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Lean Six Sigma and quality frameworks in higher education - a review of literature

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Lean Six Sigma and quality frameworks in higher education - a review of literature

Abstract

2020, Emerald Publishing Limited. Purpose: This paper aims to present a review of literature that considers the use of quality frameworks in higher education (HE). Quality frameworks provide a minimum standard of teaching and learning of students. This systematic literature review identifies the tools and techniques to continuously improve the systems and processes that underpin teaching and learning are missing. With this in mind, the authors present a focus on Lean Six Sigma (LSS) as an improvement methodology adopted by the HE sector and present the factors that drive or hinder the implementation of LSS in higher education institutions (HEIs). Design/methodology/approach: A review of the literature and thematic analysis has been undertaken relating to the application of quality frameworks and methodologies within the literature set. Findings: The findings show that quality frameworks to be lacking insofar as their focus on compliance is no incentive for continuous improvement. This finding is not unique to the HEI sector and similar challenges exist in other sectors. A further finding identifies the need for academic professional practice to go beyond quality assurance to attend to the transformation of students. Together these present an apparent disconnect between continuous improvement methodology and HE quality frameworks. Research limitations/implications: A literature review does have limitations insofar as some literature may have been missed because of different key terms. A further consideration being literature from 2019 not available at the time the review was conducted. Practical implications: It represents the state of play in regard to the use of quality frameworks operating in HE and business schools. Insight is offered into how the use of continuous improvement methods can deliver quality in HE to benefit the sector, students and others. An agenda for future research is offered. Originality/value: The discussion is valuable as it seeks to improve understanding of the relationships between methodologies with adopted quality frameworks in the HEI sector. A contribution is made in the use of force field analysis to represent the critical success factors and barriers of LSS in HEI.

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Lean Six Sigma and Quality Frameworks in Higher Education – A review of literature

Introduction

Higher Education Institutions (HEI) play a critical role in society. There have been substantial shifts in the Higher Education (HE) environment that have brought both challenges and benefits (Lu et al., 2017) such as a decline of budgets coupled with increasing and diverse numbers of student enrolments (Welch, 2017). Within the HE sector, there is increased competition amongst HEIs for funding of both operations and research budgets (Quinn et al., 2009, Mitchell et al., 2015). For example, within the Australian context, government funding for HEIs has fallen by 4% from 1996-2006 (Welch, 2017). OECD data also reveals very low levels of government spending on tertiary education, for example an average of 1.4% of GDP (OECD, 2016). Barber et al. (2013) contend that the future of HEIs funding is unpredictable. Further, it is their belief that there is a requirement for HEIs to do more with less—develop new teaching and learning strategies, increase the value proposition to students and sharpen their customer focus.

Increased global competition and reduced funding have resulted in the proliferation of league tables. This has led to contexts where performance indicators showing the impact of research and teaching demonstrate the marketability of an institution to domestic and international students (Gao, 2015). The adoption of various frameworks as a mechanism for assurance of quality education and research outcomes has become an accepted practice. Frameworks such as AACSB (Association to Advance Collegiate Schools of Business) focus on measuring quality and relevance of learning and research outcomes aligned with current HE trends. However, these frameworks are designed to measure compliance which is not necessarily an incentive for continuous improvement (Dumond and Johnson, 2013). Within the literature it seems that quality in HEIs has been viewed from two distinct perspectives (Varouchas et al., 2018). First, quality is viewed as an outcome of organisational systems, for example, the use of innovative tools in programme design, delivery, assessment and research (Asif and Searcy, 2013). Second, quality is viewed as a mechanism for continuous improvement practices, for example to drive improvement of service design and performance.

