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LSS, a problem solving skill for graduates and SMEs: Case study of investigation in a UK business school curriculum

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Case study of investigation in a UK business school curriculum

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Abstract

Purpose – This paper aims to investigate the feasibility of a systematic Lean Six Sigma (LSS) education through the curriculum of business schools to respond to the existing gap between the graduate's expectation of employability and skill requirements by the small and medium-sized enterprises (SMEs).

Design/methodology/approach – A UK business school has been used as a case study to conduct extensive module and programme review followed by a semi-structured interview with potentially suitable core and programme-specific module tutors and comparative analysis.

Findings – The result revealed a high potential of the existing modules in the business schools equivalent to the private sector training providers to increase the level of LSS problem-solving knowledge and skill for all graduates and improve their employability and productivity for the SMEs.

Originality/value – The result of this study highlights the role of LSS to reduce the knowledge and skill gap between the business schools as the source of the explicit knowledge, graduates as the knowledge and skill bearer and SMEs as the knowledge and skill users.

Keywords Problem-solving, SMEs, Lean Six Sigma, Higher education, Knowledge transfer, Business schools

Paper type Research paper

1. Introduction

Faced with a fierce global competition, more industrial demand, recent financial austerity and also growing involvement of the private sector, the higher education (HE) sector is obliged to be more innovative and proactive in their programmes. Accordingly, business schools are required to increase their mindfulness (Ray *et al.*, 2011), competitive advantage, innovation and distinctiveness in business education (Worasinchai *et al.*, 2008; Blackman and Kennedy, 2009; Woods and Dennis, 2009). They also need to be engaged in corporate problem-solving of small and medium-sized enterprises (SMEs) as the most common employer in the UK economy (Kumar *et al.*, 2011), and graduate employability more effectively (Hamel, 2009; Anninos and Chytiris, 2011) to improve competitive advantage (Kumaraswamy and Chitale, 2012; Worasinchai *et al.*, 2008; Harrington and Kearney, 2011). SMEs have been defined as organisations with less than 250 employees in the European Union (EU) definition (Kumar *et al.*, 2011).

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Reed (2009) argued about the current challenge of the significant gap in the theory/practice interface between business schools as part of academic enterprises, graduates and the industry, but no specific educational programme has been introduced to fill this gap. Antony (2008a) and Kumaraswamy and Chitale (2012) also argued that there are some practical problem-solving programmes such as Lean Six Sigma (LSS) in the industry that lack theory and are eligible and credible to be embedded in the academic curriculum of business schools to fill the gap.

Business schools are in the competition with the private sector and need relentless change and more effective university–business knowledge collaboration, especially with SMEs, for wining competitive advantage (Hughes *et al.*, 2009; Tikhominova *et al.*, 2008) to strengthen economic development (Hofer, 2005; Worasinchai *et al.*, 2008). Recent gaps and differences between business schools as knowledge provider, graduates as knowledge bearer and SMEs as knowledge user have been presented in Figure 1. This model reflects on the research argument and represents the actual problems in business schools to develop business skills. Problem-solving skills for graduates could be one of these skills, which are required by SME managers.

On the other hand, research studies have been criticising the poor involvement of the theoretical research in LSS, which is recognised as a systematic, training-intensive and practical problem-solving tool (Antony, 2012; Antony, 2008a; Hilton and Sohal, 2012; Starkey *et al.*, 2004). The literature has already acknowledged that theoretical approach of LSS education must be aligned with actual operational business problems in SMEs to provide maximum benefits (Antony, 2008a, 2008b, 2012). However, the existing literature failed to address the role of the LSS in a broader view and in integration with business schools as the enabler to reduce these gaps. For example, Reed (2009) and Ranjan (2011) have highlighted the theory/research gap between business schools and businesses to share knowledge, but they did not go further to provide any specific solution to develop better knowledge share and management. Furthermore, Harrington

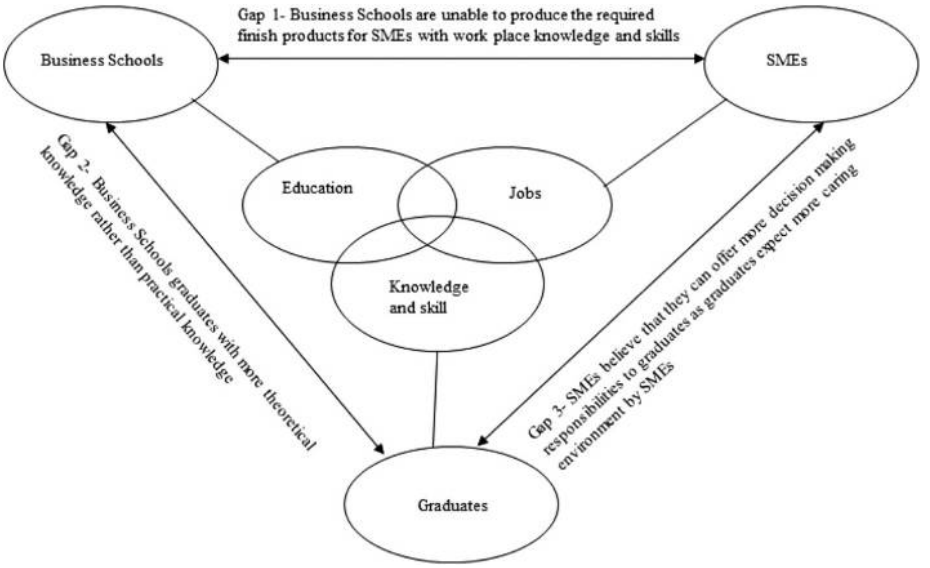

Figure 1.
The gap between business schools, graduates and SMEs

and Kearney (2011), Anninos and Chytiris (2011) and Noroda (2011) have all argued about the necessity of transition and excellence in future business schools, but failed to clearly provide any case study that can support their argument. On the other hand, Antony (2008a), Chow *et al.*, (2010), Braunscheidel *et al.* (2011) and Laureani and Antony (2012) had all highlighted the importance of theory, research and standardisation integration with LSS, but did not specifically focus on any HE sector such as business schools.

