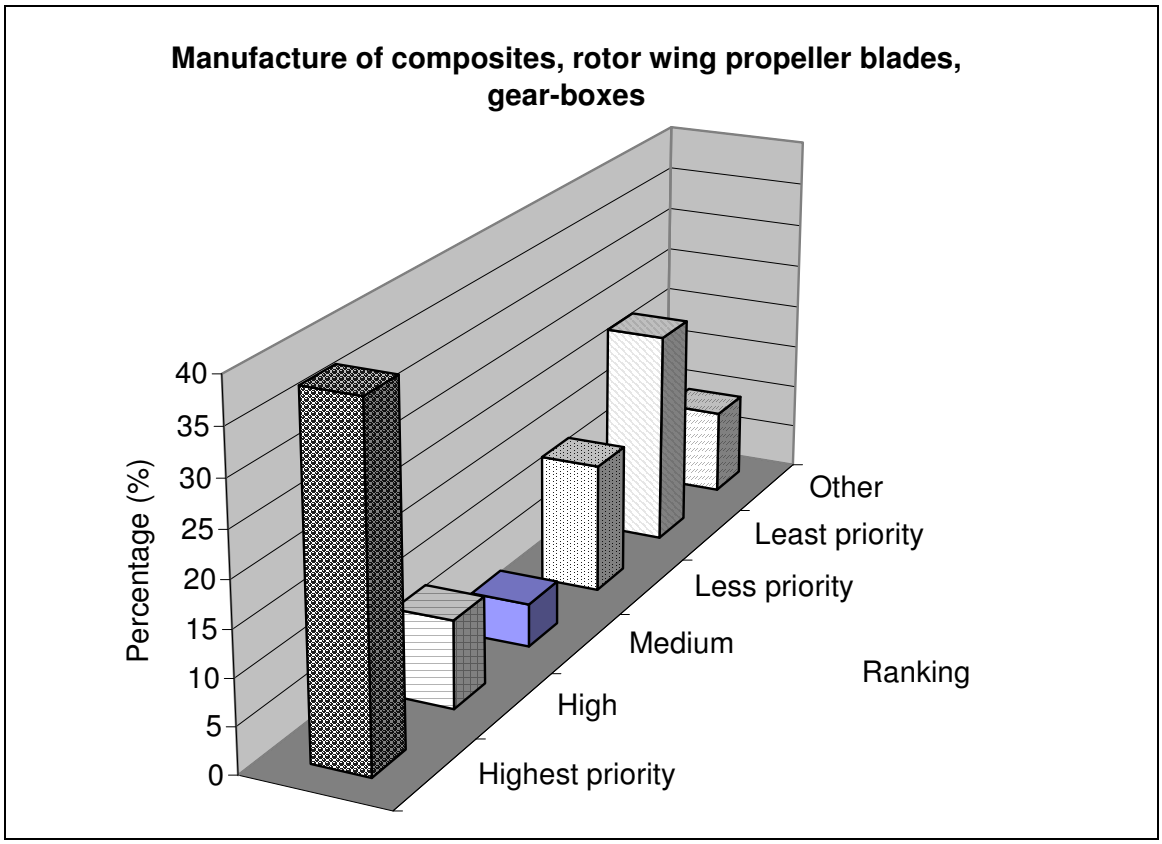

Figure (v)47 Ranking on "Manufacture of composites, rotor wing propeller blades, gear-boxes" as a competency/capability/skill needed by developing economies for the civil aircraft technology capability-building process

Elements **C** (*Manufacture of components and sub-system levels*) and **E** (*Design and manufacturing of complete engines*) followed with a score of **24%** on *Highest priority*. C had a further 33% on *High priority*. Figures (v)48 and (v)49 illustrate the findings.

