LEVERAGING LEAN SIX SIGMA AND AI FOR HUMAN-CENTRED PROCESS OPTIMISATION IN UNIVERSITY PLACEMENT SERVICES

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ABSTRACT
This paper explores systems design methodologies to enhance human-centred product-service systems by integrating engineering Lean Six Sigma techniques and AI within a university setting. It focuses on improving the efficiency of the placement booking process within engineering and design disciplines at a UK university. Conducted over 18 months, the research enabled both implementation and evaluation, generating extensive quantitative data sauced from key stakeholders (student/staff). Key engineering tools such as Stakeholder Mapping, SIPOC, Gemba walks, Hypothesis Testing, and Control Charts were instrumental in process optimisation. The initial study examined 142 students across two placement areas, revealing that only 40% booked their second Placement Review in a single email exchange, while 60% required further contact, consuming staff time. A post-implementation study with 157 students found that an AI-assisted system reduced additional contact needs by just 8.66%, not a significant figure. However, the system significantly decreased the mean time to book a Placement Review by 67.03%, improving staff efficiency and reducing wasted student time. The study underscores the importance of understanding the Voice of the Customer and Critical to Quality (CTQ) requirements to ensure alignment with student needs. An improvement of 1.19 Sigma in CTQ defects further highlighted its success. Ultimately, the AI-powered booking system marked a significant advancement, laying the groundwork for further improvements. Its success has driven broader adoption across the university, leading to substantial time and resource savings.

Keywords: Human-centred, product-service systems, lean-six-sigma, placement, booking

1 INTRODUCTION
The Placement Development team, located in a university on the southern coast of the UK, provides personalised support for undergraduate and postgraduate students in securing and completing industrial placements. However, inefficiencies in the booking process led to excessive administrative workload, necessitating process improvements and better student communication. The study focuses on improving the efficiency of the placements booking process within engineering and design areas over an 18-month period leading to specific functional changes. This allowed both the implementation of improvements and the subsequent analysis of their effects throughout an academic period. It builds on previous studies, as a second phase of design improvement initiatives, exploring systems design methodologies, to enhance human-centred product-service systems (PSS). By leveraging the transformative impact of engineering Lean Six Sigma (LSS) techniques and examining the integration of AI, the study aims to drive design options, process improvements, optimise resource use, and deliver enhanced service outcomes for students, faculty, and staff.

2 LITERATURE REVIEW
2.1 What is Lean Six Sigma in Higher Education Institutions (HEIs)?
As previously stated, this study builds on earlier research, with White [1] concluding, “This marks the initial steps in a larger journey towards organisational excellence” and emphasising that the study “underscores the effectiveness of engineering LSS techniques in transforming university services.”
LSS integrates Lean principles, aimed at reducing waste, with Six Sigma methodologies for problem-solving. Alblooshi et al. [2] explain that “combining them will result in a powerful tool that can be used

for eliminating variation and waste." Davidson et al. [3] further highlights that LSS enables HEIs "to improve administrative, academic, and developmental processes". This perspective is reinforced by Li et al. [4], who notes that:

> "Higher education as an industry faces many challenges that have impacted other sectors: increased cost, a reduction of resource support, declining student base, resulting in an overall context for change."

Additional research by Furterer et al. [5], Wheeler-Webb and Furterer [6], and Davidson et al. [3] provides clear evidence that LSS projects have successfully reduced costs and time while enhancing quality within HEIs. Davidson et al. [3] found that the majority of LSS implementations in HEIs are student-facing or focus on administrative processes. They stress the need "to identify contextualised best practices and generate opportunities for benchmarking in the sector." The push to adopt LSS for achieving similar efficiency gains and improvements is echoed across multiple studies, including those by Alblooshi et al. [2], Li et al. [4], Furterer et al. [5], and Wheeler-Webb and Furterer [6].

2.2 Integration of AI in HEIs Support Systems

With AI playing an increasingly crucial role in education, its integration with LSS systems can enhance efficiency and drive improvements and reduce complaints within Support Services. Hannan and Liu [7] identify three primary applications of AI in higher education: process automation, cognitive insight, and cognitive engagement. Among these, process automation is the most cost-effective and accessible, as it focuses on automating back-end tasks. They note that "this automation can lead to a high return on investment by saving organisations time and money on repetitive tasks," making it the primary focus of this research.

