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Integrated Mobile Learning Education Supply Chain Management for Higher Learning Institutions

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***Abstract*— The mobile devices are used to execute the teaching-learning-evaluation process in Mobile Learning (m-learning) methodology. M-learning is a trending field in educational organizations, companies, and for individual study. With the explosion of mobile device ownership among the users aged within 18–29 years who are also the attendees of the higher learning institution (HLI), gives us the opportunity to consider the use of m-learning methodology to be embedded in the HLI beside traditional methodologies. Exceptional circumstances such as the COVID-19 pandemic when traditional face-to-face methodology suddenly changed to online paradigm, is also forcing us to strongly consider the m-learning approach. However, HLI may not have a general policy to implement m-learning into the traditional learning environment. A proper educational outcome needs to be configured to implement a new process into the traditional process. Therefore, a model integrating the m-learning aspects and the education supply chain management factors obtained from this study may benefit the stakeholders of HLI, especially educators and students.**

***Index Terms*— Mobile learning, Supply chain management, HLI, education, m-learning**

I. Introduction

THE changing nature of the expectations of the global market always creates a change in the requirement of the skillset of the graduates. Specially, the adoption of technology in the society is continuously changing the nature of knowledge gathering and delivering paradigm. Higher learning institutions (HLI) are under pressure to match the market requirement of the skilled graduates. This can be done by improving the quality of teaching and learning by integrating up-to-date technologies [1]. The implementation of m-learning alongside traditional methodologies in the HLI is now in highest consideration as the possession and usage of mobile devices has increased among the attendees of the higher learning institution [2]. Such integration may contribute to the requirement of the society for a more adaptable and individualized education putting the learners at the center of the teaching–learning process [3], [4].

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Employing an additional system into the existing system depends on the proper educational outcome for all stakeholders of the institution. The educational outcome depends on different factors within each aspect of education suppliers at different decision levels of an education institution. The stakeholders of an educational institution require the appropriate relationship among these components with a targeted educational outcome to decide on implementing m-learning into the traditional learning environment [5]. This study is to embed the aspects of educational institution and the m-learning environment to create an integrated model with measured relationship among all the aspects for the stakeholders understand, measure, and decide on the integration process.

II. Literature Review

Mobile learning (m-learning) methodology is a teaching-learning-evaluation process that is executed through mobile devices and is a trending field in educational organizations, companies, and also for individual study [6], [7]. Mobile learning facilitates both individual and collaborative learning allowing truly anywhere-anytime personalized learning. It removes some of the formality and adds variety to the conventional lessons/courses [8]. M-Learning encapsulates different features of learner-centered pedagogies. This includes discovery learning, constructivist learning, problem-based learning, situated learning, etc. which raises self-confidence and self-esteem of the learners [1], [9].

Integration of m-learning environment into HLI can deliver learners with several advantages such as ubiquitous access to media, rich learning content, social interaction and collaboration with peers, and just-in-time learning at anywhere and anytime through wireless network technologies [4]. Exceptional circumstances such as the COVID-19 pandemic when traditional face-to-face methodology suddenly changed to online paradigm, is also forcing us to strongly consider the m-learning approach. However, the integration of m-learning has a lot of associated challenges. The diffusion of m-learning in higher educational institutions may result in significant cultural change. The pedagogic practices needs to be changed and new technologies and teaching methodologies must be adapted by the university educators, which might be unfamiliar to them [2]. Furthermore, some courses may not be suitable for the m-learning environment [10]. More importantly, Internet connection issues concerning bandwidth, security, speed, reliability and network coverage of service provider warrant much attention in ensuring the smooth implementation of m-learning [11]. There is also the issue of university educators

being uncomfortable using technology given that they may comprise of earlier generations.

The aspects of m-learning environment can be described in three aspects – technological aspects, learning environment aspects, and educational institution aspects. TABLE I describes the three aspects of m-learning environment which is required for a HLI to investigate for implementing m-learning environment into the traditional learning environment [5].