HEIs are continuously challenged to meet increasing customer demands and as a consequence, many have turned to continuous improvement methodologies in an attempt to leverage organisational resources (Svensson et al., 2015). The HE sector has adopted a number of frameworks for the implementation of quality. These are listed in Table 1 below:

INSERT TABLE 1

The use of these frameworks across the globe have quality assurance as their central tenant. This is achieved through a process of assuring HEIs activities against the selected standard. Each standard is unique to country or state of origin. However, this does not preclude HEIs from other countries to become accredited by a standard. For example, Australian HEIs have sought accreditation to the AACSB and EQUIS standard. These standards require each institution to demonstrate continuous improvement, which is achieved by completing, most commonly, an online questionnaire and submission which is then assessed against criteria. Upon assessment of submissions, evaluation committees decide on those submissions that will proceed to further evaluation through site visits. However, of note is that in all the identified frameworks considered in Table 1, there is no explicit imperative to demonstrate a specific improvement methodology as part of the application of the standard.

In the context of HEI business schools, quality frameworks are shown in Table 2 below.

INSERT TABLE 2.

Each of these bodies promotes an imperative of continuous improvement (Lagrosen, 2017), therefore HEIs have adopted a variety of continuous improvement methods including Kaizen, Lean and Lean Six Sigma (LSS) (Sunder, 2016). Sunder (2015) notes that an earlier iteration of AACSB does suggest the use of Kaizen as a methodology for continuous improvement. However, when reviewed, the last version of the AACSB standard had no specific methodology for continuous improvement prescribed. The application of these methods within the HE sector have varied in their approach and results. Numerous challenges have been identified and a number of critical success factors recognised. For example management commitment and the need to link LSS to the corporate strategy (Laureani and Antony, 2012b, Sreedharan et al., 2017).

This paper presents a literature review and considers the application of LSS within the context of various HE quality frameworks. It considers the organisation drivers and barriers to the long term viability (sustainability) of these approaches in achieving quality outcomes. First, we discuss the approach taken to review the literature. Second, we outline an overview of the HE sector. Third, we examine the introduction of Lean and LSS and their sustainability in the HE sector. Finally, a viewpoint is presented regarding the challenges of these approaches within the context of the adopted overarching quality frameworks. We conclude with a suggested agenda for future research.

Methodology

The research for source material involved the use of a digital university library search engine and Ebscohost database using the key terms “Lean Six Sigma” and “higher education institutions”. 2058 manuscripts and book chapters were identified. Next, the results were limited to peer reviewed journals, books, eBooks with a date range 2000-2018. This resulted in a total of 726 articles/chapters being identified. Duplicates were removed, the article

title, subject and key words were reviewed and where required the abstract was appraised for relevance leaving a total of 40 items for consideration.

Relevance was determined by asking three research questions: How is LSS being deployed in the HE sector? What are the results of the deployment? How are the barriers and drivers to success explored? Documents that were selected focussed on the critical success factors (e.g. organisation culture and deployment approach) and constraints (e.g. wrongful customer identification) for the implementation of LSS. The review also looked to include quality frameworks in use by the HEIs that support their LSS projects. The sequence of steps undertaken in the literature review process are shown in Figure 1 below.

INSERT FIGURE 1.

Once the literature was identified a thematic analysis (Fereday and Muir-Cochrane, 2006), was conducted to identify emerging themes related to the application of quality frameworks and methodologies within the literature set.

Next, from this literature we identified a number of articles which provided illustrative case studies of LSS implementations in HEIs. The data from each of the illustrative case studies is summarised in Table 3. Finally, force field analysis (Bjursell and Engstrom, 2019) was applied to the selected literature to assimilate the critical success factors and barriers to the application of LSS in HEIs. A force field analysis is useful in this context to illustrate the resisting forces to the application of LSS. The tool has traditionally been used in the analysis of perceptions to barriers and provide guidance in understanding the tensions associated with organisation change such the implementation of quality frameworks and methodologies. For examples of use of the tool see: Baulcomb 2003; Wright and Geroy 1991; Hayes 2018.