AI-powered automation can augment administrative staff by providing continuous support and integrating seamlessly into students' schedules. As Hannan and Liu [7] highlight, "AI software can augment administrative office staff while fitting into students' busy schedules by providing 24/7 support" and enabling "personalised education" by allowing students to schedule meetings at their convenience.

Chad and Gounder [8] further support this by demonstrating, that engaging learners with, before orientation improved understanding "the university's expectations of their literacy, numeracy, and digital skills." Their study validated AI's role in developing "a very successful innovative programme that can be seen as a pioneering model for Online Orientation programmes."

Additionally, research by Cingillioglu et al. [9] showcases how AI can efficiently conduct interviews and gather participant feedback, further streamlining administrative processes. However, Wu et al. [10] caution that while AI introduces "new opportunities for personalised learning and tutoring support," it also raises concerns related to academic integrity and ethical considerations.

3 METHODOLOGIES

This study forms part of the second phase of process improvement projects undertaken at the university. Like previous studies, it was conducted over an 18-month period, allowing sufficient time for both the implementation of improvements and the subsequent analysis of their impact, over an academic cycle.

As with the pilot phase, potential project charters were submitted to a panel, for evaluation and subjected to comparative analysis. This project, along with others, was selected based on its high likelihood of success, its potential benefits, and mitigation of potential impacts and inefficiencies. The implementation of engineering LSS techniques followed the Define, Measure, Analyse, Improve, and Control (DMAIC) methodology.

Key engineering tools, including Stakeholder Mapping, SIPOC, Gemba Walks, Hypothesis Testing, and Control Charts, played a crucial role in streamlining processes. Additionally, the Voice of the Customer (VoC) and Critical to Quality (CTQ) requirements were leveraged to ensure that the new system was fully aligned with students' placement needs.

4 CASE STUDY

The placement booking system supports Product Design and Engineering students during their third-year placement (Level P) by facilitating meetings with their Placement Development Advisor (PDA). These placements provide essential real-world engineering design experience, enabling students to apply theoretical knowledge, develop practical skills, and enhance employability, while also generating evidence for professional accreditation. PDA meetings play a critical role in setting objectives, tracking

student progress, and reflecting on placement experiences. While students recognised the value of the system in supporting coaching and mentoring, they expressed a preference for a simpler, more user-friendly experience. A key challenge was non-engagement with initial booking invites, often necessitating manual follow-up. This led to frustration for both staff and students, with lapses in communication resulting in delays, missed meetings, and occasional administrative errors that compromised student participation.

4.1 DMAIC Phases

During the Define Phase, initial analysis using Lean's 8 Wastes identified four key inefficiencies in the original placement booking process (Figure 1). The Stakeholder Map: with students, PDAs, etc (Figure 2) clarified who had influence and interest, guiding communication and shaping a detailed RACI matrix to define roles, responsibilities and plan design activities. This RACI supported cross-functional team engagement, alignment, goal setting, and expectations during design meetings.

