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BARRIERS AND WASTE IN THE RESEARCH GRANT APPLICATION PROCESS IN HIGHER EDUCATION THROUGH A LEAN SIX SIGMA LENS

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Abstract
Higher education institutions (HEIs) typically generate income from two main sources; student fees and research income. In contrast, the predominant waste streams in HEIs tend to include; (1) assignment/examination mark submission process, (2) photocopying process and (3) the funding application process. Unintended internal process complexities and barriers typically aggravate the challenges already inherent in the research grant application process. Although Lean Six Sigma (LSS) has been adopted by a number of HEIs in Ireland, very few have adopted an integrated LSS approach for waste reduction in the research grant application process. To identify barriers and waste in the research grant application process within an Irish HEI in an EU environment, the authors used an online survey deployed to 240 academics and researchers. The survey response rate was 13%. The participating HEI in this pilot study generated an annual income (including student fees and research income) exceeding €240 million for the academic year 2017/2018. Using an LSS lens, this paper identified the primary waste in the research grant application process from an academic and researcher perspective to be; editing and revising applications, liaising and communicating with collaborators and waiting for information. Organised thematically, the main barriers were strategic thinking, collaborator identification and co-ordination, eligibility, process, time and support & mentoring. The results from this study can be used to inform the next stage of the research where empirical studies will be carried out in other HEIs to develop a practical roadmap for the implementation of LSS as an operational excellence improvement methodology in the research grant application process.

Keywords
LSS, grant application, barriers, DMAIC, waste, higher education, operational excellence.

Introduction

Higher Education Institutions (HEIs) are under increasing pressure to generate income and reduce waste in an environment of declining resources and increasing student numbers [1–3]. The main income generation for a typical HEI comprises student fees and research with each being integral to the HEI's performance. Global university rankings (e.g. THE World University Rankings and the QS World University), which are shown to influence students' choice of third level institution, typically include comparisons of HEI performance along multiple indicators including teaching, research and interaction with industry [4]. Since the 2008 economic recession, Irish HEIs have retained their autonomy but are accountable to government through the Higher Education Authority (HEA) [5]. The HEA exercises a central oversight role in the higher education system and is ultimately accountable to the Minister for Further and Higher Education, Research, Innovation and Science for the achievement of national

outcomes through a service level agreement for the higher education sector. The HEA is also involved in quality assurance review procedures [6] and requires high levels of performance even though HEIs have experienced considerable cuts in funding, incurred a high staff–student ratio of 19:3 and are more accountable since 2009 [5]. The predominant waste streams in HEIs generally tend to be; (1) the assignment/examination mark submission process, (2) the photocopying process and (3) the research funding application process [7].

A study on the Academic Profession in Ireland, reported that on average, 39% of academics had received funding from their own institutions, 31% had received research funding from national agencies and 13% had received funding from Government agencies [5]. Furthermore, this study revealed that the proportion of time spent on funding applications ranged from 0–86% (Table 1) [5].

Table 1
Source of research funding [5].

	Mean proportion of source of funding
Your own institution	39%
Public research funding agencies	31%
Government entities	13%
Business firms or industry	4%
Private not-for-profit foundations/agencies	5%
Other	8%

