DIGITALIZATION OF LEARNING RESOURCES IN A HEI: ANALYSIS OF THE CRITICAL FACTORS FOR TRANSFORMATION

Huay Ling Tay, Stephen Low
SIM University, Singapore

Introduction

Continuous Improvements in Education Service Delivery

The last two decades have witnessed an increased pressure from customers and competitors for greater value from their purchases whether based on superior quality, faster delivery or lower cost (or combination of both) in both the manufacturing and service sectors (George, 2002). A number of organisations, including learning organizations such as Higher Education Institutions (HEIs) have adopted continuous improvement strategies for finding the balance amongst quality, cost and delivery.

In striving for continuous improvement, the use of technology for learning has grown tremendously in the last decade. The need for continuous just-in-time training has made learning technology an indispensible part of life. Nowadays, we are living in a world of increased mobility where the proliferation of mobile technologies is creating a host of new "anytime" and "anywhere" learning contexts. We live and learn in a connected world. Schools, colleges, and universities must adapt to these new sets of needs and expectations. To meet such diverse needs of learners, education service providers such as the HEIs have to constantly improve through the provisions of innovative pedagogical solutions in the form of novel and highly interactive self-learning digital materials.

This paper examines a case in a HEI that has ventured into the space of digital self-learning resources to provide students quick and easy access to their learning resources that leapfrog temporal and spatial constraints. Through this study, the authors provide a platform for informed debate across all sectors of education and learning and identify the critical factors that enable the major milestones in the tranformation journey.

The objective of this paper is twofold. Firstly, the authors aim to identify and analyse the difficulties encountered in the implementation of self-learning digital resources (henceforth called, "e-learning resources") in the form of interactive study guides (iStudyguide) and e-textbooks at a higher education institution, outlining the main critical factors concerning the major milestones on the journey of conversion. Secondly, we hope to highlight issues surrounding the use of technologies in learning so that other educational managers who are considering to pursue the deployment of similar e-learning resources can draw insights from the experience of this case study. To achieve the two-fold objective, the authors raise the following research question (RQ) to guide their study:

RQ1: Which are the key factors that facilitate the conversion of printed learning resources to e-learning resources in a higher education institution?

The various sections of the paper attempt to discuss the following: The first part reviews the relevant literature and summarizes general ideas about the use of digital technology for enhancing teaching and learning in a HEI and the concept of continuous improvement. The second part describes the major developmental milestones and characteristics of the digitalization initiatives including several critical decisions that are instrumental in shaping the transformation to the usage of digital e-learning resources in the HEI. We conclude by summarising the key lessons learned from this case study and propose our recommendations for continual improvement and future research work.

Literature Review

In an age of knowledge economy influenced by continually changing information technology (IT), network technologies have increased the pace of learning. Organizations encounter effects caused by drastic changes in this environment and individual learning and living are also connected to trends in the digitized world. It is important to include modern IT applications in education. Because of continuous technological progress in computer software development and application technologies as well as breakthroughs in digital data network bandwidth bottlenecks, e-learning technologies have changed the educational ecosphere of schools and corporate training systems. This phenomenon is extremely influential in managing the processes of teaching and learning (Govindasamy, 2001). HEIs have to harness the benefits of modern information technology and encourage students to learn through the use of digital media. Additionally, HEIs must endow students with sufficient information and response abilities, and allow them to become core points of strength that develop with the times.

The lean principle prescribes an operational system that places more emphasis on results and effectiveness rather than process and not a system that proposes standardized management logic (Fullerton and McWatters, 2001). The central idea in the “lean principle” is the removal of unnecessary waste during the production process. If resources are consumed without creating value, they become waste. Ohno (1988) defined seven types of waste that create no value: Over-production, defects, inventory, transportation, waiting, motion and over-processing. Liker (2004) proposed an eighth type of waste: inappropriate design. If these categories of wastes can be removed and the manufacturing process continually improved, a perfect lean production enterprise should be an achievable goal. Womack and Jones (2005) were the first scholars to apply the principles of "zero waste, zero defects and precise value" to the consumption end of the equation; they emphasized that lean consumption should consider production, service and consumption as three areas in which to eliminate waste. The priority of this approach is satisfying customer demand which further reduces company costs and the creation of "win-win" situations for both customers and companies.

