Institution: University of Strathclyde

Unit of Assessment: 12

Title of case study: Sustainable productivity and growth through improved performance measurement and management practices in manufacturing enterprises

1. Summary of the impact (indicative maximum 100 words)

Performance measurement research at the University of Strathclyde has directly led to major economic and social improvements in over 170 companies, and indirectly to over 1000 companies through intermediaries such as Scottish Enterprise between 2008 and 2013. These benefits were achieved as a result of novel performance measurement and management practices and supporting ICT systems that integrated shop-floor, operational and strategic performance information in real time. The result was substantial productivity and growth benefits for international and UK companies, for example a 150% increase in turnover and 80% increase in employment at Highland Spring. The European wide FP7 *FutureSME* project (2009-2013) led by the Strathclyde team developed and delivered a €6M programme to improve the competitive capabilities of European Manufacturing SMEs. In 2012, the associated training programme developed at Strathclyde was awarded the European Training Programme of the Year Medal by the Polish Chamber of Commerce.

2. Underpinning research (indicative maximum 500 words)

Context: This research is concerned with developing an empirical understanding of organisational practices and behaviours that underpin sustainable high performance. The compelling research question is "what performance measurement and management practices and behaviours distinguish high performing organisations?"

Key research findings: The new knowledge that underpins this impact was developed through a series of EPSRC and EU funded research projects between 1993 and 2013. Initial research conducted with industry leaders ICI, GE Caledonian and Clyde Blowers Ltd identified performance measurement and management as a key barrier to business-wide integration, constraining overall performance [1].

Subsequent case study based research with 36 manufacturing companies across Europe established that the measurement of business process performance is a key requirement and highlighted the need to deploy business process measures to the teams who operate (work in) these processes [2]. The study also demonstrated the feasibility of using reliability-engineering techniques to monitor and manage the performance of business processes to ensure continuing stakeholder satisfaction [2].

Subsequent research resulted in the development of the new Integrated Performance Measurement Systems Reference Model and identified Performance Measurement as an information system within the Performance Management Process [3 and 4]. This line of thinking led to further work that explored performance management of business processes and process-based teams. The key outcome of the research was that organisational performance is a function of operational and strategic work flows (i.e. business processes) comprising of people as well as machines, and that the measurement and management systems should be organised and operated as such [4 and 5].

The work on process and people-focused performance measurement and management systems continued and explored how performance may be measured and managed in extended collaborative enterprises such as supply chains and value chains. This led to a better understanding of performance measurement and management challenges in collaborative enterprises [4].

The Strathclyde team also drew on their experiences developed through parallel work (funded through the European Regional Development Fund) with over 100 small and large organisations in

the implementation of integrated performance measurement systems. This led to identification of the interplay between performance measurement, management styles and organisational culture [5]. Further research concluded that performance measurement and management practices of organisations are very much shaped by the mental models and social forces within the organisation, and those organisations *with an holistic integrated understanding of the managerial system perform better* as they demonstrate better tendencies towards learning and adaption to their environment [6].

Key Researchers: Prof. Umit Bititci (Senior Lecturer, 1996; Reader, 2000; Professor, 2002); Dr Jillian MacBryde (Lecturer, 1998; Senior Lecturer, 2004; Reader, 2011); Dr Kepa Mendibil (Researcher in 1998 and Lecturer since 2005); Dr Nuran Acur (Researcher 1998-2001, Senior lecturer since 2008) all at the Dept. of Design Manufacturing and Engineering Management, University of Strathclyde. Dr MacBryde moved to the Department of Management Science, University of Strathclyde in 2006.

3. References to the research (indicative maximum of six references)

References 3 and 5 best exemplify the quality of the body of research. Reference 6 is being returned within the UoA 12 REF2014 submission.

[1] Bititci U S, 1996, "Modelling Performance Measurement Systems in Manufacturing Enterprises", International Journal of Production Economics, vol. 42, April 1996, ISSN 0925-5273, pp. 137-147.