TABLE I
ASPECTS OF EMBEDDING M-LEARNING INTO HLI

Aspects Type	Factors to be considered
Technological Aspects	Availability, Response times, Flexibility, Scalability, Usability, Maintainability, Functionality, Reliability, Performance & Efficiency, Connectivity, User interface, Security.
Learning Environment aspects	*Learner's perspective*: the optimization of student autonomy, collaboration, interaction, communication, learning attitudes, perceiving of knowledge, generating, implementing and sharing of ideas, experimentations, understandable, usefulness, and accessibility of learning materials, proper guideline for new learning environment, balanced assessments, etc. *Educator's perspective*: effective teaching methodologies irrespective of different abilities, sexes, or ethnic backgrounds, adaptiveness of introducing a new or changed learning environment, preparation of adequate and adaptable learning materials according to the learning environment demands, quality of the outcome of the students, fair assessment of the students' abilities, multiple method of assessment, full control of the classroom, etc.
Education Institution aspects	*Input*: The student and research works/projects *Process*: Teachers, learning environment, methods, and resources, research practices and methodologies, etc. *Output*: Quality graduates and research outcomes.

A. Educational Supply Chain Management Model

The educational supply chain model works within and around the entities of a university. External entities like employers of its graduates, secondary and higher secondary schools and colleges and internal entities like its current students and alumni, university staff in designing curricula [12]–[14]. The involvement of entities in the model assures the satisfaction of all stakeholders.

Measuring the performance of an educational institution based on the input, process and output is very challenging. It requires a complete set of performance measurement criteria, factors, stakeholders, etc. along with their properties and characteristics. Integrated Tertiary Education Supply Chain Management (ITESCM) empirical model offers the potential investor as well as the current administrators of the universities of tertiary level a novel methodology for achieving their ultimate target of the creation of highly skilled graduates and novel research outcomes for society's betterment [15]. The model incorporates all the stakeholders of the tertiary educational institution, (four) factors – Program Establishment (PE), Faculty Capabilities (FC), University Culture (UC), and Facilities (FA) of the HLI. TABLE II describes the four factors of the ITESCM model for HLI [16].

TABLE II
FACTORS IN ITESCM FOR HLI

Factors	Involvement in ITESCM model
Programs Establishment (PE)	Design and launch different academic programs using a variety of innovative practices to enhance and evaluate the deviation in education and research in terms of academic practices (teaching-learning methodology, environment, etc.), practical knowledge & skills (hands-on, visual, visit, etc.), progression of facilities (ICT, library, etc.), industrial placements (internship, employment, etc.) etc.
Faculty Capabilities (FE)	Teaching, research, and academic services to ensure the best classroom environment, enable effective communication, demonstrate best practices, etc. through instruction, research, learning material preparation, curriculum development, etc.
University Culture (UC)	The culture of the organization depends on the administrator or management of the university, geographical location and social practices which also dictates the culture of the universities.
Facilities (FA)	The IT infrastructure and their services, digital libraries and their environment, and laboratories and their availability are some of the modern-day facilities which are essential component for up-to-date learning environment in a tertiary educational institution. These ensure inclusive academic environments such as, internet-based education, advanced online learning technology equipped classrooms, well-equipped and facilitated laboratories, research facilities with easy and frequent access to online resources (e.g., e-book, conference proceedings, e-journal) etc. These facilities enable the students to learn, both efficiently and conveniently.

Integrating m-learning into the educational supply chain management, considering an educational institution as a service industry, would require the service industry basics using supply chain management. The factors of service industry - service providers, suppliers, consumers, customers, can be mapped with the factors of educational institution as service industry. The mapping of each of the factors of the education supply chain management with the basics of the service industry must maintain connection all the three decision levels – Strategic level (SL), Planning level (PL), and Operating level (OL) [12]–[14].

Fig. 1 shows the basics of supply chain as service industry.

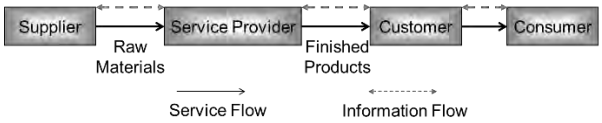

Fig. 1. Service Industry Basics using Supply Chain

ITESCM model is a combined procedure of academic supply chain management for the universities consisting of the educational management, educational supply chain, and research supply chain. TABLE III gives the mapping of service industry factors with the education and research supply chain [15].