Current understanding of pedagogical processes indicate that a major factor that drives the learning experience of students generally centers on the bundle of self-learning resources that include not only the course materials but also the supplementary resources accompanying the subject to be mastered. Thus, the methods employed to deliver the supporting self-learning resources in HEIs is a point of concern for institutions today. This concern leads to the hope of developing and establishing an educational and experience system that will engage and facilitate learning without barriers arising from constraints of time, space and location. In this study, the limiting conditions affecting students’ learning imply the concept of lean management. Lean management is derived from the manufacturing industry; it is a unique operational model taken from Toyota Production System (Ohno, 1988).

Using the concept of lean service, we examine a higher education learning environment that harnessed the use of technology to convert printed resources; including textbooks and study guides to interactive e-learning formats that are easily accessible to all learners. We aim to unveil how the use of technology can help the HEI lower its costs of operations, enhance self-learning efficiency and quality and improve its market competitiveness through the provision of superior e-learning pedagogy. The concept of lean service is applied to a unique case – a higher education institution (HEIs) context. By examining how learning resources in this HEI is digitalized and converted to online resources, this study identifies key factors that faciliate the transformation journey of the educational environment in the conversion process from the development of printed learning resources to interactive online digital self-learning resources that not only overcome issues relating to temporal and spatial barriers to learning but also provide learners “value-added” dimensions that are interactive and engaging.

Research Method—Case Study

As the digitalization of learning resource is a complex process and it involves multiple functional groups and departments, we chose a single case study approach (Yin, 2003). We conducted an in-depth case study (Eisenhardt & Graebner, 2007; Sigglekow, 2007). Our data sources include three methods: interviews, direct observation of the studied process, and analysis of e-learning resource database related to the studied process. Using an interpretative analysis approach, the data collection, analysis, and theory matching occurred iteratively over the course of our research.

Case Context - Digitalization of Learning Resources at an HEI

When evaluating the pedagogical methods adopted in HEIs, this study considered a number of criteria: - the ease of access to self-learning resources, temporal and spatial flexibility and cost, and resources logistics. These evaluation criteria that we have considered include the achievements of learning at any time, learning at any location, interactive learning and accessibility to diverse knowledge respectively.

A Process View of the Digitalization Journey

The HEI's decision to convert printed learning resources to the digital format is aligned with its mission to provide ease of access of self-learning materials to the student with minimum limitations of space and time. With effect from May 2015, the management committee of the studied HEI announce the decision to cease provision of printed study guides in a phased manner: level 1 courses in July 2014 (already completed), level 2 courses in July 2015, level 3 courses in July 2016 and level 4 courses in July 2017.

The process of developing learning resources in the HEI involves planning and coordination across multiple functional groups (academic and admininstrative) including internal departments as well as external stakeholders such as the publishers and external vendors that are engaged for the packaging and delivery services that prepare and deliver the course materials to the HEI. We present the roles and key responsibilities of the personel in these departments which are actively involved in the preparation, distribution and storage of course materials in Table 1.

Departments	Operational roles and key responsibilies
Educational Technology and Production Department (ETP)	The ETP provides course development support to enable the establihment of an engaging and interactive learning environment for the student of the HEI that includes: • The provision of pedagogical and instructional design advice for the creation of online courses • Creation of multimedia for e-learning developments • Copy-editing and formatting of course materials • Ensuring content copyright clearance • Tracking development processes to ensure timely completion of course materials for presentation and timely payments to course developers, and, • the Provision of Audio/Video (AV) Production and Training Upon receipt of the course development support/approval from the particular school of study at the HEI, the Learning Development Support will set up the project kick-off meeting with Head of Program (HoP), Course Developer (CD) and relevant External

Departments	Operational roles and key responsibilies
	Organisation participating in the course development process (if applicable). At this meeting, a detailed schedule of the deliverables will be confirmed, and agreed by all parties. The Learning Development Support will also provide the required development templates, forms and show the Course Developer personnel a sample Interactive Study Guide (iStudyguide).
Schools (Head of Programs, Instructors, Course Developer)	The Head of Programme will appoint a Course Developer and request course development support from the ETP.
Curriculum Administration (CA)	The Curriculum Administration (CA) department procures and produces the University's course materials for all students, associates and external examiners. CA department also takes charge of the distribution of the course materials to students and associates during and outside the Semestral Distribution period. A distribution process necessitates the smooth workflow in ensuring the materials are disbursed punctually and orderly.