By continually changing the funding model which is necessary to sustain Irish HEIs, increasing pressure is put on the research funding activity, thereby leading to questions such as; is it necessary or efficient for researchers and academics to bid for the same funding? What proportion of time is dedicated to the research application process activity? What are the success rates for funding? and what is the opportunity cost of successfully bidding for research funding? Ultimately, HEI research activity should be examined in terms of value-add and non-value add activities. While HEIs have implemented initiatives to reduce and/or control costs [7], more needs to be done. As the principles of LSS (which promote continuous improvement and waste reduction) are in close alignment with the mission of HEIs [1], the authors suggest that it is necessary to examine the research funding application process through a Lean Six Sigma (LSS) customer driven lens in order to identify waste activities. LSS originated in 2000 as a business improvement methodology by integrating Lean and Six Sigma philosophies with an overarching goal of maximizing shareholders' value through improving quality, speed, customer satisfaction and costs [7]. LSS concentrates on the underlying causes of process flow and waste problems in order to reduce process variations [8]. Ultimately LSS methodologies aim to; assure services/products conformance to customer needs ('voice of the customer'), remove non-value add process steps (waste), reduce quality cost, decrease cycle time and deliver product/service at the expected time in the designated location. The benefits and limitations of LSS have been highlighted extensively in the literature [9-11]. LSS strategies underpin continuous improvement programmes in manufacturing, service and public service organisations [12]. LSS can provide the concepts, methods and tools for process improvement [9]. Two approaches to LSS include; (1) an integrated approach with a view to an holistic unified methodology [9] and (2) a framework for the integration of Lean and Six Sigma [11]. In order to ensure both the sustainability and success of LSS projects, appropriate methdologies and tools should be used [13]. The DMAIC (Design, Measure, Analyze, Improve and Control) methodology is one such LSS continuous improvement methodology which has been developed to address a specific type of operational issue (another being the plan-do-check-act cycle [14, 15]).

In this paper, the authors identify barrier and wastes in the research grant application process within an Irish HEI in an EU environment through the lens of the DMAIC methodology. The HEI participating in this pilot study is a research intensive university. It has approximately 1700 academic and research staff. Of those, 240 academic and research staff from the STEM (science, technology, engineering and maths) community were surveyed. While the response rate of 13% affects the generalizability of the results, it does not mitigate against reflection. Further, the results of this study can be used to inform the next stage of the research where empirical studies will be carried out in other HEIs to develop a practical roadmap for the implementation of LSS as an operational excellence improvement methodology in the grant application process.

DMAIC

The five phases of the Design, Measure, Analyse, Impement, and Control (DMAIC) continuous improvement methodology, are clearly defined with associated supporting tools [16] encompassing statistical and non-statistical approaches [17]. Such supporting tools however need time to be correctly implemented (). The phases of the DMAIC data driven

improvement methodology, which are fundamental to successful LSS implementation are [18–20]:

- *Define* the problem.
- *Measure* the current situation and translate the problem into measurable parameters.
- *Analyze* the impact of these parameters and other facts on the critical to quality behavior.
- *Improve* the critical to quality performance through implementing process adjustments.
- *Control*: continuously monitor and revise the process in order to maintain sustainable improvements.

The manner in which the DMAIC methodology was implemented in this study is shown in Fig. 1. Only the first three stages of this methodology were used in this pilot study.

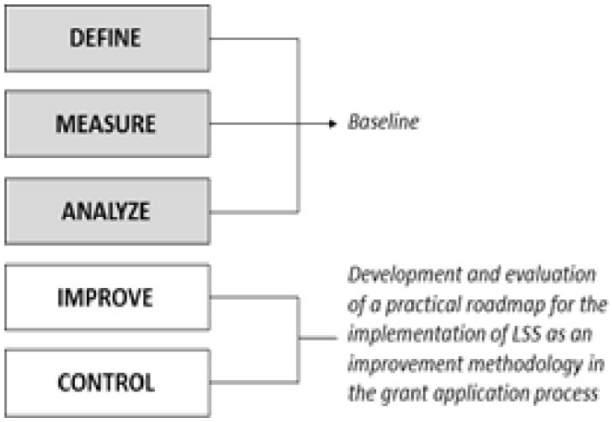


Fig. 1. DMAIC.