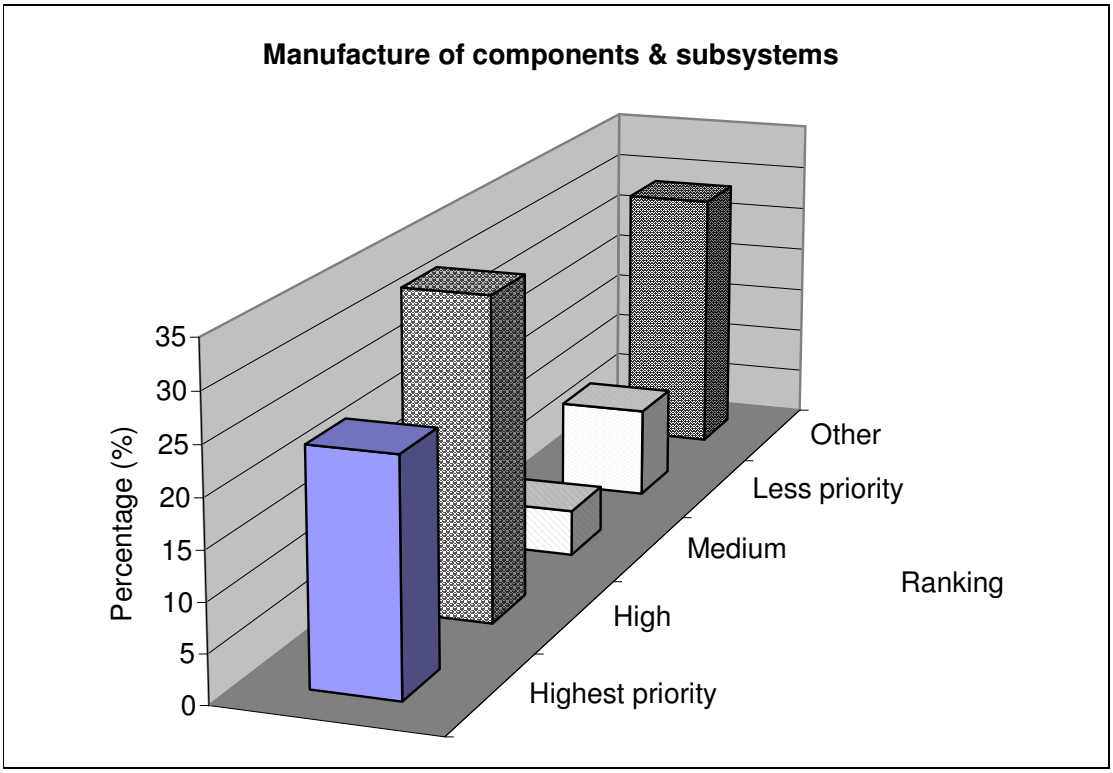

Figure (v)48 Ranking on "Manufacture of components & subsystems" as a competency/capability/skill needed by developing economies for the civil aircraft technology capability-building process

