Lean Six Sigma for reducing student dropouts in Higher Education – an exploratory study

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Abstract

This paper investigates the reasons behind student dropouts in higher education institutions (HEIs) exploring the use of Lean Six Sigma (LSS) tools in reducing dropout rates. This qualitative study used twelve semi-structured interviews with university employees (nine) and LSS experts (three), in order to understand the complexity of the dropout phenomenon and the role of various LSS tools in reducing the dropouts. Analysis revealed that, in order to develop a typology of student dropouts, maintain detailed records, and sensitize relevant authorities about the impact of a student's dropout decision, LSS was an appropriate methodology to use as a turnaround strategy for HEIs in managing the phenomenon.

Though the small sample size is a limitation of the study, the revelations of HEIs authorities and LSS experts have given new impetus to look at and take action on the issue of student dropouts in HEIs.

Key words: Lean, Six Sigma, DMAIC, student dropout rates, Higher Education
Paper type: Research paper

Introduction

Education provides a wide range of economic and social benefits for individuals and for society (Brennan et al., 2013; Baum et al., 2013). Well-educated individuals have a lower propensity to commit crime, are less likely to smoke, to drink excessively or to be obese - which all results in a longer and healthier life (BIS, 2011; Baum et al., 2013). In addition to these physiological factors, knowledgeable people reportedly have a better mental health and a higher life satisfaction (Organization for Economic Co-operation and Development [OECD], 2011). What is beneficial for an individual is also of benefit to society as a whole; there is greater social cohesion, trust and tolerance and additionally guarantee political stability and economical welfare (OECD, 2013; Brennan et al., 2013). With these unanimous benefits of education, specifically higher education, the increasing rate of student dropouts has raised the concerns of various stakeholders (Balzer, Brodke and Kizhakethalackal 2015, Thomas, et al. 2015, Waterbury 2015).

Though the word 'dropout' in higher education institutions (HEIs) carries various notions like leaving the course or programme or institute, there is absolute consensus that it causes loss in social and economic wellbeing of both individuals (or dropouts) and institutions. For instance, according to the OECD, a tertiary-educated individual, in lieu of his/her investment gets an average Internal Rate of Return (IRR) of 13.0% and 11.5% for men and women respectively (OECD 2013, 144f). Moreover, there are other social benefits from investments in HE, namely, that graduate students ensure higher tax revenues, a faster economic growth, increased productivity and a higher innovation rate among workers (Brennan, Durazzi and Sene 2013).

Considering all the financial and social benefits that successful participation in tertiary education provides, it is logical for national governments to want to increase the numbers of graduates from Higher Education Institutions (HEIs). Therefore, most countries have been primarily focusing on "widening access to Higher Education" (Trow 2006, Gaebel, et al. 2012), and not on increasing completion rate. On average, every third student who enters a program does not finish it, and either moves to another program or leaves HE without graduating (Vossensteyn, et al. 2015, Quinn 2013). Those students are generally referred somewhat negatively as *dropouts* (Larsen, et al. 2013). Dropouts are a "drain on public finance and a waste of valuable resources" (Quinn 2013), this weighs especially heavy during a financial crisis (Heublein and Sommer 2003). In England, HE undergraduate students pay £9000 per annum for their tuition. This means each student generates £27000 for an HEI over the course of a 3-year bachelor degree programme. Each student who drops out after 1 year means a loss of income of £18000 or if they last until their 2nd year and then drop out, a loss of £9000 for the institution. If a programme recruits 200 students and only 10% drop out after 1 year then the cost to the HEI is 20 x £18000 = £360000; the financial numbers start to be significant and warrant investigation.

There are limited studies within the literature that have analyzed the dropout phenomenon in the HE context. A plethora of terminology exists to explain the complexity of this phenomenon, including the 'withdrawal' of students from courses in HEIs in the United Kingdom (Aldridge and Rowley 2001); staff perceptions for 'non-completion' in higher education (Taylor and

Bedford 2004). However, there is no standard definition and classification of the student dropout phenomenon in the extant literature (Larsen, et al. 2013). In general, those who discontinue their studies from a particular course or programme or institution, for any reason are termed "dropouts". To understand the factors behind dropouts, Forsman, Linder, Moll, Fraser, & Andersson (2012) advocated the need to apply the theory of complex thinking to model student retention in HEIs. NEED TO EXPLAIN WHAT THIS MEANS.

To overcome challenges of student retention in HE, Thomas, et al (2015) page 983 suggested that "HEIs will need to do more with less, develop new teaching and learning strategies, differentiate by being distinct in the products and services it offers, offer a greater value adding proposition to the student and continue to be more "customer focused". "To facilitate these changes the LSS process improvement methodology may have a role to play (**Antony, et al. 2012, 947**). Therefore, this study was conceptualized to conduct a systematic inquiry into the functioning of higher education system, to discuss issues related to dropouts and explore how Lean Six Sigma as a methodology and strategy can be used to address those issues.