- Define: This phase commenced with a dialog on the grant application process. An analysis of the feedback from the academics and researchers (customers) indicated frustrations with the lack of support for and barriers to the research grant application process. The main requirement for this customer group is an efficient and effective process. The participating HEI in this pilot study generated an annual income (comprising student fees and research income) exceeding €240million for the academic year 2017/2018.
- Measure: After the problem was defined, the authors designed and deployed a survey to collect data on perceived barriers and wastes to the grant application process. As part of the initial survey validation, the survey was tested by an equal number of academics and researchers (10 in total). All of these experts had been awarded large research grants.
- Analyse: The resultant data was analysed under two themes; the main barriers and the main wastes in the research grant application process. The results from this phase are presented in the following sections.

Methodology

In this pilot study of the research grant application process, an online questionnaire as a data collection instrument was deployed to 240 researchers and academics from a college in a large Irish HEI having more than 1700 academic and research staff. The response rate from this pilot study was 13%.

The first part of the questionnaire was designed to collect fundamental information on the respondent i.e. their gender, role and experience. The second part of the questionnaire focused on barriers and wastes to the research grant bid process in addition to their success rate. The final section focussed on time related application activities.

Results

In an Irish HEI, academic staff are expected to allocate 40% of their time to research. However, there are no specified upper or lower limits on the time they allocate to the research funding application process. Meanwhile, researcher staff are contracted to projects which may include grant writing. Academic and researcher staff typically seek funding in a pattern that matches their workload responsibilities. Roles associated with research grant applications vary and include; Academic, Researcher, Research Coordinator and Research Project Manager.

With a response rate of 13% ($n = 240$), 31 staff were surveyed, of which 32.3% are female. 61.3% are male and the remainder cited 'Prefer not to say' (Table 2). Of those surveyed, 64.5% are academics and 35.5% are researchers (Table 3). Of the 93.5% who have bid for a grant, 31% ($n = 29$) are female. Those who did not bid for a grant cited the following reasons:

- "I am not on a permanent contract and that makes things more difficult*" [Male researcher, 2 years in the role].*
- "Eligibility criteria such as; length since PhD awarded, prior supervision experience, previously having had a competitive grant*" [Female academic, 20 years in the role].*

The most targeted funding calls are Science Foundation Ireland (SFI), H2020 and Enterprise Ireland (Fig. 2).

Table 2
Gender.

	Frequency	[%]	Valid [%]	Cumulative [%]
Female	10	32.3	32.3	32.3
Male	19	61.3	61.3	93.5
Prefer not to say	2	6.5	6.5	100
Total	31	100	100	

Table 3
Role of the respondents.

	Frequency	[%]	Valid [%]	Cumulative [%]
Academic	18	58.1	58.1	58.1
Researcher	2	6.5	6.5	64.5
Research co-ordinator, Research project manager	1	3.2	3.2	74.2
Researcher	8	25.8	25.8	100
Total	31	100	100	