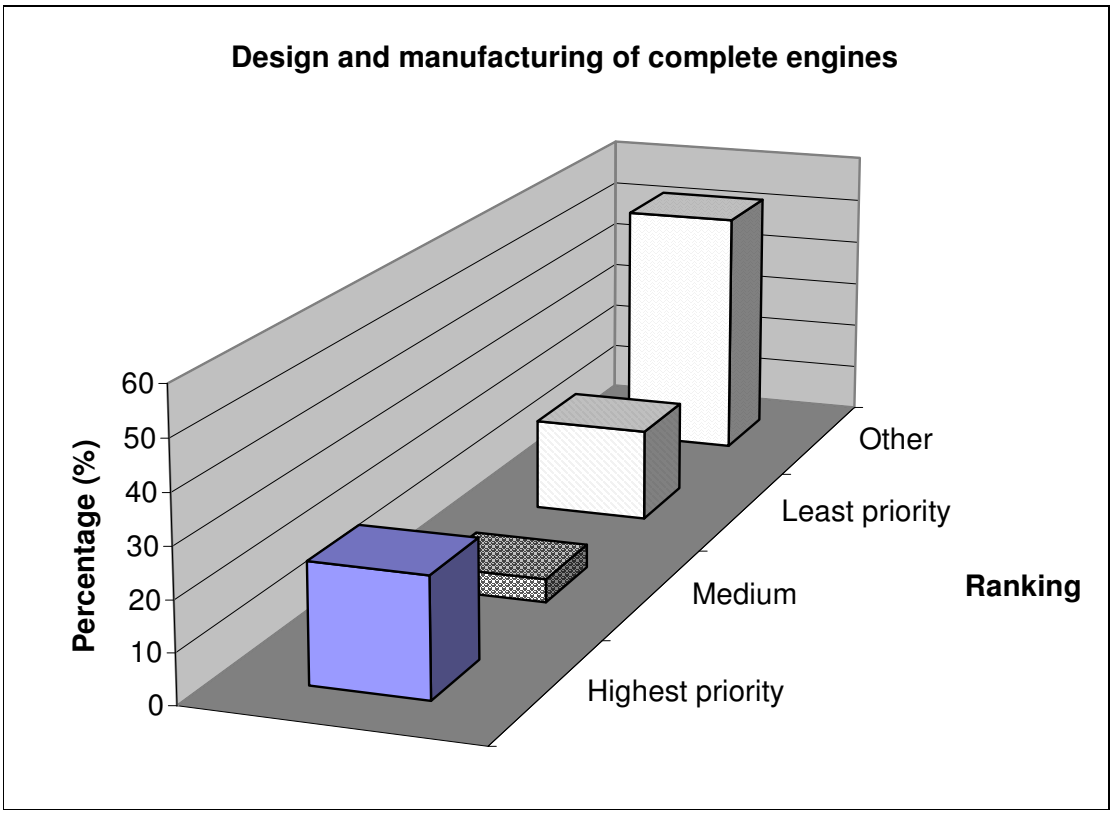

Figure (v)49 Ranking on "Design and manufacture of complete engines" as a competency/capability/skill needed by developing economies for the civil aircraft technology capability-building process

Element **J** (*Full assembling skills for passenger aircraft*) followed with a score of **10%** on *Highest priority*.

Element **I** (*Design and manufacturing skills for passenger aircraft*) scored **24%** on *High priority*.

Element **G** (*Capabilities for interior designs*) scored **19%** on *High priority*.

Element **F** (*Specialists in avionics*) scored **10%** on *High priority*.

Element **H** (*Design and manufacturing skills for helicopters*) scored **5%** on *High priority*.

16. How would you rate the current level of innovation in your firm/country as compared to that of successful firms/countries specifically within the civil aircraft industry?

On average the rating indicated by total responses on the current level of innovation in the countries interviewed varies as follows: *Very strong* (32%), *Strong* (10%), *Moderate* (29%), *Poor* (24%) and *Other* (5%).