Table 1: A summary of the generic Course (or Module) Development Process at the HEI

Overview of the Current and Modified Process Flows

Figures 1 and 2 together depicts the overall work flow for the course development, storage and distribution of print study materials at the HEI of interest. It can be observed that course development must be started first, generally about two semesters (or about a calendar year) ahead of work commencement by CA to place orders on textbooks and make arrangements to process print study materials developed by the course developers. CA will generally take about two to three calendar months to complete its materials ordering and delivery tasks ahead of distribution which normally takes place a week or two ahead of the commencement of study in a particular semester. Observations of the descriptions shown in Figures 1 and 2 reveal that the main drawbacks of providing print materials in the form of printed textbooks and study materials for every student on the course, would incur not only a laborious process of course development, but at the same time higher operating costs due to the need to maintain a huge materials store and logistics distribution network. Currently approximately half the total number of courses at the HEI still utilize this mode of course development that requires storage and distribution of printed study materials.

Figure 2 depicts the modified work flow required to accommodate the transition from the course development, production and storage of print study materials to that of the course development, e-production and cloud storage of e-study materials and assessments. A comparison of the print versus "e" course development/storage strategy would reveal that from the standpoint of physical storage and distribution, the logistical requirements of using print study materials entail time, manpower and maintenance costs to store and distribute print materials. By contrast, a leaner logistical structure can be maintained if the HEI adopts only the usage of e-materials for teaching and assessments. Although the initial financial overheads in terms of payments for intellectual and creative development/testing of e-contents, the pay-off for the high initial financial investments work favourably for the HEI in the long run.

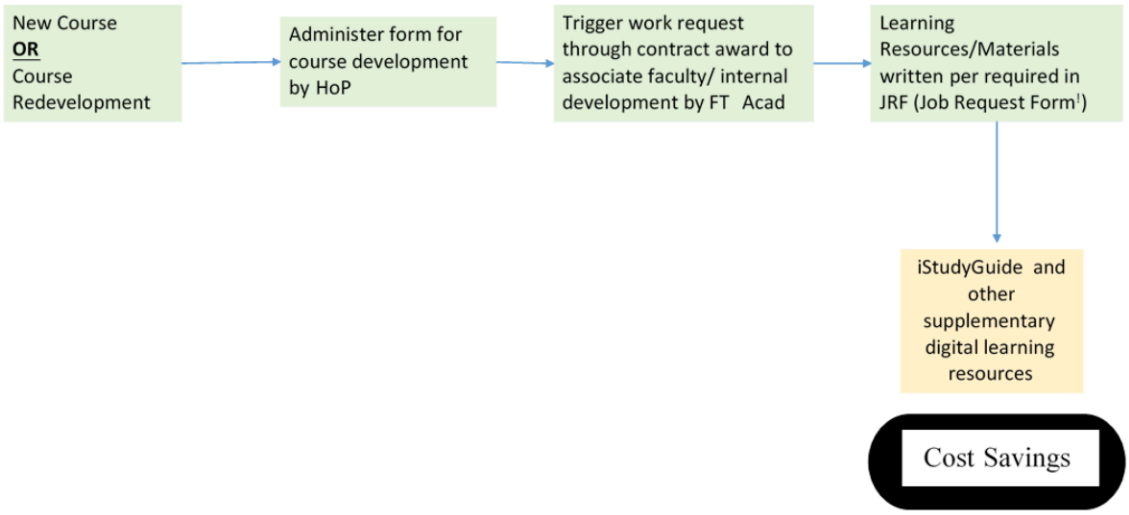

Figure 1: The key steps involved in the preparation, distribution and storage of e-course materials
[1]Learning resources/materials are modified in the digitalization journey to imply conversion from print to e-format with high interactivity.