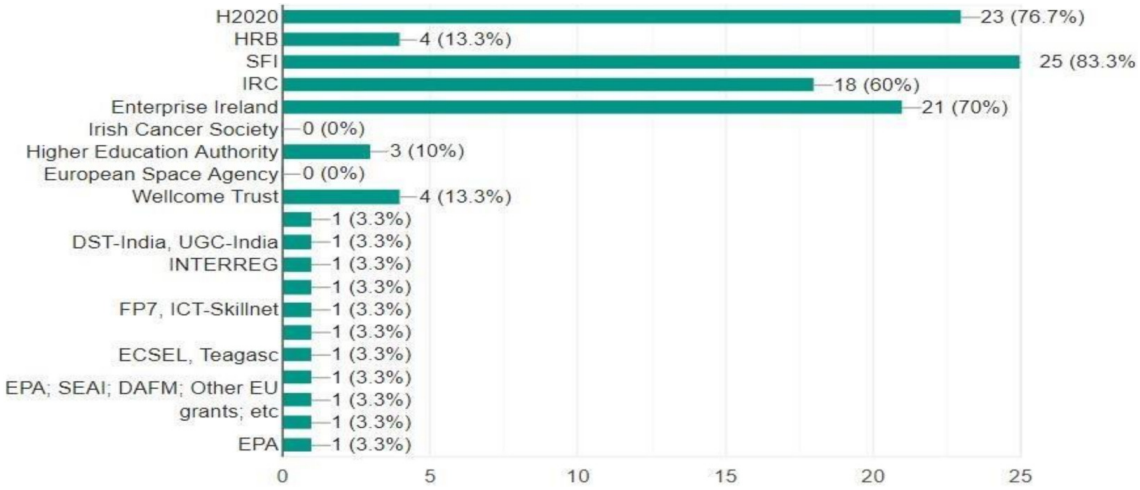


Fig. 2. Research Funding Calls.

The findings in this pilot study were analysed thematically. "Thematic analysis is the process of identifying patterns or themes within qualitative data" [21]. The analysis of the qualitative data was primarily at the level of semantic themes. However, where relevant, the authors delved deeper and examined the responses at the latent level. Thematic analysis at the semantic level is defined as an examination of the "...the explicit or surface meanings of the data" (p. 84) [21]. Meanwhile thematic analysis at the latent level is defined as the point at which one starts "to identify or examine the underlying ideas, assumptions, and conceptualisations – and ideologies – that are theorised as shaping or informing the semantic content of the data" (p. 84). The thematic analysis was underpinned by this study's research objectives; what are the main barriers and wastes associated with the research grant application process?

Barriers associated with the research grant application process

Lean principles and practices can be applied to HEI processes in order to improve the efficiency and effectiveness of service challenges [22]. A gap exists regarding the application of LSS to those HEI services which by nature contain high human input and expectation [23]. Table 4 presents the barriers faced by the academics and researchers during the grant application process.

Table 4
Barriers in the research grant application process.

Category	Commentary
Strategy	Lack of strategic thinking
Collaborator	Finding good collaborators
	Very little co-ordination across teams
	Identifying collaborators with relevant expertise
Eligibility	As a researcher with a contract position, there are many grants I cannot apply for
	PMs allocation according to research efforts
Process	Understanding the procedure of filling the forms, understanding rules, cost estimation etc.
	The lack of clear support materials explaining administrative procedures (e.g. budgets, recruitment etc.)
	Writing a detailed, convincing, novel scientific set of goals
	Striving to answer each question asked clearly and concisely
	Unpredictable process
	Writing the proposal
	Ultimately, the main challenge is in shaping the concept
	Finding an appropriate call
	Competition
	Defining impact
	How to express my idea without disclosing secrecy
Time	We lecture, mark exams and projects, do project management & administration, have to go through lengthy processes to hire staff, supervise students, are responsible for health and safety in laboratories/on-site work, write grants, travel to project meetings or to engage collaborators, project reporting and auditing etc!! No appropriate workload model exists or is enforced. As native English speakers it is also difficult as you often have the responsibility to ensure language and grammatical issues are up to standard
	The academic work simply does not give space to writing research proposals. My research proposal activity has greatly dropped in the face of mounting programme administration, new modules to teach, larger class sizes, and insufficient postgraduate support/availability for lab work and assessment grading – particularly at taught at postgraduate level
	Getting enough time to write proposals, while delivering projects & teaching, with low success
	Finding blocks of time to fully commit to proposal writing
	Trying to meet Research Office deadlines
	Importance of taking time off to develop research direction before even starting to think of bidding
	Opportunity
Support	The lack of support in terms of grant writing. This could be resolved by having longer term postdoctoral/research fellow positions linked to PIs where they can demonstrate they are able to deliver successful applications. This could be funded through return of overheads across all grants (to a certain percentage). More direct input from support services also needed
	Not being recognised/supported at institutional level
	Low support
	I lack knowledge and experience in writing bids so I am still in the process of learning with more experienced people on how to do it. The challenge is to create the opportunity to learn from others
	When leading – finding out what procedures are for submission and best practice
Evaluation	Second-guessing reviewers' interpretations of funders' guidelines

Wastes in the research grant application process

Editing and revising, liaising and communicating with collaborators and waiting for information were regarded as the most time consuming aspects to the grant application process (Fig. 3).