Lean Six Sigma Methodology

The evolution of LSS

Lean Six Sigma (LSS) is a combined process improvement methodology, which was founded on over sixty years of quality improvement efforts, undertaken by the so-called quality gurus Shewart, Deming, Juran, Crosby, Ishikawa, Taguchi and others (Snee 2010). As its name indicates, LSS is based on both Lean and Six Sigma methodologies, and aims to improve both by combining the individual concepts, methods and tools (George 2002). Lean Six Sigma is a "business strategy and methodology that increases process performance, resulting in enhanced customer satisfaction and improved bottom-line result" (Snee 2010, 10). The combined methodology uses a systematic project approach to improving processes, commonly referred to as DMAIC, from the 5 phases of Define, Measure, Analyse, Improve and Control. (Wedgwood, 2016). PUT IN about coming from MOTOROLA ETC

Although the Lean Six Sigma methodology has been extensively considered within the literature for over a decade and has been adopted by several manufacturing and service industries with remarkable results (George 2003), AREAS SUCH AS ……. the Public Sector has been slower in adapting it (Maleyeff 2007). This applies in particular to the Higher Education setting where its application is of growing importance, but still remains in its embryonic stages (Antony, et al. 2012, Albliwi, et al. 2014). However, through major changes in the HE environment it can be witnessed that LSS is growing in importance within HEIs (Antony 2014). NEED MORE ON THIS HERE. Six Sigma hones in on improving the drivers of process performance, whilst lean looks to reduce any waste in the process to improve flow. (Wedgwood, 2016).

Current status of Lean, Six Sigma and LSS in HE

Since mid-2000 and as a response to the changed environment, several HEIs have been experimenting with Lean principles and concepts (Waterbury, 2015). Among other

universities, St Andrews University and Cardiff University in Europe and Central Connecticut State University, Winona State University, University of Central Oklahoma, University of Iowa, University of New Orleans, Bowling Green State University, University of Scranton, Rensselaer Polytechnic Institute in the U.S. have been applying Lean to their administrative and core processes (Waterbury 2015). The benefits from the application of Lean thinking in administration, finance, HR, estates, library and other support services within a HE setting, is not surprising. Lean has also proved to be also applicable and beneficial for academic core processes (Balzer, Francis D E, et al. 2016). Douglas, et al. (2015) illustrated that Lean thinking theories and tools were appropriate to identify waste in both academic and supportive services. Seminal work on the utilization of Lean for course design, teaching or handling student feedback was provided by Emiliani (2004) and using the *kaizen* technique to improve graduate business school degree programs (Emiliani, 2005). Other researchers focused on applying Lean thinking on curriculum design (Dey 2007) or student assessment (El-Sayed, et al. 2011). Svensson et al. (2015) reported improvements made in terms of increased student satisfaction, identification and reduction of hidden costs and process efficiency. Sinha and Mishra (2013) successfully applied Lean for a course review process.

There are some successful Six Sigma projects in academia, such as Six Sigma in experimental learning (Box 2006), a Six Sigma framework for academic institutions (Jenicke, Kumar and Holmes 2008) or improving self-service at university libraries (Kumi and Morrow 2006). Holmes, Jenicke and Hempel (2015) introduced a Six Sigma-based framework for HEIs to select those projects that yield to highest financial performance, growth and customer satisfaction.

From a practical point of view, a few universities implemented LSS in its processes: Miami University in the US conducts regularly Lean and Six Sigma programs (Sunder 2016). Kings College saved over £1million in 2012, using LSS tools to improve college processes around its infrastructure (Sunder 2016). University of Central Florida improved the speed of the admission process for qualified students through LSS (Coowar, et al. 2006) and the pharmacy department at the University of North Carolina illustrated that it could improve employee and customer satisfaction by applying LSS techniques (Sunder 2016). However, other than these examples of the applicability of the LSS methodology in general or administrative HEI processes, practical evidence on the use of LSS on academic core processes is limited (Simons 2013; Antony, 2014) both firmly believed that improvement of the education system can be done in a similar way as any other industry, including academic and non-academic processes. Whilst reviewing the literature and reported examples, it would appear that there is a common thread among the many barriers and challenges LSS faces while implementing it into an academic setting (Pryor, et al. 2012).

Given that it is commonly agreed that student dropouts represent a "waste of valuable resources" (Quinn 2013), there is no European-wide overview about the financial impact a dropout creates for a HEI. Moreover, presently, very limited LSS literature addresses such a critical issue. This might be surprising, as LSS, being a process improvement methodology focusing on reducing waste (George 2002) seems to be well suited for effectively reducing dropout rates. Hence, the purpose of this paper is to examine and explore how the LSS DMAIC

methodology can be applied to support student dropout reduction endeavors in HEIs and to understand the potential barriers of such an initiative.