[2] Bititci U S, Carrie A S, McDevitt L G, 1997, "Integrated Performance Measurement Systems: A Development Guide", International Journal of Operations and Production Management, vol 17 no 6, May/June 1997, MCB University Press, ISSN 0144-3577, pp. 522-535.

[3] Bititci U S and Nudurupati S, 2002, "Web enabled Performance Measurement Systems: Management Implications", International Journal of Operations and Production Management, vol. 22, no. 11, pp. 1273-1287 (ISSN 0144-3577).

[4] Bititci U S, Mendibil K, Albores P, Martinez M, 2005, "Measuring and Managing Performance in Collaborative Enterprises", International Journal of Operations and Production Management vol 25, no. 4 , pp. 333-353, (ISSN 0144-3577).

[5] Bititci US; Mendibil M; Nudurupati S; Turner T; Garengo P, (2006), "Dynamics of Performance measurement and organizational culture", International Journal of Operations and Production Management. Vol. 26, Number 12, pp. 1325-1350.

[6] Bititci U S, Ackermann F, Ates A, Davies J, Garengo P, Gibb S, MacBryde J, Mackay D, Maguire C, van der Meer R, Shafti F, Bourne M, Firat S U, 2011, "Managerial processes: Business processes that sustain performance", International Journal of Operations & Production Management, Vol. 31 Issue: 8, pp. 851 - 891 (ISSN 0144-3577).

Other evidence for quality of research (grants, patents etc.)
Research grants totalling over £6M from a variety of sources including EPSRC and EU FP5&7 underpinned the research and impact described here.

4. Details of the impact (indicative maximum 750 words)
Process from research to impact:
The output of the extensive research activity conducted over almost two decades has resulted in the preparation of frameworks and models that were operationalized through practical workbooks, guidelines, audits and assessments, as well as training courses. The industry-facing seminars (e.g. JIT Club, SPEED, competitiveScotland.com) led to knowledge exchange engagements with 102 companies across the UK and over 76 companies across Europe, and involved the application of the frameworks and the associated tools and techniques. In all cases, the research team engaged with the management teams of the organisations through intensive workshops and longer-term KTP type engagements, educating and facilitating the critical evaluation of the organisations' performance measurement and management practices. The resulting tools and techniques have now been adopted by a wider community of support organisations ultimately impacting on over

1000 companies.

Type of impact:
Engagements with companies resulted in redefinition and redeployment of the organisations' performance measures with more rigorous use of the performance measurement system at all levels, aided through visual management systems. This process, in many cases, was supported by more effective use of existing, or introduction of new, ICT infrastructures within the companies. Implementation of the frameworks and models devised from the Strathclyde research resulted in:

- improved communication of organisational objectives and priorities at all levels;
- improved staff motivation, involvement and engagement at all levels
- increased participation and innovation.

The combination of these improvements led to sustainable growth in revenues, productivity and cash-flow facilitated thorough more systematic and focused customer service, and product/service and productivity improvement initiatives.

Reach and Significance
Some of the most significant benefits in productivity to be realised during the REF period, through application of the Strathclyde research, have been reported by Highland Spring, Clydesdale Bank, Blairs Windows, Riley Dunn and Wilson, and Brian Hewitt Construction. In each company, the performance measurement framework was implemented and used to assess the status of their core capabilities against three core value drivers: operational excellence, product leadership and customer intimacy.

Highland Spring Limited: The Strathclyde researchers helped the company to obtain more relevant, timely, consistent and accessible (ICT based) performance information. This facilitated more meaningful strategic and operational interactions within the organisation, resulting in more informed and confident decision making, as well as more focused action at all levels. This resulted in improved efficiencies across sales, manufacturing, materials and distribution operations, as well as improved customers service levels, resulting in a 150% increase in turnover (from £54M to £81M) and a 80% increase in the workforce (107 new employees) by the end of 2009. Further acquisitions resulted in the business growing to become the UK's number 1 bottled water producer with a turnover of c. £100M and 450 people (Sources 1 and 2).