Participants identified that they can spend anything from 10 hours to 840 hours per annum on grant applications. However, the greater the time spent in the grant application process, does not guarantee success.

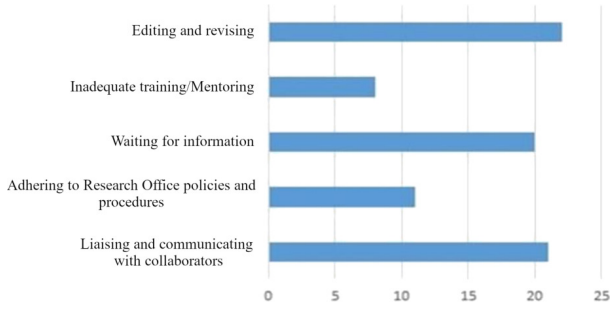


Fig. 3. Grant application time consuming aspects.

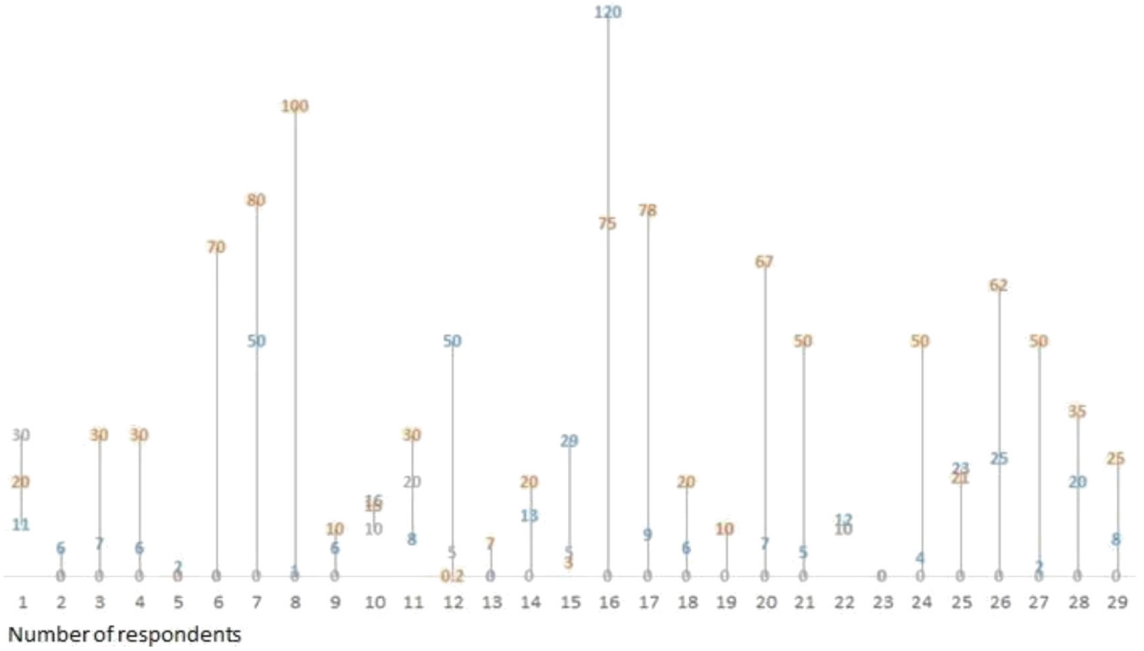


Fig. 4. Research grant applications, successful applications and incomplete applications.

In Fig. 4, the research application data is organised by individual responses (X-axis). Note that each response has between 1 and 3 numbers arranged vertically. The top numbers represent the number of grant applications; the middle numbers represent the number of successful applications, whilst the bottom numbers represent the number of incomplete applications. As an example, respondent 1 made 30 grant applications, 20 were successful, whilst 10 were incomplete. The most successful grant applicant is a male fulltime researcher. The main reasons cited by the respondents for unsuccessful grant application bids are organised by theme in Table 5.