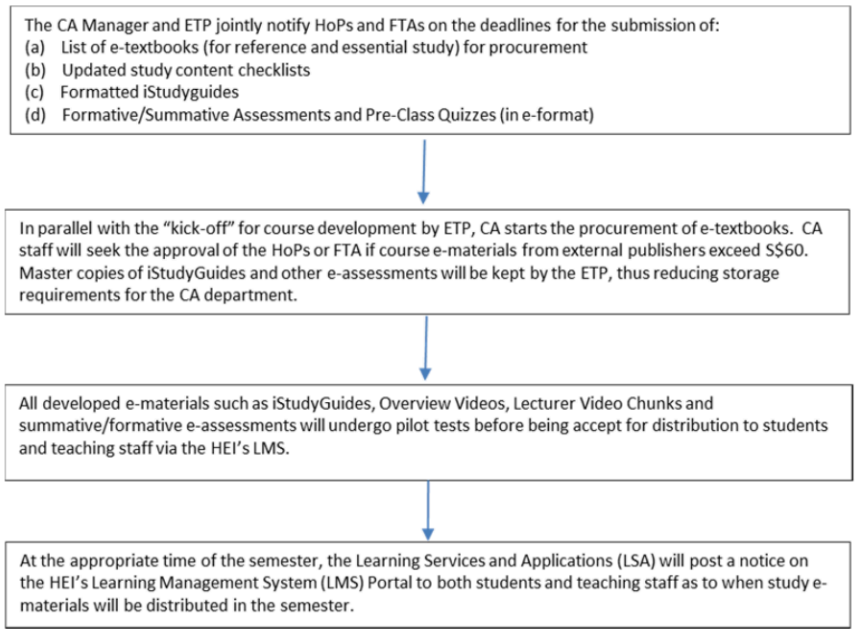

Figure 2: Workflow for CA, ETP and LSA Departments for the production and distribution of e-course materials

Figure 2 shows the modified work flow required to accommodate the transition from the course development, production and storage of print study materials to that of the course development, e-production and cloud storage of e-study materials and assessments. A comparison of the print versus "e" course development strategy mainly differs in physical storage and distribution as the logistical requirements of using print study materials entail greater handling time, manpower and maintenance costs in the storage and distribution of the print materials. In contrast, a simplified logistical structure can be maintained if the HEI adopts only the usage of e-materials for teaching and assessments. Although the initial financial overheads in terms of payments for intellectual and

creative development/testing of e-contents is higher, the pay-off for the high initial financial investments work favourably for the HEI in the long run.

Findings and Discussions

With the cessation of print learning materials requirements for level 1 and 2 courses, the HEI has been able to achieve not only monetary savings but also reap environmental benefits due to reduced paper usage. The bulk of the cost savings are mostly derived from the reduction in book printing, binding and shrink-wrapping of the printed learning materials that were required for the print resources. Other areas of improvements are observed in the new work process flow that is incorporated with advanced planning for e-Course development. A longer development time frame is implemented as the process for e-Course development entails greater support and interaction from multiple functional departments. Although there is little change in the space requirements, the amount of manual handling required in the logistical and material distributions for printed course resources by the operations staff at the CA Department are also reduced. Through an internal repository, the e-learning resources can be downloaded from an online platform that is secured by the student and instructor with password protection.

Scenario Analysis

To provide deeper insights from the case, the authors attempted a cost comparison based on a scenario that take into consideration the one-off costs to develop e-courses against future savings the the following scenarios. The purpose for the scenario is to provide a deeper understanding of the case through a quantitative measure. This is possible as one of the authors is an experienced course developer in the HEI. Based on his experience and data gathered from the context, the following scenario was analysed.

Currently, the HEI runs about 400 courses. We assume a scenario when it is possible to convert 100% of its existing courses to e-Courses at the HEI so that it may be possible to totally eliminate materials storage and handling cost. This will result in an approximate saving of 35% in operating cost. Other advantages that were recognised by the informants include the provision of greater access to digital materials which could faciliate an expansion of the HEI educational market reach to both the South-East Asian region and beyond through the medium of the world-wide web.