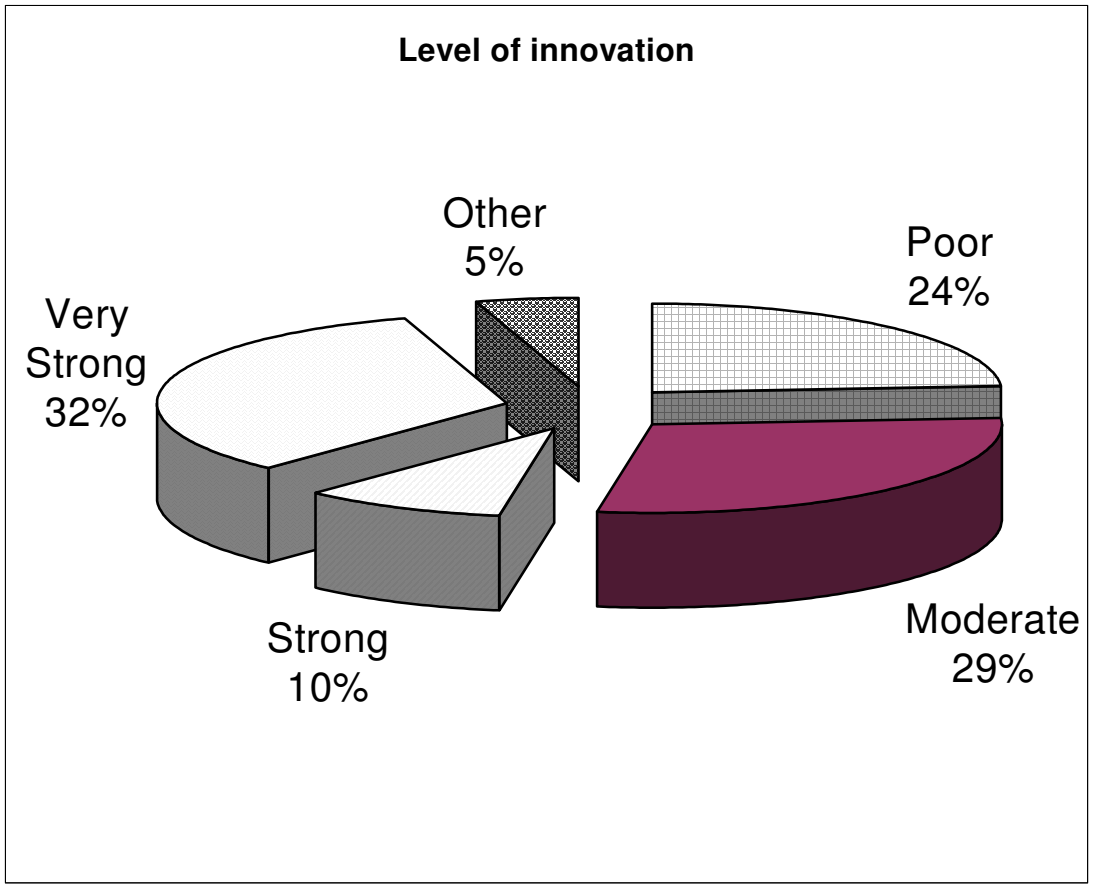

Figure (v)50 The average level of innovation in the countries studied

If the results are broken down further as *Poor* or *Good*, the scores can be graphically illustrated as follows:

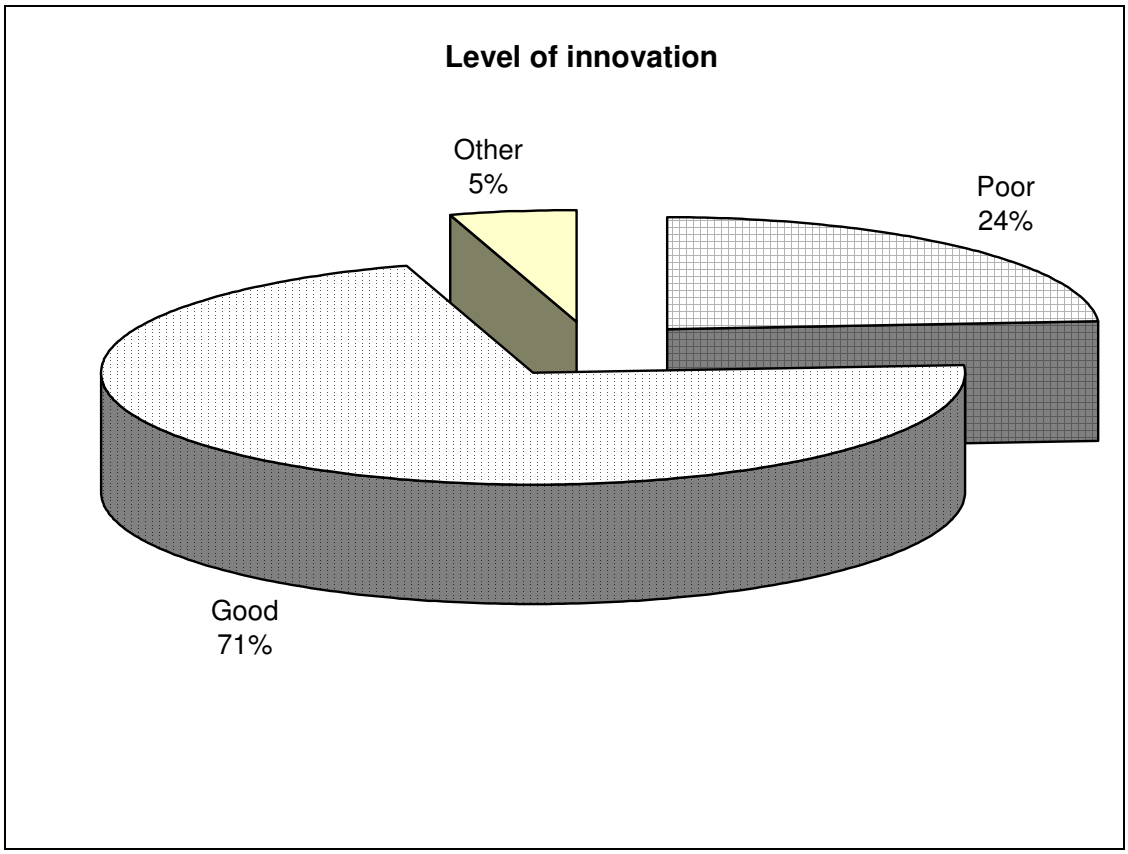

Figure (v)51 A further breakdown of the level of innovation in the countries studied