Findings and Discussion

The following emerging themes were identified and are discussed in the sections below:

- Quality frameworks role in defining quality in HEIs
- Lean within HEIs
- LSS within HEIs
- Critical success sectors and barriers of LSS in HEI

The role of quality frameworks in defining and assuring quality in HEIs

Defining and measuring quality outside of the manufacturing context is noted as a challenge due to the range of stakeholder perspectives on what might constitute quality. Two process owners may judge the quality of the same process very differently, whereas customers can

more readily agree on the quality attributes of a manufactured product (Antony, 2015). Dill and Beerkens (2013) highlight that the traditional self-monitoring of academic standards by HEIs is inadequate to cope with the volume of changes associated with the globalisation of HEIs. Governments across the globe have sought to address this issue by establishing a set of rules and norms to ensure academic standards are achieved by graduates (Dill and Beerkens, 2013). In their seminal work on quality in the higher education sector, (Harvey and Green, 1993 p.25) recognise multiple possible definitions of quality (i.e. quality par excellence; fitness for purpose; value for money; transformation)—each definition, reflecting diverse enactments of quality for the purposes of different stakeholders (i.e. government, accrediting agencies, university administrators, academics and students) involved. Harvey and Green (1993) further argue that the application of quality is important for HE and that greater practical benefit may be achieved from understanding how different stakeholders apply their criteria for assessing quality rather than attempting to distill a single definition. The authors maintain one aspect of quality is *quality as transformation*—as change in the “knowledge, abilities and skills of students” (Harvey and Green, 1993 p.25) resulting from ongoing participation in the learning process. Though this definition of quality draws attention to the transformation of students throughout the learning process, it does not consider how academics, who are also co-creators and participants in the learning process, may be transformed. To this end we draw on the work of Cheng (2017). In articulating the importance of human centric factors, Cheng (2017) proposes that quality should be a “virtue of professional practice, which could be achieved through strengthening academic’s professionalism and improving student’s capability to learn” (Cheng, 2017 p.163). From the perspective of Cheng’s work, the application of quality frameworks needs to be enmeshed with the professional practices of academic work beyond quality assurance.

HEIs have reached the realisation that their long-term survival depends on quality of services and assurance of academic standards, aspects of quality that set one HEI apart from the rest (Aly and Akpovi, 2001). The function of the various quality frameworks including QAA, TEQSA, BAC, ENQU, EQUIS and AMBA (see Table 1 above), for example, is to assure and communicate the quality of member institutions. These frameworks serve to ensure minimum standards are attained and to improve the overall quality of the outcomes as they relate to the sector, students and the community. With the intent of the frameworks being to improve the outcomes of the sector, a challenge exists for HEIs in how they are to design processes that enable the delivery of continuous improvement. Rexeisen et al. (2018) advise that continuous improvement methods combined with a quality framework brings forth benefits to the institution and others.

Lean in HEIs

Lean has been adopted as a strategy within manufacturing, service, healthcare and education to minimise or eliminate non-value added activities and add value to products and services for their customers (Womack and Jones, 1996). Balzer (2010) advises that Lean is a strategy that provides the opportunity to create a new university culture which meets or exceeds the expectations of people serviced. Furthermore, it enables the optimum use of resources it values, employee engagement and is transformational insofar as it can create a

true learning organisation. The sustainability of Lean in HEIs has been mixed as described by Waterbury (2015). The best practices of sustainable Lean have been explored by Comm and Mathaisel (2005). They identified various aspects as important including: education of employees in Lean concepts; the application of Womack's Five Lean Principles; and defining of appropriate measures of success. More recently, in the implementation of Lean within HEIs, scholars such as Douglas et al. (2015) discuss the need to contextualise practices to the unique environment of HEIs. The authors maintain that it is imperative to translate the eight generic waste categories of Lean into terms that project teams can recognise.

Balzer et al. (2016) identify a number of academic and administrative processes that have been improved within HEIs using Lean methodology. The use of Lean methodology in US based HEIs have been able to achieve results in the reduction in cycle time, cost and approval time of administrative processes. These include faculty hiring, reduction in the student waiting time for health services and international wire transfer process. Less prevalent in the literature are the documented teaching and learning case studies where Lean principles have been applied. As evidenced in the illustrative case studies included in this paper (see Table 3), only two were associated with teaching and learning (see; Pavlovic et al., 2014, Leon, 2018).