TABLE III
EDUCATIONAL INSTITUTION AS SERVICE INDUSTRY USING SUPPLY CHAIN MANAGEMENT

Supplier	**Education**	Human Suppliers: - high schools & colleges supplying students - universities supplying faculty members Non-human Suppliers: - asset suppliers like, ICT facilities, furniture, etc. - educational materials like, instruction, stationary, etc. - fund suppliers like, self-funded, parents, organizational scholarships, grant, allowances, etc.	
	Research	Internal suppliers: university self -funded research projects External Suppliers: organizations (private/public), government, etc.	
Service provider	**Education & Research**	Two *major* aspects for both education & research - Assessment - Development	Four *main events* for all *major* aspects – - Programs Establishment (PE) - University Culture (UC) - Faculty Capabilities (FC) - Facilities (FA)
Outcome	**Quality Graduates**	The university recognizes, identifies, and unifies the standards and the determinants of value addition in the university process to generate quality graduates. These graduates possess implicit and explicit knowledge, professional enrichment, proficiencies, aptitudes, expertise, morals, etc.	
	Research outcome	The research results may be delivered in form of resolution to the existing problem, development and expansion of pure theory, scholarly publications, investigative projects, theoretical & applied research, dissertation, or any other research outcomes.	
Customer	**Education**	graduates, employers of various public and private sectors, government, NGOs, family members, etc.	
	Research	The research output is consumed by the organizations or donors (like INFORMS, ACM, IEEE, IEOM, etc.) who provides funding/scope/facilities to the research projects such as, scientific publications, scholars, results, thesis, PhD dissertation, etc.	
Consumer		The society consuming the final outcomes – graduates & research.	

These supply chains are independent chains with their own characteristics considering the appropriate teaching and research activities which are the two most basic functionality of any tertiary academic institutions [17].

The developed countries prioritize higher education as it plays a major role in the economic development of a society. It provides advanced skills that command a premium in today's workplace. This enables high productivity and improved quality of life [18]–[20]. The ITESCM model considers this and put society as the consumer of the outcome of the institution.

Educational supply chain management produces several competitive advantages with its customer driven vision. These advantages are achieved by improving productivity of learning, boosting educators' & learners' satisfaction, producing quality graduates and research. Progressively, many final outcomes are recognizing the partnership with the employers in maintaining quality in their education supply chains with potential benefits [21].

The efficiency of the ITESCM model concept can be tested and observed in established academic organizations with different settings. The learning environment setting of ITESCM can be incorporated with additional learning environment, such as m-learning, which enhances the scope of this research to another strong aspect [5].

Fig. 2 illustrates the revised form of original ITESCM model that is easily understandable and more user friendly for practical field applications for educational institutions.

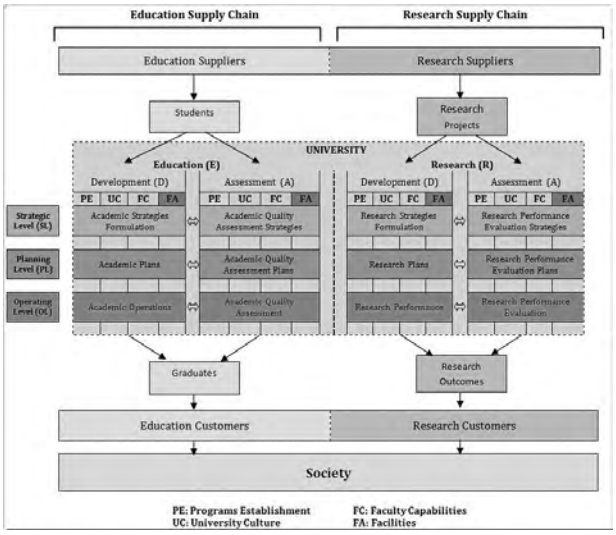

Fig. 2. Redesigned ITESCM Model [21]

III. Embedding M-Learning Aspects with ITESCM

M-Learning integrated ITESCM model would give us a better understanding of an integrated learning environment. This would also help to formulate the requirements, roadmap, or guideline to anticipate the impact on the educational outcome using this model. This study evaluates and reduces the risks by increasing the understanding this integrated learning environment under the integrated ESCM model parameters so that the drawbacks can be overcome. This would also be helpful in incorporating and measuring the possibilities of many additional learners who endure their thrust for gaining knowledge even if they are unable to attain the knowledge with the traditional learning environment settings.