Table 5
Reasons cited for unsuccessful research application bids.

Theme	Commentary
Experience	Insufficient levels of experience
Eligibility	Ineligible The application was not completely aligned with the objectives of the call Relevance to call, partner involvement and suitability of call
Information	Absence of grant records
Commercialization process	Incorrect commercialization process. Positive reviews, but final decision was not based on the reason that it is possible that someone in industry might/will be currently doing it or will do it and finish it before me.
Technical	Various technical reasons or fell short of the required marks for funding.
Competition	Highly competitive. Lack of funding.
Quality	High standards. Generally, not high enough quality research. Unfavourably reviewed. Some weak bids, some good bids which didn't hit home with reviewers, some luck of the draw. Not strong enough. Who knows?
Communication	Sometimes the reviewers misunderstood the content. I don't really know because the feedback varies.

Figure 5 highlights the percentage of incomplete bids. As is shown, 24% ($n = 25$) of respondents (Y-axis) indicated that their grant application journey concluded with an incomplete application. This identifies waste in the application process. A lack of clear support can result in unnecessary tasks which can in turn distract from the grant application process with resultant negative consequences on cognition [24].

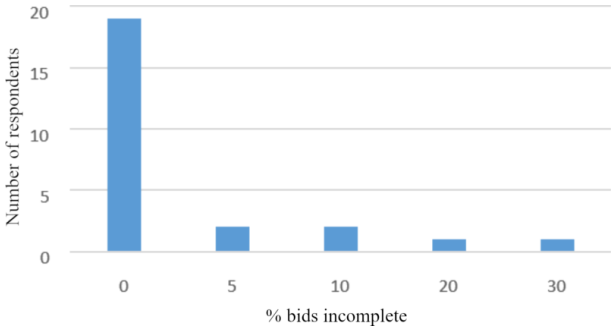


Fig. 5. % of incomplete bids.

The reasons why the respondents believed that their research grant applications resulted in an incomplete status, are organised thematically in Table 6.

Table 6
Reasons cited for why research application bids were incomplete.

Theme	Commentary
Time	Delay in receiving feedback from collaborators. Insufficient time. Not organised enough.
Technical	Issues with submission portal.
Communication	In particular, awareness of changes to the submission process that were not communicated
Error	The information was incorrect.

Discussion

On examination of the results, the greater the experience in the research grant application process, the higher the success rate and the lower the rate of incomplete applications. The findings suggest that to reduce the number of incomplete and failed applications, more time needs to be spent networking, acquiring collaborators and coordinating across teams. The findings also suggest that research agencies such as the Irish Research Council (IRC) and Science Foundation Ireland (SFI) need to change their eligibility criteria to enable contract researchers to apply as PIs for grants. Some barriers could be overcome if more focused and targeted support is provided by the Research Office. The authors suggest Lego Serious Play (LSP) as an approach to clarify support roles and responsibilities. LSP facilitates communication and shared mental models [25, 26]. The respondents suggested that mentoring by senior academics could accelerate research application success rates. The time spent on the research grant application process can range from 10 to 840 hours. To the best of the authors' knowledge, the HEI in question in this study has not set any lower or upper limits for academics regarding time spent on grant applications. Although this pilot study does not analyse the results by gender, SFI, one of the largest research funding organisations in Ireland recognises an inherent gender bias in applications. SFI's 2016 Gender Strategy sets a target of 30% female award holders and research teams to comprise at least 40% of each gender by 2020 [27].

