ROLE OF MOOCs IN ADDRESSING CRUCIAL KNOWLEDGE, SKILL AND EMPLOYABILITY GAPS: A STUDY OF ONLINE EDUCATION IN INDIA

Ph.D. Thesis
Submitted in Fulfilment of the Requirement for the Degree of

DOCTOR OF PHILOSOPHY

by

Himanshu Pawar
2K18/PhDDSM/01

Under the Supervision of
Dr. Shikha N. Khera
Associate Professor, Delhi School of Management
Delhi Technological University

To The
Department of Delhi School of Management

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Shahabad Daulatpur, Main Bawana Road, New Delhi-110042. India

2025

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Shabhad Daulatpur, Main Bawana Road, Delhi -42

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I Himanshu Pawar hereby certify that the work which is being presented in the thesis entitled **Role of MOOCs in addressing crucial knowledge, skill and employability gaps: A study of online education in India** in partial fulfillment of the requirements for the award of the Degree of Doctor of Philosophy, submitted in the Department of Delhi School of Management, Delhi Technological University is an authentic record of my own work carried out during the period from August 2018, to May 2024 under the supervision of Dr. Shikha N. Khera.

The matter presented in this thesis has not been submitted by me for the award of any other degree of this or any other Institute.

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DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Shabhad Daulatpur, Main Bawana Road, Delhi -42

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Certified that **Himanshu Pawar** (2K18/PHDDSM/01) has carried out their search work present in this thesis entitled "**Role of MOOCs in addressing crucial knowledge, skill and employability gaps: A study of online education in India**" for the award of **Doctor of Philosophy** from Department of Delhi School of Management, Delhi Technological University, Delhi, under my supervision. The thesis embodies results of original work, and studies carried out by the student himself and the contents of the thesis do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other university/institution.

Signature

Dr. Shikha N. Khera

Associate Professor

Delhi School of Management

Delhi Technological University

Date:

DEDICATION

Dedicated to Late Shri. Jagdish Chander Pawar

Beloved father, a strong man and my hero

Miss you dad…

ACKNOWLEDGEMENT

My doctoral dissertation would not have been complete without the contributions of several key people. I wholeheartedly thank them for their support and unwavering trust in my dream. I sincerely thank my supervisor, **Dr Shikha N. Khera**, Associate Professor, Delhi School of Management. Her constant support and guidance have been more than enough for me to sail through the doldrums of my PhD. Her unwavering support and belief in my ideas gave flight to my dreams, which allowed me to achieve more than my timid expectations. She has been a constant source of inspiration, zeal, and mentorship; this work could not have been completed without her.

I am grateful to **Prof. P.K Suri**, DRC Chairperson and **Prof. Rajan Yadav** for their support, guidance and belief in my work. I would also like to thank all faculty members and office staff for their support, progressive environment and guidance in all research work as well as the administrative work. I am blessed to be a part of the team at Delhi School of Management, which is an institution destined for excellence.

I am blessed to have had the support of three key scholars (**Rahul Sikka, Apoorva Jain and Harsh Gautam**) during my journey. Words cannot emulate my gratitude towards all of them. The emotional support during my doctoral journey was fulfilled by the kind, quirky and inquisitive nature of these kids. Cheers to our friendship!. Also, I thank all my senior and junior research scholars at Delhi School of Management for their love and support.

Last, I would like to thank my mother **Savita Pawar**, who has always encouraged me to follow my dreams and admired me relentlessly to become a humble soul. I would like to thank my brother, **Shashank Pawar** and sister-in-law, **Swati Pawar**, and my beloved niece, **Shreya Pawar** for their support and belief in my doctoral dream. I extend my gratitude to all my childhood friends (**Karan Magon, Harpreet Kaur, Nitin Aggarwal and Winner Sahni**) thanks guys!.

Himanshu Pawar

ABSTRACT

Online learning after COVID-19 picked up a pace in higher education like never before. Even though online learning systems have been present in the Indian education sector since the early 2000s, they have, however been considered as a supplementary method of teaching and learning. Over the years, self-directed learning via means of recorded lectures in IITs and IIMs (i.e., at the top of the Indian engineering and management institutions) has been isolated mainly for a cohort of highly successful students at the undergraduate level. The lack of resources at most Indian higher education institutions has hindered the growth of self-directed learning. Academic lectures on open platforms such as YouTube have been present for a long time but were not popular among most of the student population in India. Students and universities preferred the traditional mode of teaching and learning, i.e., face-to-face instruction, over any other medium of instruction.