The inclusion of m-learning into the educational supply chain management model creates multiple hierarchical decision-making phases as the stakeholders of the ESCM belongs to different hierarchical positions in terms of decision-making within the SCM. The mapping of the unique attributes of the m-learning features with formal learning attributes (e.g., cohorts, campuses, courses, semesters, and assessments) along with its monitoring and evaluation regimes puts m-learning in a different characterization. Any changes in these features raises concerns in terms of sustainable deployment in large-scale, as the nature and the extent of such deployment may compromise or misplace the unique attributes of both formal learning and m-learning [22].

Integrated Tertiary Educational Supply Chain (ITESCM) model has been used to map the education outcome with different criteria & aspects of m-learning and established a set of integration criteria to embed m-learning into ESCM model [16].

All the three aspects can be embedded into the factors Program Establishment (PE), University Culture (UC), Faculty Capabilities (FC), and Facilities (FA) in three decision levels Strategic (SL), Planning (PL), and Operating (OL) with the Development & Assessment for both Education and Research supply chain of ITESCM model [16]. Fig. 3 shows the embedded procedure of m-learning aspects and the components of ITESCM model.

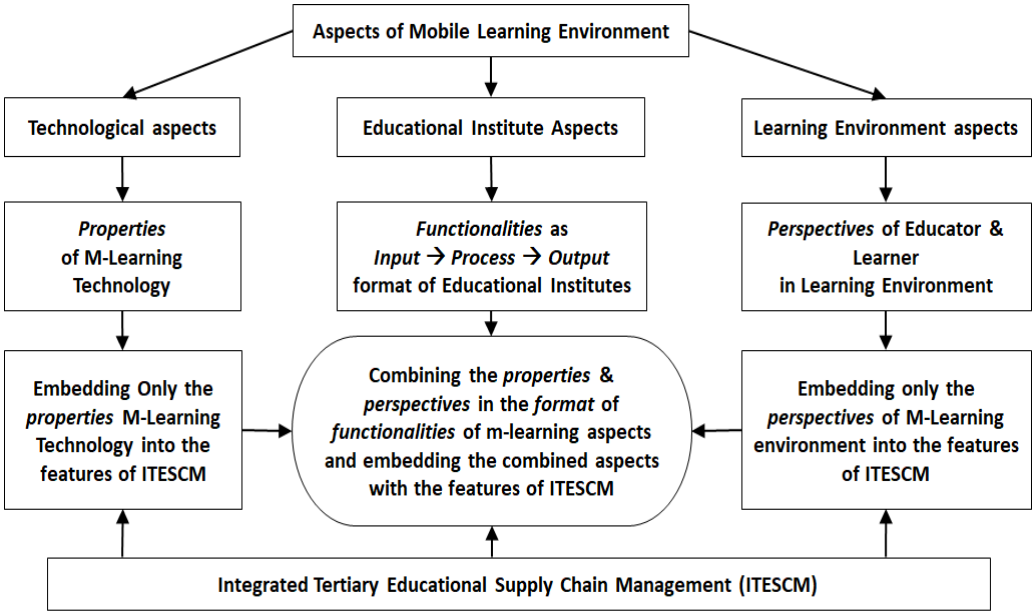

Fig. 3. Embedding Procedure

The following TABLE IV contain the embedded m-learning aspects into ITESCM model respectively for education and research. Each cell of the table contains the features, attributes, processes, measurement, functions, etc. that is required to deal with for the development and assessment for both education and research under the four factors of the university in three decision levels in ITESCM model with respect to the three m-learning aspects. TABLE IV is the combination of both technological and learning environment aspects of m-learning in terms of input, process, and output of educational institution aspects [5] showed in Fig. 3.