The results achieved through Lean implementation have struggled to be sustained. Scholars have advocated for the introduction of LSS as it synergises both Lean and six sigma (Pepper and Spedding, 2010). George (2003) purports that Lean and six sigma together overcome their respective limitations. Haerizadeh and Sunder (2018) summarise clearly the reasons Lean requires Six Sigma. These authors contend that Lean lacks the prescriptive project set up, rules and a structured road map necessary to attain and sustain results. Furthermore, Lean does not recognise sources of variation and Lean lacks the focus on measurement and analysis of improvement.

LSS in HE institutions

LSS has been used extensively within the manufacturing sector and a range of industries (for example, health care; public sector) to facilitate greater customer focus and achieve savings to the bottom-line (Antony et al., 2017). Pepper and Spedding (2010) contend that the combination of Lean and Six Sigma, "if fused together, can potentially represent an exceptionally powerful tool" (p. 151) as it looks to balance the people/culture aspects with the process/tools of Six Sigma. LSS is the most common embodiment of business improvement today (Laureani and Antony, 2012a). The success of LSS as a business improvement methodology has led many organisations across the globe to adopt it in order to create efficient and effective processes, improve customer value and experience while reducing resources (Antony et al., 2017).

LSS is being adopted by HEIs and offers a structured approach to process improvement (Svensson et al., 2015, Furterer, 2009, Antony, 2014). However, Albliwi et al. (2014) note that LSS is still an emerging approach in the HEI context and more common in institutions in North America, UK and Europe (Balzer et al., 2015, Nadeau, 2017). The American Society for

Quality has described a number of benefits for the implementation of LSS in HEIs. These benefits include: supporting accreditation requirements; provision of a template for problem solving; foster cross-organisation collaboration; supports the establishment of lead and lag indicators; make processes visible; facilitates the voice of the customer and identifies and reduces hidden costs (Simons, 2013). Much of the literature and case studies pertaining to the application of LSS has focused on projects in HEIs administrative setting, for example; student admissions, service requests from students and student graduation (Chow and Downing, 2016, LeMahieu et al., 2017). Hess and Benjamin (2015) highlight a number of opportunities for the application of LSS that considers more broadly the key processes within HEIs such as, curriculum delivery; business and support services; management, marketing and research. Projects that focus on these opportunities have been documented to a lesser degree within the literature. Sunder and Antony (2018) consider this as a result of HEIs being in the early stages of implementing LSS and are therefore yet to reap and report the benefits.

The illustrative case studies summarised in Table 3 below demonstrate the application of LSS in both administrative process projects and learning and teaching projects. Within the literature there is a greater number of examples of LSS projects undertaken to improve HEIs administrative processes. The data from the case studies has identified that LSS has been implemented predominantly in the area of customer service/administration. Each of the case studies demonstrated that improvements were achieved. While qualitative data was published, it appears that any quantifiable results were not available for publication. The LSS projects presented which draw on DMAIC are from only one cycle of the methodology rather than its ongoing application. A relatively small number of case studies presented as part of this literature review discuss the detailed application of the DMAIC cycle and include critical analysis of the approach and results. Of the illustrative case studies shown below, one refers to the need to combine both a continuous improvement method with the AACSB quality framework to benefit both the HEI and others (see Rexeisen et al., 2018).

INSERT TABLE 3.

Factors that influence successful implementation of LSS in HE

Antony (2014) advises that there are a number of elements that must be in place to increase the probable success of any continuous improvement implementation. These are referred to as critical success factors and include: intrinsically motivated academic and professional employees who demonstrate an inspired and resourceful attitude; leaders who can facilitate change through a clear vision and open communication; the use of data to make decisions rather than gut-feel. Additional factors were identified by Sirvanci (2004) as: the making of LSS an organisational priority; the appropriate resourcing of LSS projects; the identification of measurable, relevant and aligned LSS goals; an organisational culture that embraces data collection in order to measure process performance and the correct identification of the customer. Balzer et al. (2016) concludes by highlighting the need to link

the improvement initiative to strategic planning and any accreditation initiatives. These factors are discussed in detail in the sections that follow and are represented as driving and constraining forces using a force-field analysis in Figure 2 below.

INSERT FIGURE 2.