It was not until the coining of the term Massive Open Online Courses (MOOCs) in 2008 by Dave Cormier in Canada that the attention to online learning courses took a global flight. Once the potential was discussed and harnessed by top academic institutions across the globe, privately funded and government e-learning platforms began to multiply, leading to a global revolution in online learning methods. The first Indian e-learning platform funded by the government of India was launched in 2017 and was given the acronym Study Webs of Active-Learning for Young Aspiring Minds (SWAYAM). During and after COVID-19, e-learning became the norm for teaching and learning across hybrid-functioning universities and institutions. MOOCs began to be widely used for credit at universities, and the New Education Policy, 2020 also vouched for MOOCs to be a formal part of the education system in India.

Our study explores the role of MOOCs in helping students upskill themselves, which might help bridge the mismatch between academia and industry expectations. We believe in the more positive aspects of MOOCs and vouch for their effective integration in the form of supplementary aid to all higher education institutions lacking in delivering quality education, industry-relevant skills and knowledge.

Keeping in mind that the students are the primary stakeholders of education, the current study focuses solely on students' perceptions of the curriculum development process at universities.

The importance of their role is examined since the effects of any form of policy implementation that affects students directly must be seriously considered by the universities.

Our study also focuses on critical student issues with MOOCs that affect the more significant problems in the e-learning systems, such as high student drop-out rates, lack of motivation, etc. A combined understanding of such issues helps to evaluate the problems from a systems perspective. More profound interconnections between issues and their behaviour is evaluated in this current study.

Since MOOCs for credit are mandated among higher education institutions in their curriculum, it is equally important to gauge the effectiveness of such policy implementation. Our study explores this objective via in-depth interviews with students who have presented their accounts of the university mechanism for credit and helped uncover the system's loopholes.

The results of our study indicate that students are using MOOCs to upskill themselves and keep up with the latest trends in the market. The issues with MOOCs are still persistent and need more attention to detail in the larger e-learning context. The policy directives from the government fail at multiple points, and students have found to outsmart the system view means of cheating and using immoral means of securing credits. The popularity of the government-funded e-learning platform SWAYAM is on a downward spiral. There is immense potential, but the platform cannot keep up with advancements in features for e-learning platforms when compared globally. Further contributions and the limitations and scope for future work are also discussed towards the end of the work.

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1.	GER	Gross enrollment ratio
2.	RUSA	Rashtriya Uchchatar Shiksha Abhiyan
3.	HEIs	Higher education institutions
4.	MERLOT	Multimedia education resource for learning and online teaching
5.	PLOS	Public Library of Science
6.	WBIS	Web-based information systems
7.	MOOCs	Massive Open Online Courses
8.	CEC	Consortium for educational communication
9.	QA	Quality Assurance
10.	QE	Quality Enhancement
11.	HEQF	Higher Education Quality Frameworks
12.	SOLO	Structure of Observed Learning Outcomes
13.	AES	Automated essay scoring
14.	NEP	National Education Policy
15.	AHP	Analytical Hierarchy Process
16.	TISM-P	Total interpretive structural modelling with polarity
17.	ENA	Epistemic network analysis
18.	MCDM	Multi-Criteria Decision Making
19.	MCDA	Multi-Criteria Decision Analysis
20.	SMART	Simple Multi-Attribute Rating Technique
21.	IC	Internal Consistency
22.	CR	Consistency Ratio
23.	RI	Randomness Index
24.	ISM	Interpretive structural modelling
25.	MICMAC	Matrice d'Impacts croises-multipication applique´ an classment
26.	CRITIC	Criteria Importance Through Inter-criteria Correlation
27.	SECA	Simultaneous Evaluation of Criteria and Alternatives
28.	SVP	Statistical Variance Procedure

29. ANP	Analytical Network Process
30. DEMATEL	Decision making trial and evaluation laboratory
31. IRM	Influential relation map
32. NRM	Network relation map
33. SVD	Statistical variance dimension

Chapter 1

Introduction

1.1 Overview

Higher education in India has rampantly grown in size and numbers (1,113 Universities, 43,796 Colleges and 11,296 Stand Alone Institutions) and is evolving. India is currently at the peak of harnessing the demographic dividend in the form of well-educated and skilled youth, which is becoming a luxury for most developed economies. In order to extract the most value out of the Generation Y and Z youth population, the Government of India is on a mission to increase the gross enrolment ratio (GER) in higher education to 32% under the Rashtriya Uchchatar Shiksha Abhiyan 2.0 (RUSA) by 2022 (Ravi, et al., 2019).