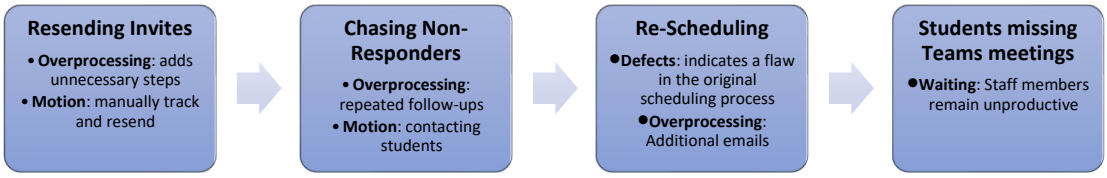

Figure 1. TIMWOODS Wastes in the original placements booking process

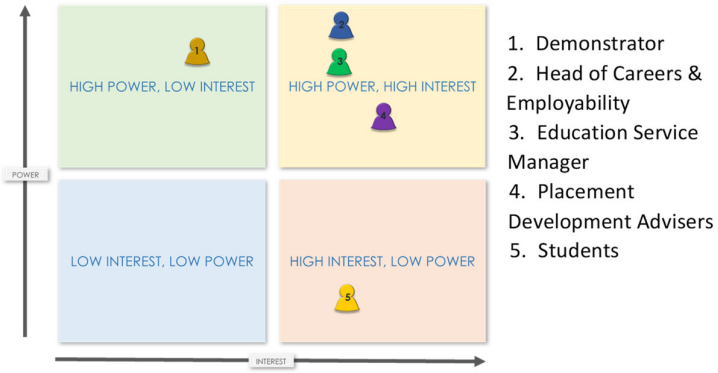

Figure 2. Stakeholder Map

A Voice of the Customer (VoC) assessment revealed key issues, including unsuitable meeting times and missed communications. Understanding student needs helped define the problem, prioritise improvements, and shape objectives. A CTQ Tree (Figure 3) illustrated essential quality elements that were measured from the perspective of Placement Development Advisers (PDAs).

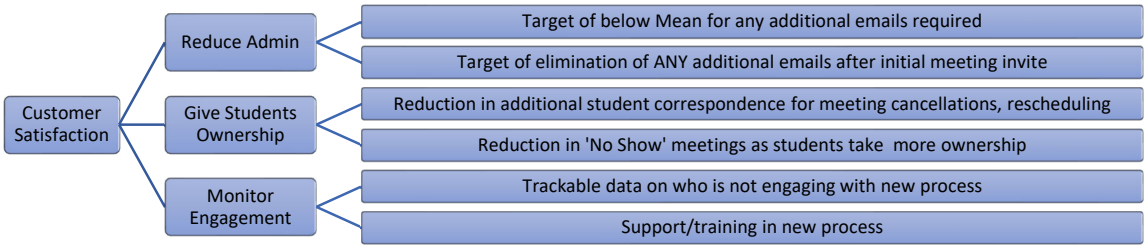

Figure 3. CTQ Tree

In the Measure Phase, key stakeholders participated in a brainstorming session and GEMBA Walk to document the current booking process. This collaborative effort-built engagement and ownership. A SIPOC diagram (Figure 4) provided a high-level process view. This was further developed into a Process Map (Figure 5) that illustrated the impact of how the lack of scheduling autonomy led to excessive communication cycles and increased the likelihood of administrative errors.

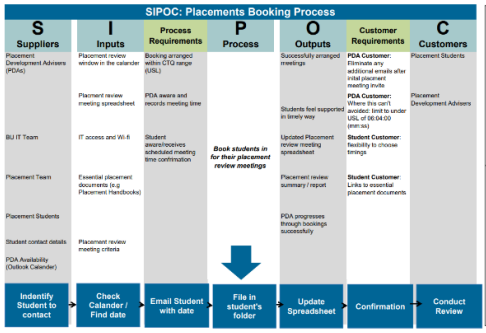

Figure 4. SIPOC

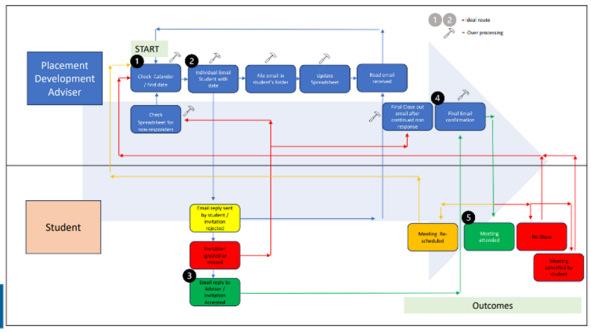

Figure 5. Pre-Implementation Process Map

During the Analyse Phase, data from 142 students showed only 40% successfully booked their second review via a single email. The remaining 60% required multiple contacts, consuming 13 staff hours due to missed or ignored messages. A Control Chart (Figure 8) identified time-consuming outliers, traced to MFA login issues abroad. This insight enabled a quick fix benefit: ensuring students updated their authentication settings pre-travel.

Root cause analysis using a Fishbone Diagram and 5 Whys helped isolate core issues. Visual mapping distinguished root causes from symptoms and guided prioritised interventions. A hypothesis was formed: using student data to implement a solution that would reduce booking time. A two-tailed T-Test on 2021–22 data returned a P-value below the threshold, rejecting the Null Hypothesis and validating the improvement.