Reflecting on the Journey of Transformation

If we reflect on the transformation journey of the HEI, our case analyses elucidates evidence of lean management philosophy as illustrated in Table 2 .

Theoretical framework of Lean	Literature	Evidence of Lean from case findings
(1) “Lean” is essentially a strategy to reach both flow efficiency and resource efficiency	(Modig and Åhlström, 2012)	Savings on space, laborious manual handling of physical stock of learning materials at CA. Cost savings from elimination of book printing, binding and shrink wrapping. At the strategic level, there is an internal e-learning committee within the HEI that provides advisory guidance on strategic improvement initiatives and planning issues to ensure structured e-Course development and delivery.

Theoretical framework of Lean	Literature	Evidence of Lean from case findings
		The deployment of an appropriate e-Course pedagogy also supports the HEI's enterprise risk management strategy in ensuring Academic Continuity in the event of disasters.
(2) "Lean" as a methodology/ using a mix of technical and managerial aspects, such as low inventories and operator-driven improvement work	(Krafcik, 1988; Liker, 2004; Womack *et al.*, 1990).	Physical inventories that includes all forms of distributed print materials, inclusive of printed study guides and textbooks are reduced. Internal employees across multiple departments and the part-time associate teaching faculty and students from the HEI are heavily involved in skills upgrading, training and process streamlining to support the development of e- learning resources.
(3) "Lean" characteristics are often associated with continuous improvement, employee involvement and the aim is to remove waste	(Assarlind *et al.,* 2013) (Ricondo and Viles, 2005) (Holbeche, 1998) (Näslund, 2008).	The quality of course materials is monitored through internal audit and via current student and instructor feedback. The Quality Assurance office follows a strict auditing procedure where random samples of the learning materials are audited. In addition, feedback from instructors are gathered in the process of course delivery and during course development to the Learning Services and Applications Department (LSA) and Educational Technology and Production Department (ETP). Other supporting functions such as the hosting maintenance quality is also overseen by LSA. Within the respective academic schools, the Dean and Head of Programs are consciously aware of the need to ensure that the development of courses should be ideally done in a single pass in order to reduce rework and waste. As such, feedback is constantly sought from course developer, external academic content assessor and supporting publishers so that the e-Course materials can be refined to facilitate effective teaching and learning. The Academic External Assessors'

Theoretical framework of Lean	Literature	Evidence of Lean from case findings
		reports on the courses that have been developed form a major part of the continual improvement process. They are instrumental in facilitating the focal areas for course content improvements and their feedback and comments are highly regarded in the decisions taken for further enhancements and revisions to the developed courses when necessary.

Table 2: Theoretical Framework of lean and case evidence of lean management

Characterisation of the critical factors

To characterise the key factors that facilitate the conversion of printed learning resources to e-learning resources in this HEI case, we focused on understanding the coordination as a mechanism to explain our observations and address this gap in the literature.

Based on our in-depth analysis of the case study data, what come across from the interviews are

1) Clear vision and purpose articulated by the higher management
A broader understanding of the entire process, guided by shared goals and knowledge helps to create an environment in which employees feel psychologically safe and empowered to suggest possible process improvements, while reducing waste associated with a culture of finger pointing (Edmondson et al, 2003).

2) Staff openness to facilitate the change and willingness to engage in job redesign
The management decision to cease the provision of printed resources and converting all students and instructors to a learning environment that employ mainly digital learning resources has triggered numerous work redesign and process refinements that are closely aligned with the development of e-learning resources. Such a prerogative to re-design existing work, reconfigure layout and upgrading of technical skills to support the development of the digital learning materials have been enhanced by the staff openness to change and upgrade their knowledge through training to meet the technical requirements needed to facilitate the conversion to digital resources across functional groups in the HEI.

3) Relationship management with key stakeholders suppliers – publishers supportive of the HEI's learning resource digitalization by providing assistances in the form of training support to familiarize with the use of the e learning resources for their textbooks as well as the entire learning resources bundle that include both the e-textbooks as well as the Interactive Study Guide (iStudyguide).