Conclusions

The objectives of this study were to identify, through the lens of Lean Six Sigma, the main barriers associated with, and the most prominent wastes in the research grant application process from the researcher and academic perspectives. According to [28, 29], LSS methodology, continuous improvement cycles can be used to aggressively pursue efficiency and tackle waste. As student fees and research income are the main contributors to HEI income, an improvement of 1% in these processes has the potential to generate in excess of €2.4 million.

Categorised thematically, the main barriers to successful research grant applications were; (1) Strategy, (2) Collaborator, (3) Eligibility, (4) Process, (5) Time, (6) Support and (7) Evaluation. Regarding the defecit in the research application support process, the authors suggest that Lego Serious Play (LSP) – a proven methodology to resolve misconceptions and miscommunications – can be used to clarify the research support service roles and responsibilities [25, 26]. Meanwhile, the top three wastes in the research grant application process were identified as (1) editing and revising, (2) liaising and communicating with collaborators and (3) waiting for information. With an increased number of applicants bidding for the same funding and some applicants investing up to 840 hours per annum on grant applications, the authors recommend a targeted and more streamlined application strategy for HEI efficiencies. Whilst gender was not reported by the respondents as either a direct challange and/or barrier, it may manifest indirectly in relation to time con-

straints and administration burden. HEIs have a responsibility to overcome any inherant gender bias in the application process and meet the targets set by funding organisations.

The main recommendations from this pilot study are:

- A consultation process between internal and external stakeholders should take place.
- A mentorship scheme should be established/fortified to support research activity.
- Administrators should be embedded more deeply into the research process to leverage a range of expertise and efficiencies.
- A system which supports the selection of an appropriate funder and the navigation of institutional policies and provides access to successful research grant application exemplars should be provided to researchers [30].

In summary, the overall performance of the academics' and researchers' experience with the research grant application process can be supported through the creation of a culture where collaboration and networking are fostered and barriers to eligibility are removed. Ultimately, this 'cultural shift' is highly dependent on senior management 'buy-in' from the university and the funding agencies.

Having identified barriers and wastes in the research grant application process, the next step of this research is to develop an extensive study on the appropriate tools and methodologies to address the identified wastes.

We sincerely thank the participating staff for their contribution to this study.

References

[1] Mazumder Q.H., *Applying six sigma in higher education quality improvement*, 21st ASEE Annual Conference and Exposition, 2014.

[2] Dempsey M., Brennan A., *Turbocharging the journey into the liminal space and beyond*, 11th International Technology, Education and Development Conference, International Academy of Technology, Education and Development (IATED), 2017.

[3] Balzer W.K., Brodke M.H., Kizhakethalackal E.T., *Lean higher education: successes, challenges, and realizing potential*, International Journal of Quality & Reliability Management, 32, 9, 924–933, 2015.

[4] Brennan A., Dempsey M., *P-PAC (Partnership in Pedagogy, Accreditation, and Collaboration): a framework to support student transition to employability in industry. A lean systems case study*, Management and Production Engineering Review, 9, 2018.

[5] Clarke M. et al., *The academic profession in Ireland*, University College Dublin, 2015.

[6] O'Dea M., Dempsey M., Brennan A., *The link between off campus work for students, reduced academic performance and increased mental health issues*, 12th International Technology, Education and Development Conference, International Academy of Technology, Education and Development (IATED), 2018.

[7] Antony J., Douglas J., Douglas A., *Waste identification and elimination in HEIs: the role of Lean thinking*, International Journal of Quality & Reliability Management, 2015.

[8] Antony J. et al., *An exploratory study into the use of lean six sigma to reduce medication errors in the Norwegian public healthcare context*, Leadership in Health Services, 2019.

[9] Laureani A., Antony J., *Leadership and Lean Six Sigma: a systematic literature review*, Total Quality Management & Business Excellence, 30, 1–2, 53–81, 2019.

[10] Alexander P., Antony J., Rodgers B., *Lean Six Sigma for small-and medium-sized manufacturing enterprises: a systematic review*, International Journal of Quality & Reliability Management, 36, 3, 378–397, 2019.