Planning and co-ordination of LSS implementation

The implementation of LSS brings many challenges to HEIs. Antony et al. (2012) emphasise that there is a general lack of awareness of the benefits of LSS outside of the manufacturing industry. Similarly, Thirkell and Ashman (2014) posit that the adoption and implementation of lean thinking can only succeed when an organisation understands and embraces the concepts. Therefore the planning and development of a customised LSS road map is a critical success factor (Antony et al., 2012). The requirement for planning and co-ordination of LSS has been identified by O'Reilly et al. (2017) as a practical implication that is often missing. Through their research they recognised the need for a clear understanding of the role of project sponsors at appropriate levels across the organisation. Sponsors should also clearly comprehend the fundamental LSS concepts, tools and techniques in order to support understanding, terminology and tools.

Customer focus

Chow and Downing (2016) advise that the HE industry necessitates the adaption of LSS methods to meet the unique structure and operating environment. The literature has highlighted that HEI administrators have had difficulty in identifying their customer and their needs (Jenicke et al., 2008) and this has had an impact on the ways in which problems are responded to. It is understood within the LSS methodology that all problems are in response to customer needs (LeMahieu et al., 2017) and therefore the way in which customer needs are understood is vital. A lack of knowledge about the variety of customers, challenges HEIs to hear the voice of different customers and develop strategies to meet their specific requirements (Antony et al., 2012). The mis-identification of the customer results in wasted efforts and can lead to the failure of the improvement initiative (Sirvanci, 1996). Within the literature HEIs have multiple stakeholders, however, Sirvanci (1996) warns against the use of terms "student" in place of "customer" as this may communicate that students are the only customers. With this belief HEIs may view student satisfaction as their ultimate goal, missing the opportunity to develop a full and comprehensive view of customer focus (Quinn et al., 2009). The customer identification step is critical and provides the direction and targets for LSS and is the driving force behind any improvement project (Sirvanci, 2004).

Organisation leadership and culture

Organisation leaders may choose to implement LSS simply because they have learned of the benefits from others or because they know about its success in other service organisations (Pamfilie et al., 2012). They contend implementing LSS is not simple and requires university leaders to convey confidence and commitment to the program to assuage doubts from staff and foster a culture of improvement— resultant in increasing staff loyalty and improving workplace efficiency (Pamfilie et al., 2012). To introduce LSS into an organisation requires significant changes in how it conducts business (Rajamanoharan and Collier, 2006). Fundamentally, employee attitudes and behaviours are critical to the successful implementation of any improvement program (Antony, 2014).

Organisational culture can be a barrier to change, especially change driven by Six Sigma principles (Chow and Downing, 2016). When compared to manufacturing organisations, service organisations and HEIs have drastically different governance models, reward structures and entrenched traditions that contribute to change resistance (Sirvanci, 2004). The long established path to leadership within HEIs is for academics to demonstrate research prowess in their discipline (O’Byrne and Bond, 2010). Traditionally HEIs are structured on a hierarchical/departmental model where leadership is very much a top-down approach (Thomas and Antony, 2014). As a result of this organisation design model, departments may compete with one another for resources thus making horizontal (process) management difficult (Sirvanci, 2004).

Communication

Antony et al. (2012) highlight the importance of communication across the various levels in HEIs. Without effective communication staff may perceive their participation to be pointless. Communicating the need for LSS and the critical role staff play in achieving the strategic goal from the outset has proven to be a successful approach as described by O’Reilly et al. (2017). These authors discussed how communications were planned and conducted university-wide with an objective to encourage staff contribution to the initiative while at the same time delivering key information on the programmed approach.

The literature has outlined a number of factors that can influence or hinder the successful and ongoing sustainability of LSS within the HEI context. A force-field analysis tool has been used to assimilate and illustrate these as drivers and restraining forces of sustainable LSS in HEIs. Readiness factors have been defined as the key ingredients for the effective implementation of a LSS program (Laureani and Antony, 2012a). These are acknowledged to assist management in their planning, implementation and communication of LSS (Elias et al., 2018). HEIs are acknowledged as complex organisations with multifarious processes, goals and priorities. Whilst LSS methodology has not been implemented on a global basis within HEIs, the literature does acknowledge there have been some that have made a serious commitment to its application (Antony et al., 2012).