In summary, a process improvement initiative can be coordinated by fostering close relationships among key stakeholders within the course material development process. Successful process transformations that crosses both internal and external boundaries hinges on the extent of timely and clear communication, shared goals and knowledge and dedicating conscious efforts in relationships management of multiple stakeholders. Finally, the continued participation of all stakeholders in the transformation efforts may be contingent to achieving the shared goal of the desired.

Conclusions and Recommendations
The study critically appraises the conversion process of the print to e-learning resources in an HEI with an aim to identify the key enabling factors that have facilitated a HEI to successfully implement

the digitalization of learning resources. Through a unique case study at a HEI in Singapore, we examined how the HEI increases customer value, expand its reach to regional market, while at the same time contribute to environmental sustainability by spearheading the digitalization of learning resources through a three-year implementation work plan that spans from 2013 to 2015. We make use of well-established lean principles to conceive the case and focuses on how the diverse functional department achieve superior performance despite encountering a highly uncertain and variable customer demand – a context considerably different from that of the typical lean manufacturing environment.

Finally, it must be emphasized that since this research is an exploratory case study, the results obtained cannot be generalized. Additionally, the enhanced connectivity enabled by online access to download digital learning resources requires internet connectivity to be readily available. Therefore, a comprehensive understanding of specific infrastructural capabilities and constraints that may varies across different context is necessary to enable an accurate assessment of similar digitalization initiatives. Future research can be conducted to provide an impact analysis of the potential risk factors if the use of printed study materials is completely eliminated, in favour of e-study materials. A potential study would be the risk impact to the HEI when there is a data network failure

References

- Assarlind, M., Gremyr, I. and Bäckman, K. (2013), “Multi-faceted views on a Lean Six Sigma application”, International Journal of Quality and Reliability Management, Vol. 30 No. 4, pp. 387-402.
- Edmondson, A. C., Winslow, A. B., Bohmer, R. M. J., & Pisano, G. P. (2003). Learning how and learning what: Effects of tacit and codified knowledge on performance improvement following technology adoption. Decision Sciences, 34(2), 197–223.
- Eisenhardt, K. M., & Graebner,M. E. (2007). Theory building from cases: Opportunities and challenges. Academy of Management Journal, 50(1), 25–32.
- Fullerton, R.R. and C.S. McWatters, 2001. The production performance benefits from JIT implementation. J. Oper. Manage., 19: 81-96.
- George, M. (2002), Lean Six Sigma: Combining Six Sigma Quality With Lean Speed, McGraw-Hill, New York, NY
- Govindasamy, T., 2001. Successful implementation of E-learning: Pedagogical considerations. Internet Higher Educ, 4: 287-299.
- Holbeche, L. (1998), Motivating People in Lean Organizations, Butterworth-Heinemann, Oxford.
- Krafcik, J.F. (1988), “Triumph of the Lean production system”, Sloan Management Review, Vol. 30 No. 1, pp. 41-52.
- Liker, J.K., 2004. The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer. 1st Edn., McGraw-Hill, New York, USA.
- Modig, N. and Åhlström, P. (2012), This is Lean: Resolving the Efficiency Paradox, Rheologica Publishing, Halmstad.
- Näslund, D. (2008), “Lean, Six Sigma and Lean Sigma: fads or real process improvement methods?”, Business Process Management Journal, Vol. 14 No. 3, pp. 269-287.
- Ohno, T. (1988). Toyota production system: Beyond large scale production. Cambridge, MA: Productivity Press.
- Ricondo, I. and Viles, E. (2005), “Six Sigma and its link to TQM, BPR, lean and the learning organisation”, International Journal of Six Sigma and Competitive Advantage, Vol. 1 No. 3, pp. 323-354.
- Sigglekow, N. (2007). Persuasion with case studies. Academy of Management Journal, 50(1), 20–24.
- Womack, J.P., Jones, D.T. and Roos, D. (1990), Machine that Changed the World, Simon & Schuster, New York, NY.
- Womack, J.P. and D.T. Jones, 2005. Lean Solutions: How Companies and Customers can Create Value and Wealth Together. 1st Edn.,Simon and Schuster, NeFree Press, ISBN-13: 978-0743277785, Pages: 368.
- Yin, R. K. (2003). Case study research: Design and method (3rd ed.). Thousand Oaks, CA: Sage.