In the Improve Phase, potential solutions were evaluated using FMEA and a Solution Selection Matrix (Figure 6). A two-phase approach was adopted: tracking disengaged students and implementing Generative AI within Power Automate. The updated Process Map (Figure 7) showed how automation via MS Bookings, using students' input, reduced over-processing, cutting down PDA tasks and signalling opportunities for further efficiency through AI.

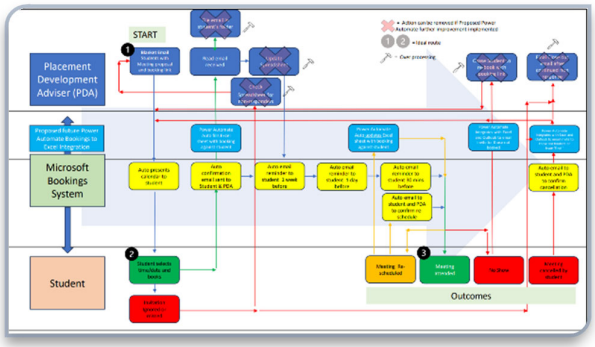

Figure 6. Solution Select Matrix

Placement Booking Process Improvement	Very Low				Moderate					Very High		
	1	2	3	4	5	6	7	8	9	10		
Solution	Has time saving Automation	Uses New Tech	Provides Student Ownership	Ease of use	Good Monitoring of engagement	Low training requirement	Low time investment	Low cost Investement	Meets Customer Critical to Quality	Flexible	**Total Score**	**Choose? Yes/No**
Weighted Criteria (what we value the most)	8	8	7	10	7	4	6	7	10	8		
Microsoft Bookings Office 365	7	6	10	10	9	10	8	10	10	10	*675*	Yes
Fixing review times pre-placement	1	1	1	10	5	10	8	10	5	2	*382*	No
Employer tasking project	1	1	1	7	5	6	6	7	3	5	*307*	No

Figure 7. Post-Implementation Process Map

Post-implementation, a control plan ensured sustainability, preventing regression. Student satisfaction was monitored via annual surveys, and regular staff meetings reviewed process performance. Staff training cycles and onboarding materials addressed turnover. Contingency plans were made for IT updates, particularly those affecting MS Bookings and Power Automate integrations.

4.2 Solution

Microsoft Bookings was selected for its ability to offer students autonomy in selecting appointment times, receiving automated confirmations, reminders, and rescheduling their Placement Reviews. Its

seamless integration with Outlook and other Microsoft tools enables calendar syncing and structured communication, supporting a human-centred Product-Service System (PSS) for placement management.

Power Automate can extend the capabilities of Microsoft Bookings by introducing Generative AI-driven automation to streamline workflows. It automates follow-ups, monitors student non-engagement, customises student notifications, and generates actionable reports to support continuous improvement. This reduces the administrative burden on staff while enhancing student responsiveness and accuracy, resulting in improved overall efficiency. The implementation of Power Automate unlocks further opportunities for AI design process optimisation. Automated workflows now:

- Log successful bookings into a master spreadsheet with student-specific dates,
- Trigger follow-up emails for non-respondents via Outlook and Excel,
- Collect and analyse feedback through Microsoft Forms, with summaries sent to advisers via Teams,
- Perform sentiment analysis to flag concerns in real-time, and
- Aggregate placement data to inform academic curriculum enhancements.

These design innovations exemplify how AI integration can significantly, improve operational efficiency and student support within higher education.

5 RESULTS

The post-implementation study involved 157 students from the same two placement areas as the baseline analysis, ensuring a comparable data set. Although the AI-enabled MS Bookings system reduced the number of students requiring further contact by only 8.66%, more significant gains were observed in AI process efficiency. Control Charts (Figure 8) indicate substantial reductions in the mean, Upper Control Limit (UCL), and standard deviation for booking times. Notably, the average time to book a Placement Review decreased from 6 minutes 4 seconds to 2 minutes, a 67.03% improvement. This change markedly enhanced staff productivity and reduced student time waste, enabling them to concentrate on enhance student learning and procession.