Conclusion

This paper has presented various quality frameworks operating within the HEI sector. The frameworks have shown to have been designed to measure compliance. Accreditation

continues to be viewed as a minimum requirement for a credible HEI and or/business school to reflect education quality. The literature has shown these frameworks to be lacking insofar as their focus on compliance with limited incentive for continuous improvement. The various tertiary education quality frameworks in use have provided HEIs with direction in regard to the necessary outcomes of teaching and learning specifically targeted at students. These frameworks do not provide HEIs with the tools and techniques to continuously improve the systems and processes that underpin teaching and learning. This has presented an opportunity within the sector to employ continuous improvement methods. Together, the synergies expected could be greater than the application of one or the other method/framework alone. This is discussed in the literature surrounding the use of LSS in HEIs which provides a limited amount of empirical evidence of its use in the sector. The majority of projects presented in the illustrative case studies have primarily focussed on student-facing or administrative processes.

With a focus on LSS as a continuous improvement method, this paper identifies the factors that may be considered as necessary for the successful implementation of LSS in HEIs. Key points of the literature foreground the roles of cross-organisation communication; active, committed leadership; an organisation culture that embraces improvement and customer focus. In summary, LSS is a powerful continuous improvement methodology that HEIs may leverage to improve administrative, academic and development processes. By adapting LSS to local context and conditions, HEIs can reap benefits of continuous improvement resultant in a positive impact on their quality outcomes beyond accreditation.

Agenda for future research

There is an opportunity for future research to be undertaken on a broader scale to include, for example teaching and learning processes. Opportunities exist for longitudinal, empirical research for the critical analysis of the success of LSS in HEIs and to facilitate benchmarking and knowledge sharing in the sector. If consideration is given to an LSS project of this nature, it could provide an opportunity for the HEI to differentiate itself from its competition through a focus on teaching and learning. Further, not all the case studies presented the outcomes of the LSS projects in terms of quantifiable results. There is a need to present such results as it provides data to identify contextualised best practice and generate opportunities for benchmarking in the sector. Each of the case studies identified presented one cycle of the improvement framework.

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Table 1.0 HE Quality Frameworks

Name of Framework	Source Country	Imperative of Framework Improvement approach recommended
TEQSA (Tertiary Education Quality Standards Agency) in Australia.	Australia	Imperative is to protect student interests and the reputation of Australia's higher education sector through a proportionate, risk-reflective approach to quality assurance and assessment that supports diversity, innovation and excellence. Nil approach recommended.
BAC (British Accreditation Council) in the UK.	UK	Imperative is the accreditation of educational quality to guarantee a standard which is used by students, parents, agencies and beyond as a guarantee of standards via a process of assessment. Nil approach recommended.
ENQA (European Association for Quality Assurance in Higher Education).	Europe	ENQA promotes European co-operation in the field of quality assurance in higher education and disseminates information and expertise among its members in order to develop and share good practice and to foster the European dimension of quality assurance. Nil approach recommended.
New England Association of Schools and Colleges (NEASC)	USA	The accreditation of independent, international and public schools through a process of quality assurance and assessment. Nil approach recommended.
Commission on Institutions of Higher Education (NEASC-CIHE)	USA	Through its evaluation activities the Commission provides public assurance about the educational quality

		<p>of degree-granting institutions that seek or wish to maintain accreditation.</p> <p>Nil approach recommended.</p>
Commission on Technical and Career Institutions (NEASC-CTCI)	USA	<p>Through a program of quality assurance and assessment, accredits a wide range of comprehensive technical high schools and career centres throughout New England.</p> <p>Nil approach recommended.</p>
Northwest Commission on Colleges and Universities (NWCCU)	USA	<p>Through its accreditation activities the Commission provides public assurance about postsecondary institutions educational quality and assessment.</p> <p>Nil approach recommended.</p>
Higher Learning Commission (HLC)	USA	<p>HLC accredits degree-granting post-secondary educational institutions in the North Central region of the USA through a process of quality assurance and assessment.</p> <p>Nil approach recommended.</p>
Southern Association of Colleges and Schools (SACS)	USA	<p>Accreditation of degree-granting higher education institutions through quality assurance and assessment.</p> <p>Nil approach recommended.</p>
Commission on Colleges, Western Association of Schools and Colleges (WASC)	USA	<p>WASC accredits elementary, secondary, adult, and postsecondary education through a process of quality assurance and assessment.</p> <p>Nil approach recommended</p>