TABLE IV
M-LEARNING ASPECTS EMBEDDED INTO ITESCM (EDUCATION & RESEARCH) [5], [22], [31]–[40], [23], [41]–[50], [24], [51]–[60], [25], [61], [26]–[30]

EMBEDDED ITESCM WITH M-LEARNING ASPECTS					
SUPPLY CHAINS		**EDUCATION SUPPLY CHAIN:**		**RESEARCH SUPPLY CHAIN:**	
INPUT		**EDUCATION SUPPLIERS**: ICT equipment (hardware/software), ICT trained faculty members, M-Learning based learning materials, teaching methodologies, etc.		**RESEARCH SUPPLIERS**: research portal, mobile device access to server, connectivity with other researchers through mobile devices, etc.	
PROCESS		**DEVELOPMENT**	**ASSESSMENT**	**DEVELOPMENT**	**ASSESSMENT**
PE	**SL**	Curriculum outcome for all courses in integrated learning environment.	Integrated assessment policies to achieve the outcome of the curriculum using ICT system.	Adaptability of conducting research using m-learning environment.	Policies to ensure authenticity and security for m-learning system.
	PL	Define & design m-learning component of each course.	Assessment criteria for each component within the course.	Parameters for all research components on the m-learning platform.	Acceptability in research community using the m-learning platform.
	OL	Partial/full implementation for selective or all courses using the m-learning platform.	Assessment criteria, Security & validity of the system fulfils the expectation of the student outcome.	Learning & using of the platform under standard research guidelines.	Accepted research outcome with standard, usability, security, validity, and time constraints.
UC	**SL**	Robust use of the m-learning through ICT applications for academic & non-academic functions.	Level of adaptability and satisfaction of the use of m-learning and its application for all stakeholders.	Multiple use criteria with required resources through the m-learning concept for all research activities.	Level of adaptability, acceptability, connectivity of the research process using the applications.
	PL	Regular update & inclusion of new academic & non-academic areas into m-learning environment with latest technologies.	The inclusion must be adequate, rational, appropriate with user satisfaction towards the updated version of the applications.	Regular inclusion of new and latest methodologies using latest update of m-learning applications.	Maintain the defined parameter of research process and outcome with latest features in the m-learning system.
	OL	Proper awareness and implementation for all stakeholders	Time & effort to adapt the latest inclusion.	Acceptable, responsive, usable, & available to all the stakeholders	Time & effort to adapt the latest research process and system updates.
FC	**SL**	Irrespective of ICT background, teachers must be set to collect, use, prepare, and deliver learning materials.	Compliance of a fair assessment policies, criteria, and process to evaluate the students with integrated m-learning components.	Irrespective of ICT background, researchers must be set to collect, use, prepare, and deliver research materials.	Assessment policies, criteria, and process to evaluate the research outcome through m-learning process.
	PL	Training, teaching methodologies, learning materials, flexibility, connectivity, etc.	Students' outcome of knowledge gathering and implementing using the system.	Training, relevant research methodologies, adaptability, acceptability, connectivity, etc.	Use of m-learning process for research outcome in knowledge implementing, building, & sharing.
	OL	Preparing & delivering learning materials based on m-learning applications.	Adequate assessment process to evaluate the comprehensibility of the materials delivered.	Prepare, practice, deliver, & implement research materials based on m-learning process.	Acceptable assessment process to evaluate the worth of the research materials delivered.
FA	**SL**	ICT infrastructure within and outside classrooms, m-learning based applications.	Connectivity, reliability, privacy, services, troubleshoot, etc.	ICT infrastructure & m-learning applications with compliance to the need of the research process.	Connectivity, acceptability, reliability, privacy, etc.
	PL	Scope of the ICT infrastructure to strengthen the knowledge building.	User satisfaction, students' output.	Scope of the ICT infrastructure to support the research process.	Stakeholders' satisfaction.
	OL	Implementation, maintenance, & update.	Scalability, functionality, performance, etc.	Implementation, maintenance, & update.	Scalability, functionality, performance, etc.
OUTPUT		**FINAL OUTCOME**	**CONSUMER**	**FINAL OUTCOME**	**CONSUMER**
		GRADUATES: quality graduates equipped with latest technologies displaying implicit and explicit knowledge, proficiencies, aptitudes, expertise, morals, professional enrichment, etc.	**SOCIETY**: Utilizes the graduates through the employers and/or entrepreneurship to expand the society	**RESEARCH OUTCOMES**: resolution to the existing problem, development & expansion of pure theory, scholarly publications, investigative projects, theoretical & applied research, etc.	**SOCIETY**: Implements the research outcome through the public/private organizations to develop the society
		EDUCATION CUSTOMERS: graduates, family members, employers of government and private organizations.		**RESEARCH CUSTOMERS**: the organizations or donors who provides funding/scope/facilities to the research projects.	