[11] Haerizadeh M., Sunder V.M., *Impacts of Lean Six Sigma on improving a higher education system: a case study*, International Journal of Quality & Reliability Management, 36, 6, 983–998, 2019.

[12] Albliwi S.A., Antony J., Lim S.A.H., *A systematic review of Lean Six Sigma for the manufacturing industry*, Business Process Management Journal, 21, 3, 665–691, 2015.

[13] Antony J. et al., *A study into the reasons for process improvement project failures: results from a pilot survey*, International Journal of Quality & Reliability Management, 2019.

[14] Antony J., Gupta S., *Top ten reasons for process improvement project failures*, International Journal of Lean Six Sigma, 10, 1, 367–374, 2019.

[15] De Mast J., Lokkerbol J., *An analysis of the Six Sigma DMAIC method from the perspective of problem solving*, International Journal of Production Economics, 139, 2, 604–614, 2012.

[16] Easton G.S., Rosenzweig E.D., *The role of experience in six sigma project success: An empirical analysis of improvement projects*, Journal of Operations Management, 30, 7–8, 481–493, 2012.

[17] Zu X., Fredendall L.D., Douglas T.J., *The evolving theory of quality management: the role of Six Sigma*,

Journal of operations Management, 26, 5, 630–650, 2008.

[18] Khajuria A., Raina A., Singh M.P., *Implementation of DMAIC six sigma principle in thermoforming for improving rate of production*, International Journal for Research in Mechanical & Civil Engineering (ISSN: 2208-2727), 4, 1, 13–22, 2018.

[19] Hakimi S., Zahraee S.M., Mohd Rohani J., *Application of Six Sigma DMAIC methodology in plain yogurt production process*, International Journal of Lean Six Sigma, 9, 4, 562–578, 2018.

[20] Antony J. et al., *An evaluation into the limitations and emerging trends of Six Sigma: an empirical study*, The TQM Journal, 31, 2, 205–221, 2019.

[21] Maguire M., Delahunt B., *Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars*, AISHE-J: The All Ireland Journal of Teaching and Learning in Higher Education, 9, 3, 2017.

[22] Balzer W.K. et al., *A review and perspective on Lean in higher education*, Quality Assurance in Education, 24, 4, 442–462, 2016.

[23] Li N., Laux C.M., Antony J., *How to use lean Six Sigma methodology to improve service process in higher education*, International Journal of Lean Six Sigma, 2019.

[24] Brennan A., Dempsey M., *The student voice: The student's own views on smartphone usage and impact on their academic performance*, INTED, Valencia, 2018.

[25] Tawalbeh M. et al., *Lego® Serious Play® as a Business Innovation enabler*, 5th European Lean Educator Conference, 2018.

[26] Dempsey M., Riedel R., Kelly M., *Serious Play as a method for process design*, IFIP International Conference on Advances in Production Management Systems, Springer, 2014.

[27] Fritch R. et al., *Practitioners' perspectives: a funder's experience of addressing gender balance in its portfolio of awards*, Interdisciplinary Science Reviews, 44, 2, 192–203, 2019.

[28] Cudney E.A. et al., *Systematic review of Lean and Six Sigma approaches in higher education*, Total Quality Management & Business Excellence, p. 1–14, 2018.

[29] Antony J., Forthun S.C. Trakulsunti, Y., Farrington T., McFarlane J., Brennan A., Dempsey M., *An exploratory study into the use of lean six sigma to reduce medication errors in the Norwegian public healthcare context*, Leadership in Health Services, 2019.

[30] Brennan A., Dempsey M., *Perceived Non-Value Add Activities in the Research Grant Application Process through a Lean Six Sigma Lens*, [in:] Antony J. [Ed.], *Lean Six Sigma in Higher Education: A Practical Guide for Continuous Improvement Professionals in Higher Education*, Emerald publishing "inpress", 2020.