The purpose of this article is to review the contribution of modules and programmes in a business school curriculum to common LSS themes to fill these gaps. A module in HE was defined by the Cambridge dictionary as one of the teaching units that together make a complete course or programme. Leadership, project management, process improvement, operation management, statistical problem-solving and performance measurement tools and skills are common LSS themes, which have been highlighted by the literature (Antony, 2014; Prashar, 2014; Antony *et al.*, 2007; Kumar *et al.*, 2011; Hilton and Sohal, 2012). This would potentially develop LSS integration with both HE and research to enhance skill and employability of graduates and the theoretical approach of the LSS. The detailed inter-relationship between LSS themes and proposed gaps has been indicated in Table I. This table was produced as the result of an intensive LSS literature review by authors and presents the ideal fitness of LSS themes to fill each gap.

The key issue here is to highlight the role of interface between business schools and the LSS in a cost-effective and collaborative knowledge transfer (Burke, 2011; Kumaraswamy and Chitale, 2012) and an innovative knowledge creation (Kumaraswamy and Chitale, 2012; Hughes *et al.*, 2009; Tikhominova *et al.*, 2008; and Wu and Lin, 2009). The LSS training and education programmes can be distinguished as a tool to transfer the explicit knowledge of the academia to a tacit knowledge for graduates (Wu and Lin, 2009). Tacit knowledge may be more dynamic than explicit knowledge in a continuous learning environment and may be more beneficial to SMEs (Wu and Lin, 2009). It is also expected that LSS can facilitate the tacit knowledge transfer to an enhanced explicit knowledge for students through case studies and projects.

2. LSS and knowledge exchange

LSS is widely recognised as a systematic, comprehensive and disciplined methodology that employs both statistical and non-statistical tools and techniques to obtain critical knowledge of processes and products essential for reducing the variability and defect, solving problems and achieving both operational and business excellence and customer satisfaction (Antony, 2007; Gijo *et al.*, 2014; Biranvand and Khasseh, 2013; Wu and Lin, 2009; Tracy Zou and Lee, 2010; Aboelmaged, 2010; Manville *et al.*, 2012; Pepper and Spedding, 2010; Braunscheidel *et al.*, 2011; Lee *et al.*, 2011; Assarlind *et al.*, 2013).

The structured and comprehensive training is a critical success factor of any LSS project alongside the top management commitment, leadership and using statistical tools and techniques (Antony, 2014; Brun, 2011; Manville *et al.*, 2012; Wu and Lin, 2009, Aboelmaged, 2010, Manville *et al.*, 2012; Hilton and Sohal, 2012). Knowledge management in the current LSS training lacks intellectual capacity, which introduces a challenge (lee *et al.*, 2011). The significance of timely, comprehensive and standardised LSS training has been highlighted by research studies to make it more effective and productive (Laureani and Antony, 2012; Pandey, 2007; Chow *et al.*, 2010; Cho *et al.*, 2011;

Table I.
Role of LSS themes to minimise the proposed gaps

LSS themes	Gap 1 – inability of business schools to provide required workforce for SMEs	Gap 2 – lack of practical knowledge and skill for graduates provided by business schools	Gap 3 – difference between SMEs' perception and expectation from graduates
Statistical problem-solving tools	Graduates are able to systematically collect data and solve problems in SMEs	Graduates learn problem-solving and decision-making skill and knowledge to be used in practice	Graduates can be involved in decision-making process with having practical systematic problem-solving skill
Performance measurement tools	Graduates learn about theories and skills of data collection, data analysis and performance measurement tools and techniques		Graduates can build trust by proposing some professional aspects of performance measurement
Process improvement methodology	Graduates learn a systematic process improvement methodology with professional usage for any sector		Graduates can be involved in decision-making process with practical skill in sustainable improvements
Project management	Practical project management skills of graduates would be developed and assessed with integration with practical problem-solving tools and techniques during dissertation projects		Graduates can practically lead sustainable problem-solving or business improvement projects in SMEs
Operations management	Graduates would be able to be involved in problem-solving, improvement and performance measurement of all operations in planning, sourcing, making, delivering and sales processes		Graduates gain more confident to be involved in decision-making and project management of all operations
Leadership	LSS leadership focuses on both practical and theoretical aspects		Decision-making tools will be taught through LSS teaching

Manville *et al.*, 2012, Tata and Jones, 2011; Chow *et al.*, 2010). This will eventually promote creating the knowledge management pool and a continuous tacit and explicit knowledge transfer (Wu and Lin, 2009; and Tracy Zou and Lee, 2010). It was reported by the research outputs that effectiveness and productivity characteristics are missing in the current LSS training provided by the private sector (Laureani and Antony, 2012), and there is a need for more rigorous, robust and standardised LSS training to enhance cost efficiency, governance and standardisation.

The evidence from iSixSigma, a key electronic LSS reference source[1], indicates that the LSS Belt training courses are heavily involved in practical and technical aspects of LSS and would not specifically highlight the business and management aspects such as culture, leadership, human resource management, process and operation management. It also seems that academia has a critical role to design, redesign or modify appropriate modules and programmes to teach leadership, project management, process improvement, operations management, statistical problem-solving and performance measurement tools and skills as key themes in LSS training and education (Antony *et al.*, 2007; Kumar *et al.*, 2011; Hilton and Sohal, 2012).