The primary objective of the Define phase is to decide whether the project chosen is the most appropriate one to take on at that moment in time. Providing a number of criteria are met, including that the value proposition is understood, then the project can proceed. Woodall, Hiller and Resnick (2014) posited that customer value within HE is a 'slippery' concept. However, importantly, each phase of DMAIC utilizes a range of tools and techniques to investigate the specific problem, including who are the customers and stakeholders.

Research Methodology

The study is based on a qualitative approach, with an in-depth study of the contemporary issue of student dropouts in the higher education complex environment, where the expertise of different stakeholders is sought (LSS experts and university employees). The primary research philosophy of this study is based on an interpretive first understanding of the context – a strategy that meets the need of this research is an exploratory study (Shields and Rangarajan 2013).

Case selection

Convenience sampling technique was applied focused on gaining in-depth and qualitative insights rather than generalizability (Yin 2009, Powell 1997). Fricker and Schonlau (2002) also suggested convenience sampling might be useful in developing research hypotheses in the early phases of research. For LSS expert selection, five or more years of experience with LSS and possessing a Master Black Belt (MBB) were the minimum requirements for this study. The selection criterion of university includes – they needed to be public, located in Western Europe and be of typical nature in terms of age, size and reputation. To understand the applicability of LSS in HEIs context, we selected three Master Black Belts (MBBs), based on their relevant experience, and three universities based on their willingness to participate. Further, each university was represented by their three employees to discuss the dropout phenomenon and its response mechanism. Table 1 presents the participants' profile. The participants were promised anonymity, thus their names and university they belong to, are codified by pseudonyms.

Table 1: Participants' Profile

Case	Code	Location	Examined faculty	Position
LSS expert	L1			MBB
LSS expert	L2			MBB
LSS expert	L3			MBB
University A	A1	Germany	Engineering	Course Coordinator
University A	A2	Germany	Engineering	Research Assistant
University A	A3	Germany	Engineering	Managing Director Education
University B	B1	Spain	Engineering	Student Coordinator
University B	B2	Spain	Engineering	Course Coordinator
University B	B3	Spain	Engineering	Lecturer

University C	C1	Scotland	Management	Senior Administrative Assistant
University C	C2	Scotland	Management	Information Services
University C	C3	Scotland	Management	Administration Officer

Data Collection

The small sample size of subjects is justified with the scope of this study, which is concerned with gaining an interpretive first understanding of a contemporary issue (Saunders, Lewis and Thornhill 2009). To achieve the research objective, semi-structured interviews are advocated as appropriate data collection means (Yin 2003) which allow insights in the words of respondents themselves (Patton 2002). Semi-structured interviews allow a free-flowing information exchange through open-ended questions, enabling interviewees to "speak spontaneously and unrestrainedly" (Decorp 1999, 47) around previously defined themes (Ayres 2008, 810) and at the same time allow the researcher better comparison of the interviews afterwards (Patton 2002). Apart from that, the raw data obtained in form of quotations enriches the data collection. The list of questions for the semi-structured interviews was constructed with great care in view of achieving the overall goal of addressing the objectives of the research and a smooth conversational flow (Frey and Oishi 1995). Figure 1 demonstrates the flow diagram of data collection process.
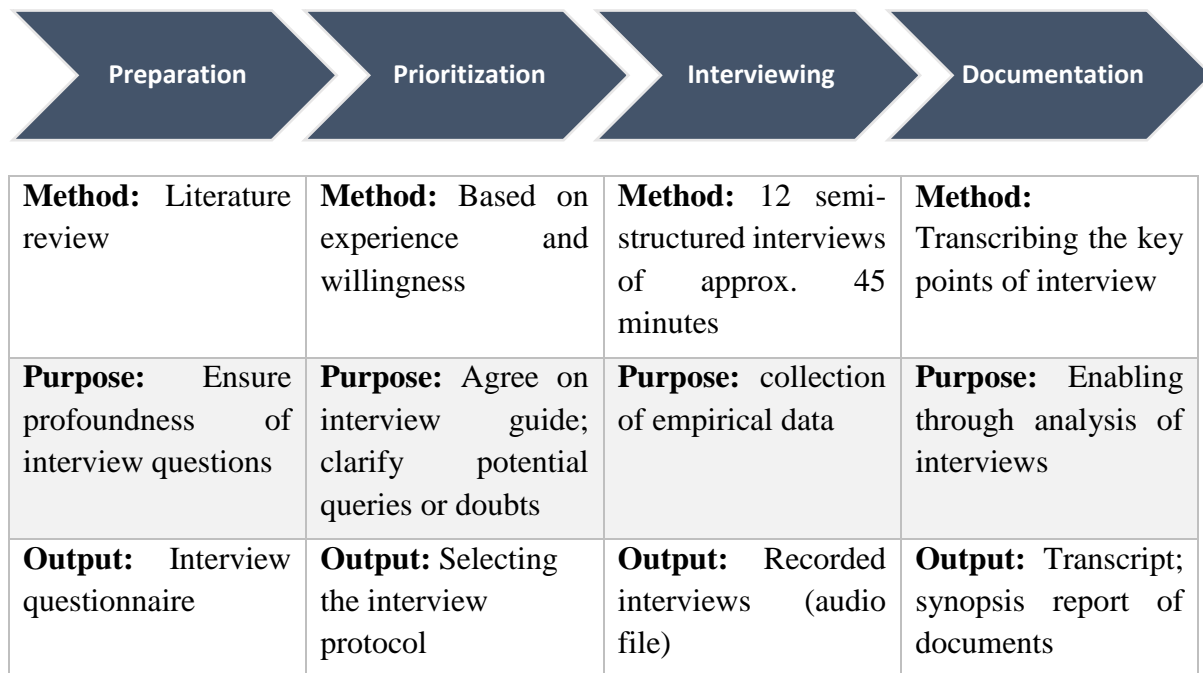
Preparation	Prioritization	Interviewing	Documentation
Method: Literature review	**Method:** Based on experience and willingness	**Method:** 12 semi-structured interviews of approx. 45 minutes	**Method:** Transcribing the key points of interview
Purpose: Ensure profoundness of interview questions	**Purpose:** Agree on interview guide; clarify potential queries or doubts	**Purpose:** collection of empirical data	**Purpose:** Enabling through analysis of interviews
Output: Interview questionnaire	**Output:** Selecting the interview protocol	**Output:** Recorded interviews (audio file)	**Output:** Transcript; synopsis report of documents