Table 2. Business Schools Quality Frameworks

Name of Framework	Source Country	Imperative of Framework/ Improvement approach recommended
Within the context of business schools further accreditations exist including AACSB (Association to Advance Collegiate Schools of Business)	USA. Offers accreditation across the globe.	Accreditation through quality assurance and assessment. Nil framework recommended.
EQUIS (European Quality Improvement System)	Europe. Offers accreditation across the globe.	Accreditation through quality assurance and assessment. Nil framework recommended.
AMBA (Association of MBAs)	Global.	Accreditation through quality assurance and assessment. Nil framework recommended.

Table 3.

HEI	Project Foci	Achievements	Higher Education Framework	Citation
An International University located in India	Improve the search time for a book in the library from 15 to 5 minutes. Project team implement the Dewey Decimal Classification system.	Search time reduced to approximately 5 minutes. Customer satisfaction improved to 4.7 out of 5.	Nil identified	(Sunder 2016)
Allameh Tabatabai University, Tehran, Iran	Improve low student satisfaction, decrease student advising wait times.	Student satisfaction improved to 82%. Student wait times decreased. Improvements to routine procedures/practices.	Nil identified	(Haerizadeh & Sunder 2018)
Faculty of Mechanical Engineering, University of Nis, Serbia	The aim of the improvement of the education process is to reduce variation and minimise the number of exams that are not passed.	The number of students that passed exams increased from 179 to 231. All classrooms in the Faculty were cleaned, renovated and equipped with new furniture. All unnecessary items that were no longer required were removed.	Nil identified	(Pavlovic et al. 2014)

King Abdullah University of Science and Technology, Saudi Arabia	Student on-boarding for new international students.	Minor IT changes to the common causes of delay in student on-boarding were achieved. FAQ's updated and link attached to student emails from the on-boarding office.	Nil identified	(Svensson et al. 2015)
Clarkson University, Posdam, USA	Engineering management students participating in LSS projects implemented via university-industry partnerships	Students that achieved green belt certification transitioned into industry more easily, gained credibility among co-workers and supervisors, enabled them to make contributions quicker than other new employees, got the job they wanted more quickly and achieved career advancement	Nil identified	(Leon 2018)
A college in Taiwan	Project designed using DMAIC model. The project foci being the development of a procedure for a teaching feedback system.	A survey was conducted at the end of the semester looking at both importance and performance of teaching. Results from the survey were mapped and a prioritised list of improvements identified.	Nil identified	(Yu & Ueng 2012)
AACSB accredited Business College in Midwest, USA	Evaluate the value of LSS tools to help organise assessment activities using DMAIC model.	DMAIC model was deemed useful tool for engaging in thought experiments. The use of continuous improvement methods such as LSS used in combination with AACSB, assessment of learning guidelines benefits both institution and individuals.	AACSB	(Rexeisen et al. 2018)
Rensselaer Polytechnic Institute at Hartford (Connecticut)	Implementation of Kaizen to improve part-time graduate Master of Science in Management program for executives.	Elimination of ambiguity in syllabi grading criteria. Elimination of variation in syllabi format, course description, objectives. Elimination of duplicate teaching materials including case studies and journal articles. Reordering of class sequence of topics to improve flow and timing. Increase use of adult learning methods to	Nil identified	(Emiliani 2005)

German HEI	Application of Kaizen to course improvements	expand learning opportunities. Study provided evidence to support the use of Kaizen in university teaching. Findings identified improvements made to course concept, materials, presentation style and content.	Nil identified	(Kregal 2019)
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