The degree qualification, proceeding to the HE or issuing the LSS certification within existing studied HE programme or through breakthrough short training courses will maintain the revealed challenges in governance, cost and standardisation of the LSS training, education and assessment (Antony, 2012; Laureani and Antony, 2012) for all parties. Figure 2 represents the integrated model of the LSS certification and the LSS education to address the discussed gaps in Figure 1. The "Body of Knowledge" presented in Figure 2 refers to the intellectual knowledge inside business school, which is provided for students through teaching and learning practices. The "Body of Experience" refers to the tacit knowledge, exploration and skills gained in SMEs, which can be developed through dissertation project or placements and can be deployed as case studies. The "Certification" presented in this figure refers to any qualification, which can be provided as the result of studying in the business schools including degree classifications. This model also indicates that LSS knowledge in students can be formally assessed during the summative assessment process in business schools in a

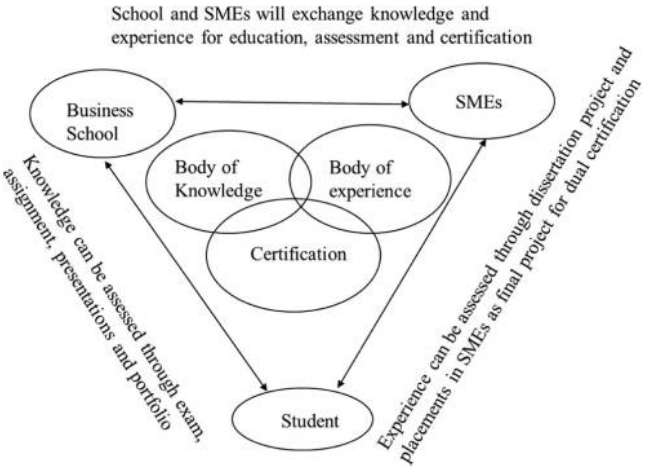

Figure 2.
Integrated model of LSS certification and education

more formalised and standardised format. This can be followed by a degree qualification for graduates partly through assessing students in LSS-related modules and case studies or projects in SMEs.

The students' practical skill can also be initially assessed by SME managers through project management in their dissertation project or even through placement activities in which SME management can also monitor student's competence in practice rather than theory. The assessment process could fit with the actual expectations of the problem-solving from managers in the business. This could be an interim process for permanent appointment for graduates. The certification process could also be involved with the accreditation and membership in professional bodies that recognise LSS and are usually in collaboration with the business schools. Integration of LSS as a professional skill with modules and courses in business schools is the evidence of developing the professional skills, which is the main focus of professional bodies. This would potentially increase the possibility of accreditation of these programmes by these professional bodies.

In response to the argument by Antony (2008a) to highlight the research gap in LSS programmes, the result of other research studies (Aboelmaged, 2010; Braunscheidel *et al.*, 2011) revealed that there is a limited LSS knowledge share between academic and organisational environment. This knowledge share has mainly been focussing on the investigation of feasibility of the LSS adoption in organisations including training rather than as immediate evident of motivation to adopt LSS through magnet curriculum to attract academic research and learning (Aboelmaged, 2010; Braunscheidel *et al.*, 2011).

These arguments instigate the provision of the LSS education as an excellent platform for integrating statistical, managerial and technical tools and skills into any appropriate curriculum of UK-based business school to enhance problem-solving and employability skills of graduates. It is important to verify the differences between business schools and engineering schools to fill some of these gaps. The authors acknowledge that some of the numerical aspects of the LSS would have already been targeted by the engineering schools, and therefore, there may not be a gap. However, the focus of this paper is on business schools, where the gap has been found between knowledge creation of business schools and required practical business problem-solving skills including technical, organisational and statistics skills.

3. Business schools and LSS knowledge transfer to SMEs

The theory/practice gap in the education/research structure of business schools (Reed, 2009) and the dual potential role of business school and industry in knowledge exchange (Alferoff and Knights, 2009; Scarborough and Knights, 2009; Kieser and Leiner, 2009; Harrington and Kearney, 2011; Ranjan, 2011) have been highlighted to emphasise on requiring significant changes in research and education of these schools (Noroda, 2011; Anninos and Chytiris, 2011; Harrington and Kearney, 2011; Starkey and Tempest, 2008; Starkey *et al.*, 2004). Business schools aim to prepare the good innovative and insightful managers and leaders with valuable knowledge through teaching common business principles such as human resource management, organisation behaviour, operations management, marketing management, strategic management, supply chain management, finance and accounting.

The role of LSS tool in problem-solving of both manufacturing and service SMEs has been in the centre of attention by many academics (Prashar, 2014; Gijo *et al.*, 2014; Kumar *et al.*, 2011; Kumar *et al.*, 2009, Antony *et al.*, 2005; Antony, 2008b; lee-Mortimer, 2006; Kaushik *et al.*, 2012; Antony and Desai, 2009; Laureani and Antony, 2012; Hilton and Sohal, 2012; Manville *et al.*, 2012). Organisational learning capabilities, leadership (Antony, 2014; Suresh *et al.*, 2012; Malik and Blumenfeld, 2012), personal and corporate competence of the project leaders, project team and facilitators (Hilton and Sohal, 2012) and also appropriate technical capabilities (Malik and Blumenfeld, 2012) have been highlighted by the literature as critical subjects to succeed in any LSS project. These subjects can be discovered immensely as academic subjects in the undergraduate (UG) and Postgraduate (PG) academic curriculums of business schools or even engineering schools to develop insightful managers and leaders to deal with business problems. LSS can also have a positive impact on manufacturing sector through its emphasis on more technical aspects such as LSS Define, Measure, Analysis, Improve, Control (DMAIC) projects (Antony *et al.*, 2005; Hughes *et al.*, 2009; Kaushik *et al.*, 2012; Tracy Zou and Lee, 2010) in more technical courses in engineering schools.