Figure 1: Approach for collecting empirical data

The pilot study was conducted with two academic supervisors along with a MBB and a university employee and they suggested minor amendments in the interview protocol. The corrected interview protocol for university employees dealt mainly with three themes – (1) the awareness of employees regarding the dropout issue and its consequences, (2) the university's current strategy to reduce dropout numbers, (3) the current approaches to evaluate the underlying reasons why students decide to drop out. The questions for the LSS experts were

related to the following themes: (4) how can LSS be applied to students drop out issues, (5) what relevant tools of LSS can be utilized to reduce dropout rates and 6) how can LSS contribute positively to student retention and satisfaction in HEIs.

Prior to the twelve interviews with the LSS experts and university employees, the purpose of the research was explained in simple terms, and they were informed about their right as participants to confidentiality, anonymity and the possibility to skip a question, or stop the interview at any moment (Saunders, Lewis and Thornhill 2009). Furthermore, it was also highlighted that no right or wrong answers to the questions exists (Polit and Beck 2004). All interviews followed an interview protocol prepared upfront to enhance analysis of the responses (Yin 2009). Researchers ensured they kept the interview length to under an hour to avoid fatigue among participants and ensure validity of their responses (Barratt, Choi and Li 2011).

The interviews with the MBBs were conducted face-to-face at their offices and the interviews lasted about 45 minutes. The nine interviews with the university employees across the three participating universities were conducted by telephone which took about 40 -70 minutes. In two cases, interviewees were contacted again to resolve queries as responses to a question were vague (Westbrook 1994). All interviews were audio-recorded and field-notes were taken during the interviewing process. On request, the interviewees were provided with a copy of the interview transcript for their validation prior to analysis.   To triangulate data, public and non-public documents regarding dropout numbers and dropout definitions were collected from the universities.

Data Analysis

The interviews were transcribed and a thematic analysis was performed to codify and analyze responses from the LSS experts and university employees. This research method enables researchers to analyze the vast information of interview-data in a systematic manner (Boyatzis 1998). Due to the exploratory nature of this research and the lack of previous literature in this area to build up on, an inductive coding approach was applied (Boyatzis 1998). As suggested by Eisenhardt (1989) and Yin (2003), data was first analyzed within each MBB and each university along the research questions described above. UNCLEAR. Secondly, the similarities and differences among the answers of the interviewees were examined. The analysis of the between-cases followed the themes which were described above. To suggest key interventions of LSS based on results, we followed an iterative process, as shown in Fig. 2, for data verification and analysis.

Figure 2: Iterative process of thematic analysis

Analysis of findings

Data analysis revealed rich information on the working style of HEIs, dropouts handling approaches and LSS based interventions. The findings are structured around five key emergent themes or issues reflected by university representatives and LSS experts responses on those. These themes are discussed below.

i. Ambiguity on dropout definition

A major theme which emerged from interaction with university employees is that there is no standard definition of dropout in their academic guidelines or charter. This theme could be supported with following quotations of employees:

> *In spite of Bologna reform, I don't find any standard definition of dropout exist in our university guidelines. At times, university doesn't pay any attention on dropouts, the focus is simply on attracting new students. (B2)*

> *I didn't know it before (about dropout), but for your interview I looked it up. Now I know it. (B3)*