IV. INTEGRATION OF M-LEARNING INTO ITESCM

The aspects of educational institution and the m-learning environment needs to be embedded to create an integrated model to implement a new process (m-learning) into the traditional process (traditional learning). The model needs to be in a format where the administrators [16] –

- can provide the required elements to implement m-learning as *input* into the model,

- identify, measure, and formulate the impact & relationship among the aspects and the factors for each aspect at different decision levels as *process*, and
- examine if the required educational outcome is achieved as *output*.

The educational institution aspects are identified through the input, process, and output of the institution itself.

- The input in terms of m-learning aspects are the suppliers of education and research for technological and learning environment aspects.
- The process are the development and assessment of education and research in terms of four factors – Program Establishment (PE), University Culture (UC), Faculty Capabilities (FC), Facilities (FA) of the university, each under the three decision levels – Strategic (SL), Planning (PL), Operation (OL).
- Finally, the output is the graduates and research outcome into the society. The technological aspects and the learning environment aspects are combined to map the factors of educational institution aspects.

The following Fig. 4 illustrates the integration process to create the Integrated M-learning Education Supply Chain Management (IMLESCM) model. The embedded factors of the m-learning aspects from TABLE IV are integrated in three phases – Input, Process, and Output.

- The embedded input factors map with the Suppliers for both Education & Research, respectively.
- The embedded process factors map with the Service provider for both Education & Research respectively.
- The embedded output factors map with the Outcome & Consumer for both Education & Research, respectively.