The application of LSS in academic business disciplines such as financial services (Panday, 2007, Antony, 2007; Delgado *et al.*, 2010), human resource departments (Pandey, 2007; Chow *et al.*, 2010), information management systems and administration processes (Antony *et al.*, 2012), strategic management and managerial decision-making (Friday-Stroud and Sutterfield, 2007), customer satisfaction analysis (Behara *et al.*, 1995) and supply chain management and logistics (Shokri *et al.*, 2010, Nabhani *et al.*, 2009; Narasimhan, 2009; Aboelmaged, 2010) has also been highlighted by the literature.

There is very little evidence of the cohesive knowledge and information sharing within an enhanced circle of collaborative knowledge exchange between SMEs, business schools and graduates, which makes business schools unable to provide challenging and stimulating experiences for their graduates (Bickerstaffe and Ridgers, 2007; Reed, 2009). Business schools can play a bigger role to enhance this circle through proactive approach of the LSS teaching or the incremental LSS training for SMEs through placement, dissertations or research projects. Nevertheless, this depends on the level of integration depth and range between business schools and SMEs through LSS. If the placements, projects or dissertations are about LSS awareness, SMEs' background investigation or small LSS projects, the level of required resources for all three parties is minimum. However, more in-depth and bigger involvement needs higher level of resources, such as budget, and placement availability that may be considered as a challenge for students, business schools and SMEs. The systematic problem-solving knowledge and the skill development nature of the LSS education would adhere to the development of a cohesive circle of collaborative knowledge exchange between these three stakeholders.

This study intends to evaluate the potential idea of using the presented LSS themes as an innovative graduate skill development approach in the business-related UG and PG modules and courses to enrich the distinctiveness of the research and professional-integrated modules and the graduate employability in the UK or EU business schools.

4. Research background and case review

This section intends to provide useful information about the HE case study institution, process of sampling, data collection and data analysis. A broad review of all modules

and programmes and also some open-ended interviews have been conducted in a UK-based business school accommodating nearly 4,470 students in UG, PG and doctoral levels through six different subject groups. This business school has employed 131 academic staff; 80 per cent of them were academically qualified (completed a doctoral degree), whereas 20 per cent were professionally qualified (having master's degrees with senior management experience in their previous industrial background). The intellectual contributions of the school have been around 1,160 publications with 15 per cent of them as peer-reviewed journal articles, in which 40 per cent of those articles have had contribution to practice. There are 24 active UG and 18 PG programmes or courses that recruit students globally.

As the first step, teaching and learning outcomes and material of all delivered modules in the business school have been reviewed through analysing the module descriptors (MDs) and teaching and learning plans (TLPs) to identify the suitable modules that potentially can fit LSS themes in their teaching structure. Aims and learning outcomes of modules, syllabus and key words, teaching material and assessment strategy were the key criteria to review the TLP and MD. The programme specifications have also been reviewed to identify the taught modules, structure and also other useful information for these programmes such as requirement of placements and dissertations. Having identified the suitable modules and programmes (courses), six core UG and ten core PG modules alongside a few suitable programme-specific modules were selected as sample to conduct a semi-structured interview with their module leaders. The sampling was conducted through the purposive method in which appropriate modules were identified as the result of module review prior to the data collection.

The authors found the quantitative data collection and analysis inappropriate for this research because of the necessity of interaction and in-depth discussion with the module leaders and also difficulty to get academics to understand the LSS concept through survey. The semi-structured interview was selected to encourage participants talk openly and widely to gain different views and insights, alongside the pre-designed questions (Appendix A). However, there was no intension to limit discussions, and most of the discussions with interviewees went beyond these questions. The interview questions have been developed as the result of the extensive literature review. The ethical consideration has been taken in account, and the formal procedure to meet ethics requirement in the school was completed. The reason to select core modules was to ensure about the highest credibility and coverage of all programmes or courses by selecting the maximum number of the core modules, which are delivered for all students from all programmes.

Then, a qualitative data analysis through content analysis of interview transcripts or some recorded interviews was conducted. The coding framework was selected as a four-steps model to breakdown, analyse, compare and categorise sentences (Aronsson *et al.*, 2011). This was followed by a comparative analysis in which the capacity of the delivered core modules in this school to teach LSS themes has been compared with established LSS training subjects, delivered by the private sector. The presented selected LSS training subjects in the following section is the result of that review and on-line search in various reliable private LSS training sources such as "International Association of Six Sigma Certification". Then, and as the last episode of the methodology, following questions were raised to reflect the presented gaps. Both

Questions 1 and 2 reflect on all three gaps presented in Figure 1, whereas Question 3 reflects on the justification and effectiveness of this research argument:

Q1. Can current UG and PG modules fit LSS themes in their teaching and assessment structure?

Q2. Can existing programmes or courses fit LSS in their teaching curriculum?

Q3. Can current modules cover the existing private sector LSS training subjects?

5. Result

The initial result of the interview analysis indicates that five out of six UG module leaders that were interviewed knew about LSS. The result of interview has also confirmed that all UG module leaders that were aware of LSS have been concerned with adequacy and capability of teaching resources, especially for more technical aspects. This has also applied to the Master of Business Administration (MBA) and other PG modules, where most of the MBA and PG module leaders were aware of LSS and had the same concern. However, this was less critical matter for them, as the module size for PG courses is smaller than UG modules and can be handled with less teaching staff. It was evident from the teaching material of all of these interviewed UG and PG modules that some of them could incorporate LSS themes and principles such as Total Quality Management (TQM), Lean Management, Statistics, Research Methods, Organisation Improvement and Leadership without any referral to the LSS. Having presented some overall results of the interview, the following result is presented as the direct analysis for each presented question.

Q1. *Can current UG and PG modules in the business school fit LSS themes in their teaching and assessment structure?*

The result of the module review and interview presented in Table II revealed that there are some delivered core Level 4 (first year), Level 5 (second year), Level 6 (final year) and Level 7 (PG) modules that can meet or have already met one or more than one LSS themes including the LSS methodologies and their tools and techniques in their teaching structure. It was apparent that only the module leader for the "Management" module, which is a Level 4 core module, was not aware of the LSS. However, as discussed above, there are different basic and principle leadership and management aspects of the LSS that could be addressed in this module without referral to the LSS. The other UG module leaders were familiar with the LSS relatively, and all supported benefits of the LSS to increase the problem-solving skills for the UG students through business curriculum. All PG module leaders had some theoretical knowledge of LSS and initially supported the theoretical benefits of incorporating LSS in the business curriculum.