The discussion with LSS experts showed that a university must develop a standardized typology to classify and define various kinds of dropouts. They unanimously emphasized the need for defining the problem or issue in hand, in this case dropout, to successfully implement the quality improvement measures of LSS.

ii. An incomplete or no data set on the reasons why students drop out

The interviews of university employees revealed that due to the historically grown differences among Western European HE systems, no standard definition and measurement method exists regarding student dropout. Currently, universities measure dropouts based on different characteristics regarding the (1) student's behavior (different kinds of involuntary dropout and voluntary withdrawals), (2) different institutional levels ranging from abandoning a specific course to leave the HE system level, and (3) the timing a dropout occurs. However, none of the selected universities had a withdrawal/exit form to capture the reasons behind students' dropout. The LSS experts raised their concern that availability of partial or no data presents a major challenge for LSS projects, as it prevents the detailed analysis of underlying reasons why a student's dropout occurred. The following quotation conveys the concern of a LSS expert:

> *I have seen in many cases (that) wherever the LSS project has any mess on information availability, the chances of successful implementation is very less. In fact, one should take some time to strengthen the available information system. (L3)*

The MBBs stressed the prerequisite to develop a detailed withdrawal/exit form to capture the reasons behind any student dropout during few academic cycles before opting for any LSS project.

iii. Reluctance of specific students to provide honest answers on their drop out motivation

University employees mentioned that in many cases they do not have a clear understanding why students decided to quit their studies. Students are reluctant to answer frankly to this

delicate question, or they refuse to answer at all. However, LSS experts mentioned that finding the root causes and tackling them consequently is the very core of LSS. The lack of a clear understanding of those reasons is a problem as per MBBs understanding, but they suggested more effort has to be put during the define and measurement phases of DMAIC (Design, Measure, Analyze, Improve and Control) cycle to gain a clear set of data. Additionally, different LSS tools such as cause and effect analysis and root cause analysis, can play a very vital role in understanding the underlying factors influencing students' dropout decision in a HEI.

iv.   *The employees awareness on impact of a student's dropout decision and their role*

The researchers recognized that many university employees are not aware of their role on the students' dropout decision and impact of a dropout on the economy of the institute and the society (Figure 3). For instance, four out of nine interviewees believed that their job had no or a low impact on a student's decision-making process. Although the lack of awareness among the process stakeholders represents a problem, all three MBBs uniformly agree that through applying the LSS methodology this can be overcome. The analyze phase of the Six Sigma methodology helps staff members to understand and evaluate the driving factors behind a student's dropout decision and thus can make the university employees aware of their impact. L1 highlights the point that that the real challenge is to make the result of the analysis phase accessible to university staff so they can understand the impact of their work on a student's decision-making process.
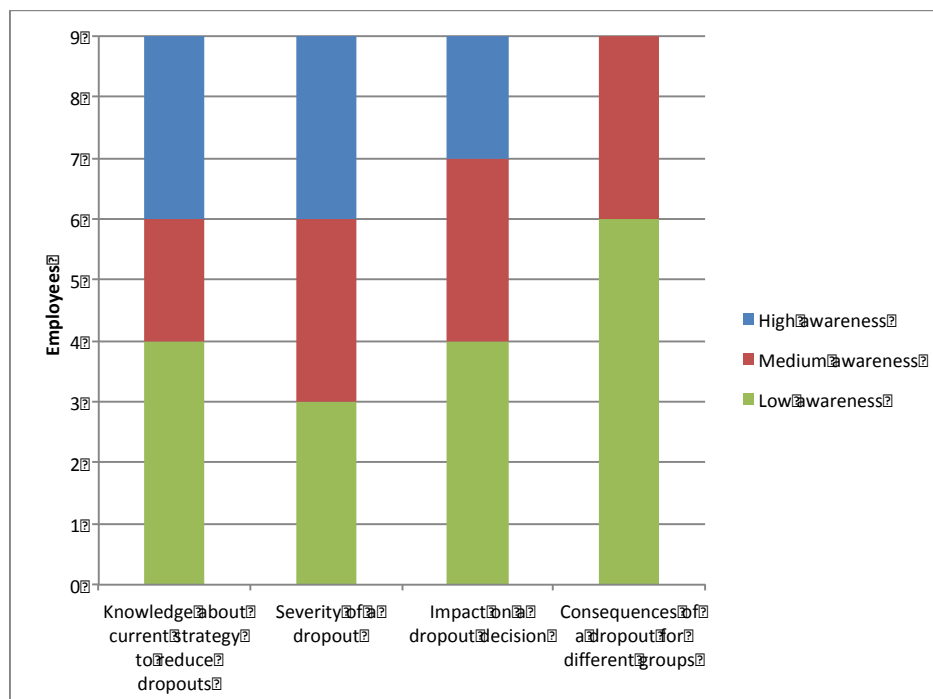