Clydesdale Bank: Prior to engagement with Strathclyde, the bank had implemented in-house productivity and customer focused performance measurements, without achieving significant improvements. The Strathclyde research team conducted a maturity assessment and then a pilot intervention with two different teams, using one half of each team as a control group. Approximately one year after the intervention the bank reported 6% improvements in staff engagement, productivity and customer service (Source 3).

Blairs Windows: A quick response manufacturing programme was implemented which enabled the company to produce customised products for their customers in very short turn-round times. This contributed to the reputation of the company and customer satisfaction.

Riley Dunn and Wilson: The company benefited from a business process re-engineering programme which stream-lined their book binding processes, improving productivity and use of labour.

Brian Hewitt Construction: The Strathclyde researchers assisted with the development and implementation of engineering systems to enable the company to very quickly design and manufacture commercial buildings. This was based on creating systems that would generate the design of a new building through use of a library of design rules.

Wider impact
The European wide FP7 *FutureSME* project (2009-2013) led by the Strathclyde team developed and delivered a €6M programme to improve the competitive capabilities of European

Manufacturing SMEs. The research described above, and particularly the maturity models and the visual performance measurement and management approaches, formed the foundations of the project. Over the duration of the project, it delivered detailed longitudinal interventions with 13 European SMEs, as well as education programmes and performance measurement and management maturity diagnostics with 63 manufacturing SMEs across Turkey, Italy, Czech Republic, Poland, Spain, Slovakia, UK and Ireland. In 2012 the training programme developed was awarded the European Training Programme of the Year Medal by the Polish Chamber of Commerce (Source 4).The following quotations from three different companies provide corroborating evidence of the benefits experienced:

> *"We worked with Prof Bititci and his team to adopt the performance measurement and management methods and tools developed through his research. The visual management approach has transformed the way we manage the strategy and performance of our business which resulted in the company exceeding its growth objectives".* Source 5 - Linn Products, UK.
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> *"In a constantly changing global environment, the performance measurement and management approach developed at Strathclyde University taught us how to adapt to change, which has had a positive impact on our business".* Source 6 – Deka Elektroteknik A.S, Turkey.
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> *"Our consultant, Dr Laului, has introduced us to the visual performance management tools developed at Strathclyde. It helped us survive through a deep recession and made us stronger for growth in the future"* Sources 7 and 8 – Roco Manufacturing, Ireland.

Furthermore, organisations such as the Scottish Manufacturing Advisory Service, Tsunami (Ireland), Ernst & Young (Italy), Lean Institute (Poland) and the Turkish Shoe Manufacturing Federation (Turkey) have adopted the methods and tools developed through the Strathclyde research and are actively encouraging their clients/members to engage with the methods described resulting in the total reach exceeding 1000 manufacturing companies across Europe (Source 9).

5. Sources to corroborate the impact (indicative maximum of 10 references)

1. The Highland Spring case has been published in the European Case Studies Clearing House, see www.ecch.com/educators/search/results?s=BD16E2A9F70DEB152BCDBBCADA6026D6
2. KTP final reports and letter from Group Operations Director of Highland Spring Group Ltd.
3. Letter from Head of Customer Quality and Collateral, Clydesdale Bank.
4. Letter from Lean Enterprise Institute, Poland confirming award of the European Training Programme of the Year Medal.
5. Statement from Managing Director, Linn Products UK
6. Statement from Managing Director, Deka Elektroteknik A.S, Turkey
7. Statement from Managing Director/Owner Roco Manufacturing
8. http://www.futuresme.eu/docs/case-studies/2011/01/26/case-study-of-business-improvement-at-roche-manufacturing.pdf Future SME case study Roco Manufacturing
9. Video clips at www.futuresme.eu/case-studies/futuresme