Module leaders for both "Business Processes and Systems" (Level 4) and "Business Performance Management" (Level 5) agreed that LSS could be recognised as a potential backbone of the re-development of these modules to make them practically more productive and effective elements to complete the learning loop. It was found that the "Solving Business Problems" module in Level 4 and the "Business Performance Management" module in Level 5 are core modules that can potentially fit more technical aspects such as statistics or some key tools for LSS methodologies. Module leader for the "Business Processes and Systems" module agreed to incorporate some principles of the LSS education such as TQM, Lean and Performance Measurement in the teaching

LSS themes in training and education	Core module	Problem-solving tools	Performance measurement tools	Process improvement methodology	Project management	Operations management	Leadership
UG Level 4 modules							
Solving business problems	✓	✓	✓				
Business processes and systems	✓	✓	✓	✓	✓	✓	
Management	✓				✓	✓	✓
UG Level 5 modules							
Business performance management	✓	✓	✓	✓	✓	✓	✓
UG Level 6 modules							
Strategic management and leadership	✓			✓	✓	✓	✓
Dissertation and professional project	✓	✓	✓	✓	✓		
MBA modules							
Business research analysis	✓	✓	✓	✓			
Operations management and organisational improvement	✓	✓	✓	✓	✓	✓	✓
Dissertation	✓	✓	✓	✓	✓		
Research methods	✓	✓	✓	✓	✓		
Other postgraduate modules							
Business research analysis	✓	✓	✓	✓			
Analysing organisation	✓	✓	✓	✓	✓		
Managing sustainable competitive advantage	✓	✓	✓	✓	✓	✓	✓
Business environment and strategic management	✓			✓	✓	✓	✓
Dissertation	✓	✓	✓	✓	✓		
Research methods	✓	✓	✓	✓	✓		

Table II.
Core UG and PG modules in the business school to incorporate LSS in their teaching structure

structure. He also agreed to systematically incorporate the LSS definition, benefits, key success factors and barriers of LSS as part of one or two lecture topics for this module. The module leader for the "Business Processes and Systems" module said:

> It is easy for us to develop the LSS or Six Sigma principles more systematically as part of our operations management lectures as the tail for TQM and Lean Management lectures, and it would even be better if the lecture lies before the statistics lectures in other level 4 modules.

The module leader for the "Business Performance Management" module also agreed to encounter the DMAIC methodology as part of the teaching structure. The module leader for the "Business Performance Management" module said:

> We are prepared to develop some of our lecture and workshop material as the following chain of Six Sigma related topics in the level 4 modules to provide a systematic business performance improvement tool; this would enhance the practical implications of this module as part of the learning outcomes.

She has also acknowledged the requirement of the staff development and resource management to cover the big range of students from variety of programme backgrounds.

"This is massively in the favour of this module to present some practical aspects of statistics with a real world examples and through real problem-solving methods", said the module leader for the "Solving Business Problems" module, when was asked about the benefits of the LSS in their teaching structure. In contrast; he has also acknowledged the difficulty of the teaching staff development to incorporate the LSS methodology in their statistical material teaching in a short period of time. In another scenario and through discussion for other question about the importance of some LSS themes in teaching for the Business Schools, the module leader for "Business Performance Management" module has emphasised on "process improvement", "variability and defect reduction" and "continuous quality improvement".

In addition, it was found that these two modules alongside a Level 6 core module as the "Strategic Management and Leadership" can also potentially cover more business principles and strategic aspects of the LSS in their teaching structure. This was supported by the module leader for the "Strategic Management and Leadership" module to follow the other two modules to support the leadership and strategic aspects of the LSS after learning about more technical and operational aspects. The module leader for the "Strategic and Leadership Management" module said:

> We would consider to establish a strong chain of business management and leadership education that could support businesses and I think LSS could be a right example; my main concern is the degree of changes that we might have to do in our teaching content.

The "Business Research Analysis" and the "Analysing Organisations" are Level 7 or PG (including MBA) core modules that can potentially cover technical and statistical aspects of the LSS, whereas business- and management-related aspects of the LSS could fit in PG core modules such as the "Operations Management and Organisational Improvement" and the "Managing Sustainable Competitive Advantage". The module leader for "Operations Management and Organisational Improvement" said:

> We have been covering different areas of organisational excellence and we have already been teaching Six Sigma and Lean in a very limited level; but this can definitely be modified towards these two tools if there is any agenda to promote LSS for PG students.

His remarks have been reiterated by the researchers in regards to practical implications for PG graduates. The response from module leader was not clear because he would not be sure about the cultural elements of the offshore businesses that would be the main employers of the PG graduates who are mainly international.

The "Dissertation" as a UG and also PG core modules and the "Work Placement" can be used equivalent to the practical professional project in which students can apply their LSS knowledge in the practice and business environment for a period of 4-5 months project. The dissertation module leader said:

> It was clear to us that most of the final year UG and PG students have been doing their dissertation in SMEs if they wished to collect primary data. This has been much more effective process if they have had one year placement with the potential data in their hand.

The response from the dissertation module leader who coordinates both UG and PG dissertations was positive to encourage students to do some LSS case studies in small scales if it is possible, but he also recognised the issue of supervision, and also the student-led dissertations in this case. "I am a bit concern that we push students towards certain topics and, therefore, deter students to select their own research topic as it should be", said the module leader for dissertations. However, he was happy to start this in a small scale and for a limited number of interested students with supervision from the competent staff at the early stages. It was found that LSS teaching themes can align some UG modules such as the "Solving Business Problems", the "Business Processes and Systems" and the "Business Performance Management" to make a more effective and productive teaching stream.