Figure 1: Awareness of the dropout phenomena among university employees

v.   *The university's current strategy to reduce dropout numbers*

It was noted that the selected universities have no long-term strategy how to systematically

reduce dropout numbers. Although each university offered different services to students, those services mainly focus on students who were about to drop out and to a lesser extent to reduce factors leading to this point. Therefore, the employees were also not aware or trained in formulating dropout reduction strategies. As B3 commented:

> *I don't know such a strategy, if we have it it's not communicated (B3)*

Moreover, the university employees, although chosen based on their impact on a student's dropout decision were not aware of all the services offered by the university. A2 stated:

> *I don't know for sure if we have all those services you are asking about, but we have a Student Service Center where they could know that (A2)*

From the perspective of LSS, MBBs recommended that HEIs can conduct detailed feasibility analysis of impact and effectiveness of their offered services for the students who are about to dropout or prone to dropout. Table 2 summarizes the LSS experts' responses to overcome the barriers to implement LSS based dropout reduction strategy.

Table 1: Between case analysis - Specific barriers & their control strategy

Aspect	Impact Assessment			Overall Impact Assessment	Answer to research question
	L1	L2	L3		
Ambiguous data	-	--	-	-	The lack of clear data is a problem, but LSS is still applicable (L2, L3). More effort is required during the Measurement Phase to gain valuable data (L2, L3).
Malleability of crucial factors	-	+	-	-	At first an understanding of the determining factors and how much they impact the dropout rate is required (L2). Often controllable factors impact non-malleable ones, so the focus should lie on the malleable factors (L1, L3). It is almost always possible to improve something (L1).
Lack of awareness of poor processes	+	+	+	+	LSS can make process stakeholders aware of a process outcome, as the analyses phase makes clear what within the process goes wrong (L1, L2, L3)

The applied scale for the impact assessment ranges from high barrier for the implementation of LSS (--) to low/no barrier for the implementation of LSS(++).

Discussion

This study sets out to investigate how LSS can be used as a process improvement methodology to reduce dropout rates in HEIs. It became evident with systematic qualitative inquiry that HEIs did not have a clear understanding of the underlying factors why students decided to dropout and the dropout issue received too little attention from university authorities. The research findings also support that LSS has potential to address both the above mentioned problems.

The limited knowledge on factors leading to a dropout is partially due to ambiguity among universities over the definition or classification of dropouts. In addition, HE authorities mention that many of the so-thought important factors leading to a dropout are not malleable for them. Based on a systematic literature review by Larsen, table 3 provides an overview of factors thought to have an impact on a student's dropout decision and assesses their malleability by HE authorities.

Table 3: Influence and malleability of factors leading to a dropout

Overall category	Sub-category	Influence	Malleability
Study Conditions at University	Institutional Resources	+	High
	Study content, study structure, organization of exams	+	High
	Learning environment and learning quality	+	High
	Support and counselling services	#	High
	Subject of study	#	High
Academic integration at university	Objective features of academic integration	++	High
	Subjective features of academic integration	+	High
Social integration at university	Social integration at university	+	High
Personal efforts and motivations for studying	Motivation	++	Low
	Preference for the subject of study and other related aspect of motivation	+++	Low
	Personal effort	++	Low
Pre-university institutional procedures	Admission requirements, admission types	#	Low
	Information services prior to university application	#	Low
Prior schooling/ academic achievement	(Upper) secondary school achievement	++	Low
	(Upper) secondary school type	#	Low
Personal characteristics of the student	Age	++	Non
	Gender	++	Non
	Personal traits/ dispositions	#	Non
Socio-demographic background of the student	Parental educational attainment	++	Non
	Parental occupational level	++	Non
Conditions external to university	Financial situation	+	Non
	Student job	+	Non

The scale applied for the influence of the factor ranges from +++ high influence to 0 no influence whereas # represents blurred or ambiguous evidence.
Source: compiled by the authors, adapted from (Larsen, et al. 2013)

The LSS methodology is of significant use to derive to a less-ambiguous dataset: By following the DMAIC cycle HE authorities get encouraged to define dropouts in sufficient detail

(student's behavior, institutional level, dropout timing) and opt a structured approach using various validated tools to address the dropout issue (Figure 4). Although such an activity may not solve the issue that students are reluctant to provide honest answer on their dropout-reasons, it leads to a less ambiguous dataset and consequently better understanding of the factors leading to a dropout. Based on the clearer dataset, the impact of each factor can be assessed and be assigned to the group of malleable or less-malleable factors. To reduce dropout numbers, the focus should obviously lie on malleable factors because their control lie in purview of universities authorities. For instance, common agreement exists among scholars that higher spending on resources for students and teachers decreases a student's dropout probability (Kolland, 2002; Pohlenz et al., 2007). However, the MBBs affirmed that also seemingly non-malleable factors can be influenced through controllable factors. It was suggested that HEIs have to conduct experiment to test the influence of improvement in combination/sequence of malleable factors on non-malleable factors.