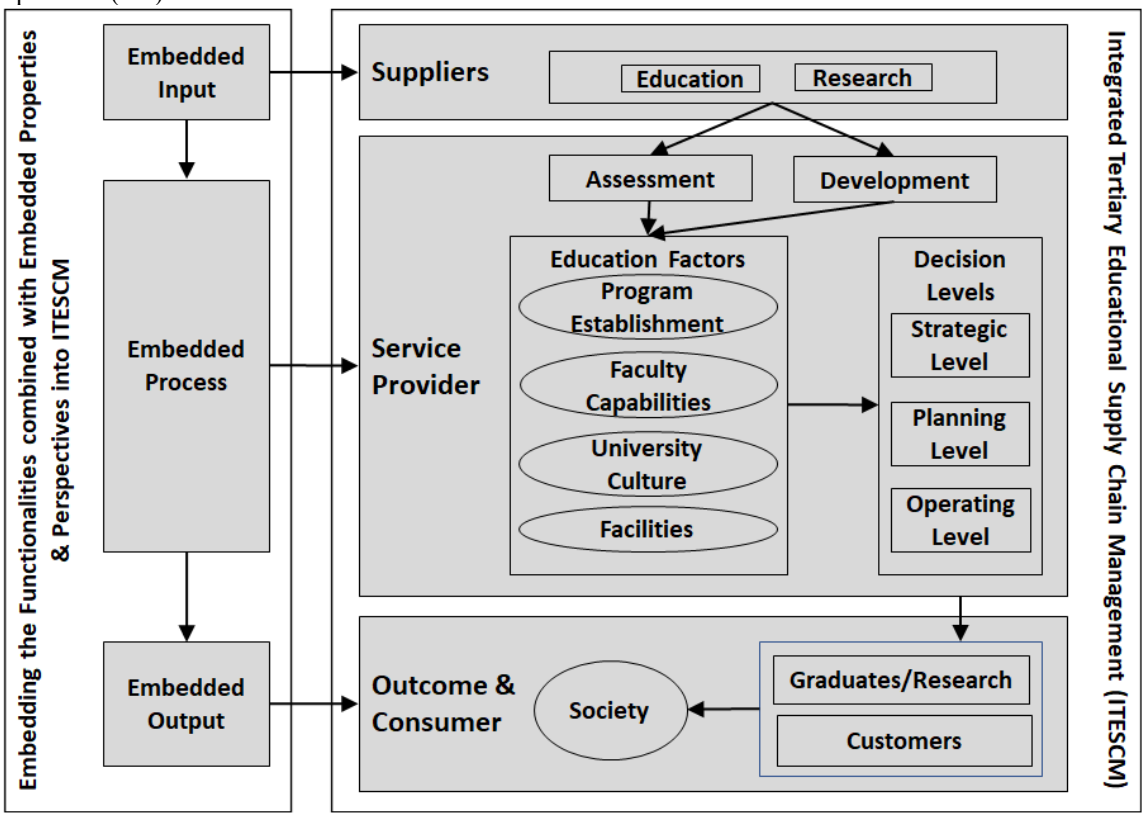

Fig. 4. Integrated Mobile Learning Educational Supply Chain Management (IMLESCM) Model

The IMLESCM model is a combination of education supply chain and research supply chain. In both chains, there are three inputs and three outputs as embedded in the TABLE IV. The following two figures, Fig. 5 and Fig. 6, shows both the supply chains in detail.

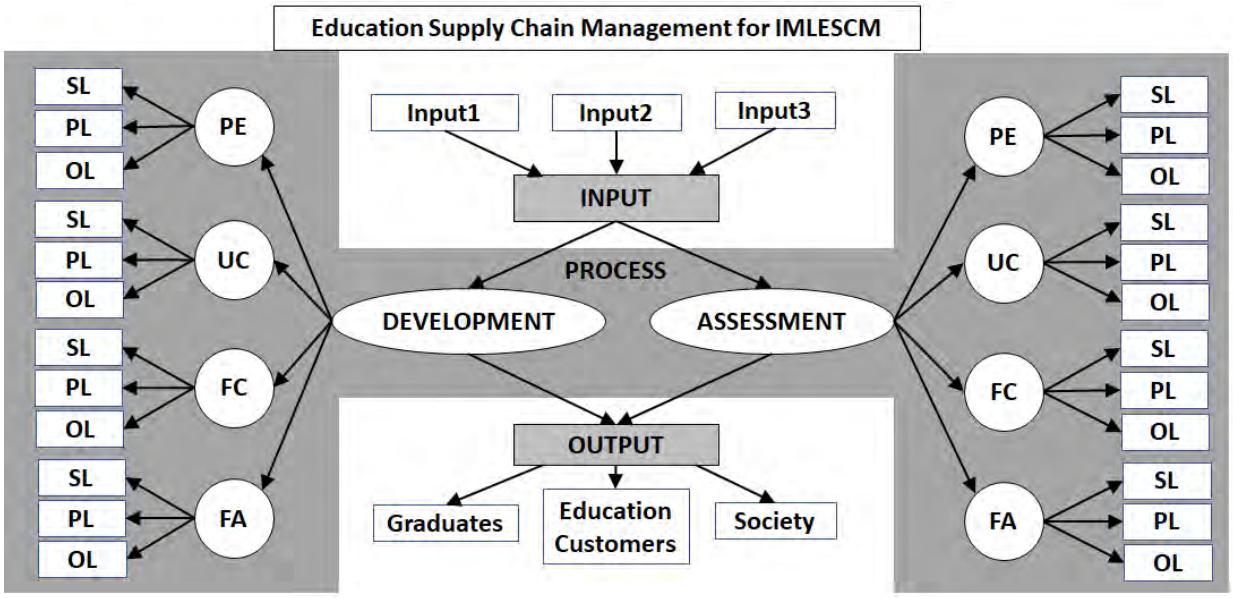

Fig. 5. IMLESCM: Education Supply Chain

Fig. 5 shows the education supply chain of the model IMLESCM. There are three inputs based on the embedded criteria of m-learning environment – infrastructure development (availability, cost, maintenance, etc.), human resource & learning materials (training, teaching methodology, learning materials, assessment process, etc.), and unified m-learning management platform for ease of use and accessibility [24], [25], [59]–[68], [26]–[28], [33], [43], [55], [56], [58]. The process contains all the four factors for three decision levels for both development and assessment phases. There are three outputs – quality of graduates as outcome, meets the requirement of education customers (e.g., employers), and the societies advancement as the overall consumer of the outcome.