Q2. *Can programmes or courses fit LSS in their teaching curriculum?*

The result of the programme review, interviews and module review revealed that LSS themes can relatively and under certain depth fit in the curriculum of all UG and PG "Business and Management" programmes, as all interviewed core modules are being delivered in the corresponding programmes. The authors decided to carry out further analysis in relation to the course or programme suitability of the LSS education. Having analysed the programme-specific modules from Business and Management programmes, the module leader of some appropriate programme-specific modules as sample have been interviewed under the purposive sampling strategy. The result of this in-depth analysis, which was presented in Figure 3, revealed that some UG programmes with more business and management focus have more compatibility to incorporate LSS themes. This was due to having more focus on LSS themes in some programme-specific modules. The x-axis in Figure 3 represents the number of core and programme-specific modules in each programme or course (y-axis) that can fit one or more than one LSS themes in their teaching structure. For instance, delivering modules such as the "Business Research and Reflective Practice" and the "Managing professional skills" for the "Corporate Management" programme have been found as two programme-specific modules that could present the higher degree of LSS methodology in their teaching structure as the tail of what has been delivered in the core modules. This might make the "Corporate Management" programme as one of the most suitable courses to incorporate the LSS education and perhaps certification.

The result for PG programmes has suggested that business related programmes such as the "MBA", the "Business with Management", the "Global Business

Figure 3.
Number of UG modules in each programme that can deliver LSS themes

Management" and the "Business with Logistics & Supply Chain Management" have more compatibility to be involved in the LSS teaching modules. This was supported with indication of higher number of the programme-specific modules from these programmes that can fit LSS themes in their teaching structure. The "Work-Based Action Research Project" and "Consultancy Projects" are two practical modules taught in MBA programme that can fit any skill development aspects of LSS problem-solving perspective such as implementing methodologies in SMEs. The "Managing Sustainable Supply Chain" is a PG module that is delivered specifically for the "Global Business management" and the "Business with Global Logistics and Supply Chain Management" programmes. This module has been found to be capable of delivering business and strategic aspects of LSS themes such as operations management, project management, performance measurement and process improvement. Apart from this, as Business and Management students from all programmes will be taught with core modules in all levels (UG and PG), all graduates from Business and Management programmes would have some level of LSS knowledge and skill.

Q3. *Can current modules cover the existing private belt-system LSS training subjects?*
The result of comparative analysis through on-line sources presented in Table III revealed the capacity of some core and programme-specific modules in this business school to meet common required theoretical and practical LSS training and education themes. Therefore, these modules meet professional and practical aspects of the provided LSS education and training by private sector. The result of the interview analysis also revealed the capacity of a few core and programme-specific modules from Level 4 to Level 7 to meet one specific belt-training level of the LSS (Black, Green, Yellow) depending upon the level of LSS themes involvement in teaching curriculum. The "Dissertation projects" in both UG and PG courses can be recognised as an equivalent to the professional or practical projects undertaken through private training providers.

The result of interview and also MD and TLP review revealed that technical training subjects delivered by the private sector such as applying LSS methodologies, selecting successful LSS projects and selecting right statistical tools can be taught during the first two years of UG study in the business schools (through the business problem-solving,

Delivered subjects in a private Belt system LSS training	Respective core modules of the business school			
	UG Level 4	UG Level 5	UG Level 6	PGT and MBA
Communicating a business strategy across the organisation			Strategic management and leadership	Business environment and strategic management
Integrating with Lean Manufacturing, total quality control (TQC) and other improvement methods	Business processes and systems		Dissertation	Business environment and strategic management, dissertation
Applying the DMAIC improvement process	Business processes and systems and business problem-solving	Business performance management	Dissertation	Operation management and organisational improvement, managing sustainable competitive advantage
Selecting successful Six Sigma projects and project teams	Business processes and systems	Business performance management	Dissertation	Business research analysis, analysing organisation, Managing Sustainable Competitive Advantage, Dissertation
Planning and executing projects		Business performance management	Strategic management and leadership, dissertation	Dissertation
Benefits of Six Sigma projects	Business processes and systems		Dissertation	Operation management and organisational Improvement, analysing organisation
Selecting the right statistical tools	Business problem-solving	Business performance management	Dissertation	Business Research Analysis, Dissertation
Six Sigma philosophy of process improvement	Business processes and systems	Business performance management	Dissertation	Operation management and organisational Improvement, Managing Sustainable Competitive Advantage
Customer centred business	Business processes and systems	Business performance management	Strategic management and leadership, dissertation	Operation management and organisational improvement, managing sustainable competitive advantage
Lean principles	Business processes and systems	Business performance management		Operation management and organisational improvement, managing sustainable competitive advantage, dissertation
Statistics	Business problem-solving		Dissertation	Business research analysis, analysing organisations, dissertation
Group/organisational assessment			Dissertation	dissertation

Table III.
Respective core modules in business school to meet common LSS training subjects provided by the private training organisations

the business processes and systems and the business performance management modules). It was suggested that more business- and strategic-related subjects such as "Communicating a Business Strategy" can be delivered in the third or final year of study (e.g. strategic management and leadership module). The coverage of these LSS subjects in PG courses is more levelled down and balanced, as a few modules have the capacity to cover all relevant subjects in their teaching structure. This means that business schools have no disadvantage against the private sector training providers in relation to capacity and capability of teaching the required subjects for an LSS education that promotes problem-solving skills. The main challenge here is the teaching resource development, which represents the degree of knowledge and experience within teaching team of those modules. This, however, has not been recognised as a great deal in this studied business school. The module leader for the "Business Processes and Systems" module said:

> This issue would be gradually solved by sending few potential academic members of staff to the Six Sigma training belts or through actual LSS research project delivery for local SMEs by the academic staff.