Define
- Define 'Dropout'
- Define student's expectation from a particular programme
- **Tools suggested**: Brainstorming, Voice of customer analysis (VOC)

Measure
- Gap in meeting student's expectation
- List of factors with degree of influence on dropout decision
- **Tools suggested**: Sampling plan; Pareto diagram

Analyse
- Analysis of students' feedback
- Structured compilation and discussion on factors responsible for dropouts
- **Tools suggested:** Decision tree analysis; Fishbone diagram

Improve
- Pilot scale implementation of rapid-results initiatives
- **Tools suggested:** Design of Experiments; Benchmarking

Control
- Based on rapid-results initiative, designing long-term structural changes
- **Tools suggested:** Monitoring and control plan; cost effectiveness analysis
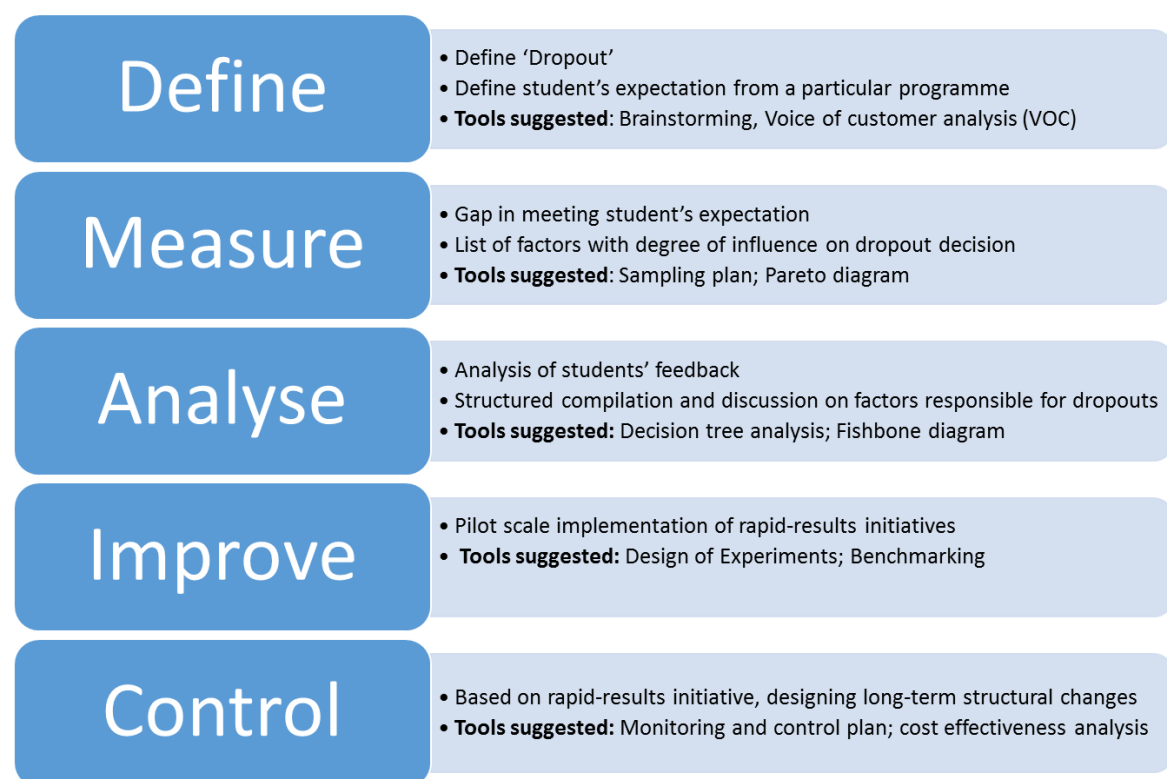
Figure 4: Dropout control strategy suggested by LSS experts

In addition to the problem of an ambiguous dataset, none of the three case universities has a systematic strategy how to reduce dropout rates, the interviewees were not aware of the financial consequences of a dropout for their university or the affected student, and focus of all three universities were mainly on students who are on the edge of dropping out. As Larsen writes: "the European evidence on the possible effects of dropout preventing or reducing measures at university level must be considered rather limited" (Larsen, et al. 2013, p.59). We realized that limited awareness among management is at the core of dropout problem. Without management commitment, no resources will be made available and any dropout reduction program is doomed to fail. LSS can be used to overcome this problem: Understanding the interests and needs of the stakeholders and showing them up *what's in for me* is a required first

step. Often, the interests of management are of monetary nature. Demonstrating the management that the current fire-fighting mode is costlier than a continuous improvement approach provides resources which can be used for pilot projects. Those pilot projects should follow a bottom-up approach to reap the *low hanging fruits* and these results can be shared with management to get further resources approved for future initiatives.