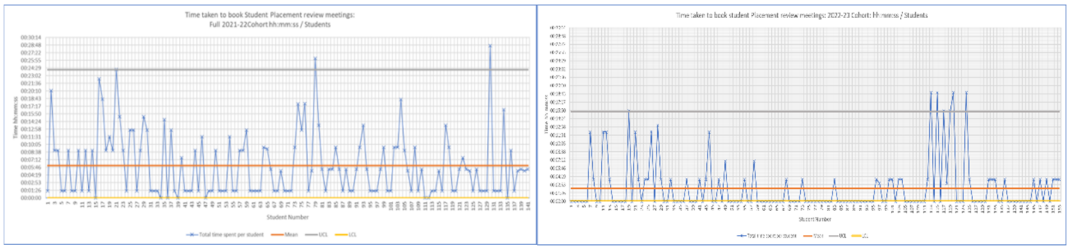

Figure 8. Control Charts (Pre and Post Implementation)

While placement engagement remained relatively stable, 46% of the 2021–22 cohort (53 of 115) and 38% of the 2022–23 cohort (42 of 112) secured placements, the statistical correlation to pass rates was inconclusive. Nonetheless, user feedback highlighted strong satisfaction, particularly regarding time savings. Persistent challenges include communication barriers for overseas or disengaged students. Future onboarding will address these issues through targeted MS Bookings training and clearer expectation-setting, tailored to accommodate diverse learning needs.

A key outcome was the reduction in CTQ (Critical to Quality) defects. Post-implementation analysis showed a Sigma level improvement from 1.19 to 2.29, reducing defects per million opportunities from 656,000 to 215,000. These results affirm the effectiveness of AI integration in improving process quality, student experience, reduction of wasted time and improved efficiency.

6 DISCUSSIONS AND CONCLUSIONS

The successful implementation of Lean Six Sigma (LSS) in developing an AI-assisted placement booking system demonstrates the transformative potential of human-centred design for process optimisation in higher education. Building on the project's first phase, this initiative underscores how engineered LSS techniques can meaningfully enhance university administrative services and the student experience. The project's outcomes have led to broader institutional adoption of Microsoft Bookings,

showcasing its scalability and effectiveness in improving service delivery.

The initiative achieved an improvement of 1.19 Sigma levels, reaching a post-intervention Sigma score of 2.29. This aligns with typical benchmarks for early-phase LSS projects while highlighting the scope for continued refinement. The phased implementation strategy, initially focusing on Microsoft Bookings, followed by deeper integration of Generative AI via Power Automate, provides effectiveness in ensuring controlled, sustainable design and development (Figure 7).

Emerging literature supports the project's human-centred, AI-enabled approach, indicating that students are equally comfortable interacting with Generative AI or chatbots as with human staff for routine tasks such as scheduling. Nonetheless, technical challenges persist. A Microsoft-wide glitch affecting Bookings and Power Automate temporarily disrupted the automated tracking of disengaged students, requiring manual intervention. This anomaly, reflected in the Control Chart (Figure 8), has since shown marked reduction.

Institution-wide, the adoption of Microsoft Bookings for scheduling Placement Reviews has been highly successful, extending across placement teams and significantly streamlining administrative workflows. This system has improved coordination and student engagement, with positive feedback from both staff and students. One student remarked, "It was very easy to book this online and only took a few minutes - it's a great system, really easy to use!" Similarly, Placement Development Advisers (PDAs) noted a reduction of "at least 2.5 emails per booking," affirming the system's efficiency and benefit.

Ongoing challenges, such as varying digital competencies among staff and fluctuating student engagement, have been addressed through structured training, support resources, and iterative workflow design improvements based on feedback. Looking ahead, Generative AI offers further promise in predictive scheduling, proactive reminders, and enhanced user interaction. Despite remaining limitations, the new system has demonstrably improved operational efficiency, reduced manual workload, and fostered a more structured and accessible experience for students navigating placement reviews.

To conclude these changes have enabled students to be free to focus their time on Placement study and to achieving their objectives, within Product Design and Engineering settings, rather waste time on arranging meetings or unnecessary added admin.

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