6. Research, managerial and business implications

This research study was conducted in a single case study that could limit the validity and significance of this study in the HE sector. A multi-case study analysis involving different business schools or even other faculties or schools could be approached. Engineering faculties or schools are a clear example of data collection extension and benchmarking because of the nature of their technical modules. However, this was not practically possible at the time this research was conducted because of time restrictions. The result of this study was consistent with the literature for the role of business schools to promote more competitive advantage, innovation and distinctiveness in the business education (Worasinchai *et al.*, 2008; Blackman and Kennedy, 2009; Woods and Dennis, 2009). The LSS integration with the business schools curriculums could potentially increase the opportunity for promoting more innovative and distinctive curriculum with more emphasis on skill development for graduates. The result would also support the literature (Kumar *et al.*, 2011) about the requirement of more significant role from business schools to develop the corporate problem-solving in SMEs. LSS would have the potential to develop this collaboration through establishing its themes in business and management modules.

The result of this study is consistent with the research arguments that had identified a theory/practice gap for LSS and business schools (Reed, 2009; Antony, 2008a). It appears that integrating LSS themes with business and management modules would reduce this gap. This would promote more academia-led research programmes and research papers in both conceptual and case study aspects of LSS. This study also supports the literature proposal about improving business school competitiveness in the market (Hughes *et al.*, 2009; Tikhominova *et al.*, 2008), where LSS integration with HE teaching can potentially develop income generation for HE sector through projects, and providing training sessions for businesses.

The result of this study has addressed the issue of research gap in the LSS that was acknowledged by the literature (Antony, 2012; Antony, 2008a; Hilton and Sohal, 2012; Starkey *et al.*, 2004). Integrating LSS themes in the business and management modules

would encourage academic staff and graduates to be involved in more LSS research activities and collaborate with LSS practitioners. This would consequently promote the collaborative and innovative knowledge development and transfer for business schools that has been recognised as a requirement by the literature (Burke, 2011; Kumaraswamy and Chitale, 2012; Kumaraswamy and Chitale, 2012; Hughes *et al.*, 2009; Tikhominova *et al.*, 2008; Wu and Lin, 2009). This study has addressed the maintenance of governance, cost and standardisation of LSS training, education and assessment (Antony, 2012; Laureani and Antony, 2012) through proposing a systematic and standardised HE structure in business schools with the sustained quality assurance for LSS training and education.

All highlighted critical academic subjects to succeed in LSS projects have been met in this study. Organisational learning capabilities, leadership (Suresh *et al.*, 2012; Malik and Blumenfeld, 2012), personal and corporate competence of the project leaders, project team and facilitators (Hilton and Sohal, 2012) and also appropriate technical capabilities (Malik and Blumenfeld, 2012) could fit in the analysed modules for both UG and PG levels.

This study revealed that business schools could potentially enhance graduate's capability to be employed in different sectors that have already been applying LSS. Financial services (Pandey, 2007, Antony, 2007; Delgado *et al.*, 2010), human resource departments (Pandey, 2007; Chow *et al.*, 2010), information management systems and administration processes (Antony *et al.*, 2012) and supply chain and logistics management (Shokri *et al.*, 2010; Nabhani *et al.*, 2009; Narasimhan, 2009; Aboelmaged, 2010) have all been business and management areas that have been targeted by LSS projects. Strategic management and managerial decision-making (Friday-Stroud and Sutterfield, 2007) and customer satisfaction analysis (Behara *et al.*, 1995) are other management areas that would be integrated with LSS projects. These have also been established as either a business programme or an academic teaching context within a module in the investigated business school.

It appears that this research study could promote a closer collaboration between SMEs and business schools through a theoretical and professional approach. This collaboration would be strengthened through sustainable knowledge and skill development for business school graduates that can establish a greater impact on SME requirements for problem-solving skills. This would potentially increase the employability of graduates, while improving the performance of SMEs continuously. It will also develop an enhanced and effective curriculum in business schools, ultimately resulting in developing more innovative and competitive business schools.

7. Concluding remarks and future work

It was concluded that LSS education can be established in both UG and PG levels in business schools through a standard teaching and assessment structure of both core and programme-specific modules to promote skill development, innovation and competitiveness. It will potentially provide graduates with a theoretical and practical knowledge and skill of problem-solving with a reliable and standard assessment and certification, which is required by the SME managers. The teaching structure in business schools, which covers both theoretical and practical perspectives, will underline the common LSS training themes that are required for a young graduate equivalent to certain levels of the LSS Belt training. Therefore, it was concluded that

business schools can have a significant role to reduce the existing knowledge transfer gap and to reduce the research gap in the LSS practice, if they apply a structured LSS education as part of their curriculum.

This research study has been limited to a qualitative approach within a single business school, and this could be extended to more validating quantitative methods after the pilot study in some modules or programmes in one business school or for other business and engineering schools. This research study recommends the necessity of establishing an LSS-oriented teaching in all business schools in a smaller scale such as continuous re-engineering and re-designing of some core modules in a certain period of time. There is a vast opportunity for the further research study to highlight the gaps and provide more detailed aspect of LSS role in reducing the gap between business schools, graduates' employability and SMEs problem-solving required skills. The researchers believe that the same type of research could also be applied for the engineering schools, where there is the same gap and also high compatibility between LSS teaching and curriculum of engineering schools in practice similar to business schools.

There is a need for more extensive review of other business schools. The authors would recognise this studied gap as the system problem and, therefore, would recommend extending the research to student alumni and SMEs as the future study. This could be promoted for any business school with established LSS as part of training course or UG and PG programmes, which have accessibility for data through interviewing alumni from these courses or programmes and any SMEs that have been involved in any LSS-related academic activity with the school. There are also some practical implications to be considered such as school/university-wide policies, admission and logistical limits to design a new programme or a new module, resource availability for placements, projects and case studies and also operational and administrative issues of modifying different modules under different leadership.