Conclusion and agenda for future research

This paper has addressed the research question of how LSS can be used as an improvement methodology to reduce dropouts from HEIs. To authors' best knowledge, this is possibly the first study exploring the possibility of using LSS as a methodology to address the dropout rates in HEIs. The findings of the study are based on qualitative analysis of data gathered from interviews with LSS experts and university employees of three different Western-European HEIs. The research findings clearly indicated that LSS has potential to bring systematic improvement in HEIs' dropout reduction approach.

Summary of Findings

The relevant literature and interviews findings reveled that current dropout-reduction-endeavors are of limited effectiveness due to three main-reasons, and that the LSS methodology is of use to overcome each of these reasons:

(1) There is no clear understanding of the underlying factors leading to a student dropout. This is partly caused as some universities tend to collect data on students' dropouts in insufficient detail or collect numbers on such an event differently which hinders data comparison. In addition, students refuse to provide honest answer on the delicate question why they opted to drop out. Although an ambiguous dataset represents a problem for a data driven improvement methodology such as LSS, particularly, during for the *Define* and *Measure* Phases, HEI authorities need to get sensitized to distinguish dropouts in greater detail and collect numbers on such an event in a consistent way so that they can track the influence of improvement measures. Dropouts need to be differentiated based on the student's behavior (different kinds of involuntary dropout vs. voluntary withdraw), at which institutional level the dropout occurs and when such a dropout occurs.

(2) Another limitation of any dropout reduction endeavor is the limited influence university authorities have on some factors leading to a dropout. There is general agreement among researchers that personal characteristics of the student (age, gender, personal traits, etc.), the student's socio-demographic background (parental education attainment and occupational level) or a student's financial situation has an impact on a student's dropout decision. However, all those factors tend to be out of the circle of influence of university authorities. For the purpose of reducing dropout numbers the focus should obviously lie on those factors which can be influenced. However, although seemingly non-malleable factors often can be influenced through controllable factors. In any case, a clear understanding of the different factors and their impact is a required prerequisite for understanding the reason behind dropouts and designing appropriate improvement measures.

(3) During the interviews with university authorities the researchers came to know that many university employees are not aware of the dropout issue, which goes in alignment with findings from the literature. University employees, although chosen carefully based on their job position, are not aware of their influence. None of the three case universities has a long-term strategy how to reduce dropout rates and current strategies focus mainly on students who are about to dropout. In addition, there is no knowledge about the quantitative impact or effectiveness of current programs. Without being aware of this issue, no resources can be made available and no management commitment can be bought in. The LSS methodology is suitable to mitigate this issue. By understanding and focusing on the interests of management – which are getting influenced by corporate culture progressively (Christopher 2012)- the severity of the dropout issue can be outlined. Based on this, LSS practitioners can convince HEI authorities that a *fire-fighting* mode is less efficient than improving the process through a continuous improvement methodology.

Managerial Implications

The findings of this study contribute to the understanding of how the LSS methodology can be a viable approach to reduce dropouts from HEIs. The paper provides few important findings drawn from HEI authorities and LSS practitioners point of views. By being one of the first studies addressing the dropout issue through the lenses of the LSS methodology, the paper identifies barriers LSS practitioners and HE authorities need to consider upfront in any dropout reduction program. The three most prominent barriers identified from our study include: i) ambiguous dataset on student's dropout reasons, ii) the non-malleability of some important factors impacting a student's dropout decision and finally iii) the lack of awareness among university authorities for this issue. Based on these three points, the paper provides important inputs to the HE authorities on how LSS, by following the DMAIC cycle, can be applied to overcome these barriers.

Further, HE authorities are provided with an extensive list of factors which are thought to impact a student's dropout decision. This list can be used to reallocate resources to more effectively reduce dropout rates and can be communicated to students to make them aware of the most common causes which led to a dropout among their peers. Based on this list, different job positions within a university with an impact on a student's dropout decision can be identified.

Limitations and Agenda for Future Research

This study is subject to the limitations associated with qualitative studies such as small sample size and problem of generalizability. The findings of the study are based on nine interviews selected from three different Western European Universities and three LSS experts (MBBs). Although all university employees were chosen carefully, no generalization can be derived from the interviews. However, expanding the study's scope and scale, such as focusing exclusively on faculty, including further universities or addressing employees with other job descriptions, would improve the reliability and validity of the findings in future research. As student dropout rates is an ongoing issue for many universities across Europe and even round

the world, there is an immense desire to explore the use of LSS methodology to address this issue so that financial savings can be demonstrated. The authors would also argue the fact that dropout rates might have an impact on the reputation or image of the HEI and LSS may be a good strategy to be considered by the senior leaders in HEIs to avoid such scenarios. It is worth exploring how DMAIC methodology can be used to reduce dropout rates with the application of most relevant and appropriate tools. Perhaps a LSS GB project can be kicked-off as a pilot project in one department and then the knowledge gained from this pilot project can be fairly easily transferred to other departments and across the HEI.

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