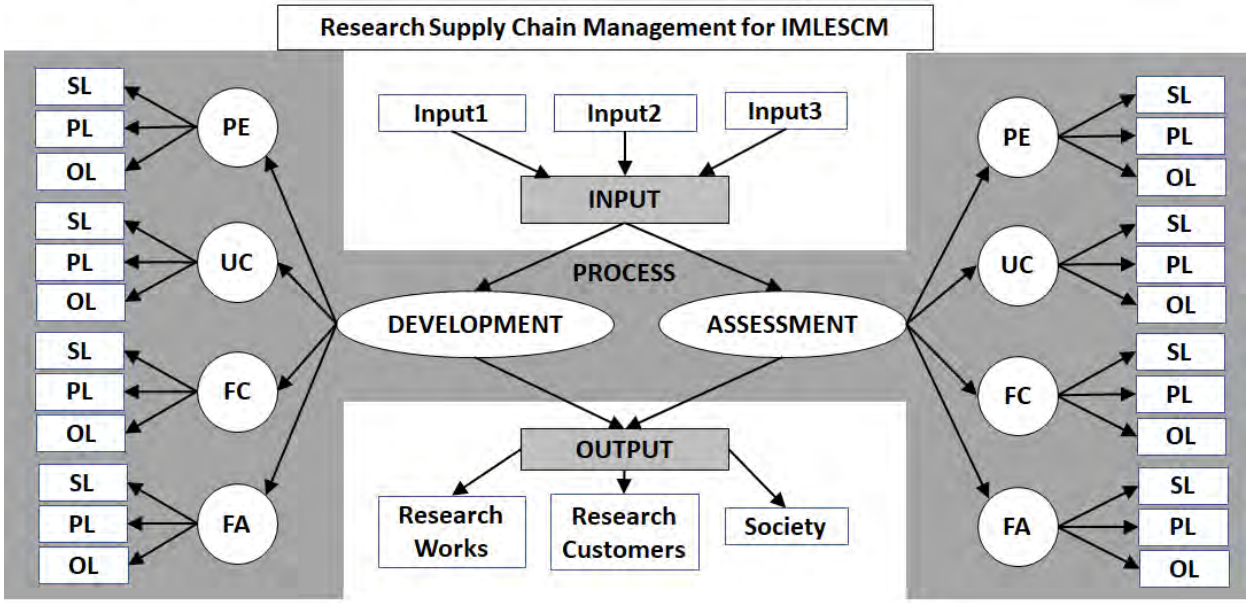

Fig. 6. IMLESCM: Research Supply Chain

Fig. 6 shows the research supply chain of the model IMLESCM. There are three inputs based on the embedded criteria of m-learning environment – infrastructure development (availability, cost, maintenance, etc.), human resource & research materials (training, research methodology, research materials, research outcome, etc.), and unified m-learning management platform for ease of use and accessibility [24], [25], [65], [66], [33], [58]–[64]. The process contains all the four factors for three decision levels for both development and assessment phases. There are three outputs – research outcome, meets the requirement of research customers (e.g., research funding agencies), and the societies advancement as the overall consumer of the outcome.

V. Conclusion

This study illustrates an integrated mobile learning education supply chain management (IMLESCM) model for the aspects of m-learning environment and the educational institution. The m-learning environment aspects were studied and identified. These aspects were embedded into each of the phases, aspects, factors, and levels of an empirical education supply chain model. The next step for this research is to collect data from different stakeholder of the IMLESCM model with respect to the institutional input, process, and output structure. These collected data from the stakeholders will also require an organized methodology towards a considerate process to test the reliability of the model, identify the integration criteria, assessment criteria, and most importantly to initiate and sustain the new integrated model for all relevant stakeholders of an academic institution.

Finally, these embedded aspects of m-learning were integrated into the ITESCM model in the format – input, process, and output. The goal was to develop a model that can take the supplies for implementing m-learning environment as input into the model by the stakeholder of the universities, process the decision levels of the stakeholder of the universities in different factors of the phases of the model, and ultimately provide an output that gives the quality of products, i.e. graduates and research outcomes for the betterment of the consumer, i.e. the Society.

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