Note

1. iSix Sigma, available at: http://store.isixsigma.com/product/Training-Materials–Aids/six-sigma/Six-Sigma-Black-Belt-Training-Course v11?utm_source=iSixSigma&utm_medium=RokTabs&utm_campaign=CrossPromote

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Appendix

BUSINESS SCHOOLS AND SMES KNOWLEDGE EXCHANGE USING SIX SIGMA

The purpose of this study is to evaluate if and how the Six Sigma is used to fill the existing gap between productivity of business schools, SMEs, and employability of graduates.

We are seeking contemporary insights into how the Six Sigma could be used to enhance knowledge and skills and learning in higher education practice.

The interview will take approximately 45 minutes to complete.

Q1a. Have you ever heard or/and read anything about "Six Sigma"?

Q1b. If yes, can you tell us briefly what you understand 'six sigma' to be?

Q2. How important are the following components when conducting your research?

Problem Solving Tool

Process Improvement Methodology

Performance Measurement Tool

Business Improvement Strategy

Customer Satisfaction Programme

Variability and Defect Reduction

Performance Efficiency

Quality Improvement Programme

Continuous Improvement Programme

Total Quality Management Culture

Leadership Role in Problem Solving Tool

Leadership Role in Quality Improvement Programme

Organisational Culture in Problem Solving, quality improvement and customer satisfaction programme

(*continued*)

Figure AI.

Other……..

Why do you think they are important or not important?

Q3a. How important are the following components in the employability of graduates for each of Newcastle Business School's portfolios?

Problem Solving Tools	Quality Improvement Programme
Process Improvement Methodologies	Continuous Improvement Programme
Performance Measurement Tools	Leadership role in Problem Solving Tool
Business Improvement Strategies	Leadership role in Quality Improvement Programme
Customer Satisfaction Programmes	Organisational Cultural in Problem Solving

Quality improvement and customer satisfaction programmes

Variability and Defect Reduction	Performance Efficiency

Why do you think they are important and the rest are not?

Q3b. How important is it for students to apply the following components in their research projects (i.e. UG & PG Dissertations, Knowledge Transfer Partnerships etc)?

Problem Solving

Process Improvement

Performance Measurement

Business Improvement

Customer Satisfaction

Variability and Defect Reduction

Performance Efficiency

Quality Improvement

Continuous Improvement

Figure AI.

(*continued*)

Total Quality Management Culture

Leadership Role in Problem Solving

Leadership Role in Quality Improvement

Organisational Culture in Problem Solving

Quality improvement and customer satisfaction

Why do you think they are important and the rest are not?

Q4a. How important is the potential role of this Business School to deliver the following components for SMEs ?

Problem Solving Tool

Process Improvement Methodology

Performance Measurement Tool

Business Improvement Strategy

Customer Satisfaction Programme

Variability and Defect Reduction

Performance Efficiency

Quality Improvement Programme

Continuous Improvement Programme

Total Quality Management Culture

Leadership Role in Problem Solving Tool

Leadership Role in Quality Improvement Programme

Organisational Culture in Problem Solving, quality improvement and customer satisfaction programmes

What could be the potential or actual resource constraints?

Q4b. How important is the existing role of this Business School to deliver the following components for SMEs?

(*continued*)

Figure AI.

Problem Solving Tool

Process Improvement Methodology

Performance Measurement Tool

Business Improvement Strategy

Customer Satisfaction Programme

Variability and Defect Reduction

Performance Efficiency

Quality Improvement Programme

Continuous Improvement Programme

Total Quality Management Culture

Leadership Role in Problem Solving Tool

Leadership Role in Quality Improvement Programme

Organisational Culture in Problem Solving

Quality improvement and customer satisfaction programmes

Q5a. Which of these components are useful in your teaching activities?

Problem Solving Tool

Process Improvement Methodology

Performance Measurement Tool

Business Improvement Strategy

Customer Satisfaction Programme

Variability and Defect Reduction

Performance Efficiency

Quality Improvement Programme

Continuous Improvement Programme

Figure AI.

(*continued*)

Total Quality Management Culture

Leadership Role in Problem Solving Tool

Leadership Role in Quality Improvement Programme

Organisational Culture in Problem Solving, quality improvement and customer satisfaction programmes

Why do you think they are important?

Q5b. How important is it to use live case studies about any of the following components in your teaching activities?

Problem Solving Tool

Process Improvement Methodology

Performance Measurement Tool

Business Improvement Strategy

Customer Satisfaction Programme

Variability and Defect Reduction

Performance Efficiency

Quality Improvement Programme

Continuous Improvement Programme

Total Quality Management Culture

Leadership Role in Problem Solving

Why do you think they are important and what could be the limitations?

Q6a. Please indicate your role (please tick as appropriate)

Executive Manager	Professor	Subject Group Leader
Principle Lecturer	Reader	Programme Director
Programme Leader	Senior Lecturer	Lecturer

(*continued*)

Figure AI.

Graduate Tutor Associate lecturer Post-Doctoral Lecturer

Q6b. Which of the following do you practice?

Quantitative Research Qualitative Research Both of these

Q6c. Please, indicate your subject group:

Business Analysis

Logistics & Supply Chain Management

Information Management

Marketing & Tourism

Finance & Accounting

Human Resource Management

Strategic Management

International Business

Corporate Management

Q6d. Please, indicate which portfolios that you are teaching (tick all that apply)

Undergraduate Postgraduate Corporate Management

Q7a. Please list all modules you have been involved as module tutor or part of teaching team across all semesters:

Q7b. Which one do you think could be integrated with LSS after this discussion?

Q7c. Have you had any professional experience prior to working in Newcastle Business School?

Q7d. If yes, please specify which sector(s)?

Q.9 Would you be willing to take part in further research?

Figure AI.