The Indian higher education sector faces issues and challenges of myriad forms and stature. The burden on higher education institutions (HEIs) to provide ***quality education*** has consistently risen due to the rise in GER, whereas the Indian model of small, high-quality institutions has resulted in a disintegrated system that is hard to manage (Ravi, et al., 2019). All stakeholders, either directly or indirectly involved, have their own areas of concern, which majorly revolve around the issue of quality of education in one form or another. For example, the government is striving towards setting up institutes of high quality and infrastructure, in contrast, students expect quality education and employable opportunities from their institutions and industry professionals expect skilled graduates of the highest quality. According to Sharma and Mishra (2010) issues such as the under-representation of poor and marginalised sections of society in higher education, low level of girl child enrolment due to social and cultural biases (Dnyandev, 2017), low and mediocre levels of state university standards etc. regresses the quality of higher education in India. Lack of equity and finance leads to disparity in enrolment across HEIs, and the rift between rural-urban participation is dragging the growth of the education sector. Furthermore, according to India Skills Report 2023, lower levels of ***quality education*** also lead to ***low levels of employability*** in the industry, which is a significant concern for the Indian higher education sector, which rests in slumber at the untapped potential of youth in the country (WheeBox, 2023). Over the years, the gap between what institutions are offering and what the industry demands has considerably widened due to poor education standards, lack of institutional autonomy and burdensome corporate regulations (Ravi, et al., 2019; Pathak, 2016; Pantt, 2017; Qazi, 2018). The number of graduates being churned out far outpaces the number of jobs being created by the government and the industry. The organised sector has always complained about the low quality of higher education across institutions and the lack of relevant skills in graduates (Mehrotra et al., 2013; Shukla et al., 2019; Chakrabarty, 2019; Cheema, 2020). Synonymous with the past 7 years findings from the India skills report, various news articles and domain experts have also consistently expressed worries over the stagnant growth of employable graduates (~50.3%) and widening skill gap (WheeBox, 2023).

Thus, it is evident that ***skill gap*** is a seasoned issue that has plagued the productivity of Indian higher education institutions over the years. If this remains the case, then only the top institutions in the country would be churning out employable graduates, and the majority of tier 2 and 3 state institutions would struggle to get their students in the job market, leading to greater disparity. Therefore, the government of India has set up numerous vocational training institutes deployed skill development initiatives via ministries of skill and development, textiles, agriculture and farmer welfare, human resource development and, commerce and industry, etc. Various schemes cater to individuals and students from both the organised and the un-organized sectors of the economy, such as the Pradhan Mantri Kaushal Vikas Yojana, Skill development for minorities and Scheme for Higher Education Youth in Apprenticeship and Skills, etc. but extra hands are forthwith needed to improve the pace of change in skill-development and employability rates.

1.2 Relationship between skill gap and knowledge gap

From the higher education/industry perspective a ***skill gap*** can be defined as a situation where HEIs fail to supply the right talent at the right time to meet the employers' requirements (Ryan, 2016). Every year, several agencies release concerning data on the issue of increasing skill gap across developing countries, which echoes in the minds of policymakers as a failure of their education systems and undermines the country's potential to grow and advance towards economic maturity (Agarwal, 2009). The mismatch between what the educational institutions provide, what the students seek and what the employers need creates a huge deficit (Tran, 2018). As mentioned earlier, only ~50.3% of graduates are employable in India, which should make all higher educational institutions ponder the why? Factor.

In order to answer the why? Aspect we must look at some of the plausible reasons, such as lack of infrastructure, quality teaching, administration, policies, motivation, etc., from a systems perspective because this is not a problem of an individual institution or a university but rather the whole system needs to be critically examined. The direct relationship between the ever-widening skill gap and the growing population of India (Mehrotra et al., 2013) should not be sidelined as just one of the important factors since, India is facing problems of both demand and supply i.e. more individuals are available for low skills level jobs and few for high level skills jobs requiring domain knowledge and expertise (Aggarwal, 2016; Leuven & Oosterbeek, 2006; McGuinness, 2006; Montt, 2015). HEIs are not able to produce employable graduates with relevant technical, team building and soft skills thus leading to a broader skill gap and disappointment during campus recruitments. Equipping entry-level graduates with skills necessary to cope with technological advancements, industry 4.0, AI and machine learning, etc., vests with the HEIs. Lack of industry collaboration, the stagnant and outdated curriculum at the undergraduate level, the old wine in a-new bottle approach (Nayak & Sahu, 2016), and lack of quality teachers and infrastructure (Unni, 2016) are some of the reasons that affect the quality of graduates in India. Unni (2016) identified three types of skill mismatch in higher education: *Type 1* occurs when we have over-educated youth being hired for jobs that doesn't require such qualifications; *Type 2* occurs when then there is a skill mismatch in technical education, such as agriculture, engineering and technology etc. and *Type 3* occurs when companies recruiting fresh graduates complain about the poor quality of higher education (Raybould & Sheedy, 2005; Crossman & Clarke, 2010). In the Indian context, all three gaps point in one direction again, i.e. lack of quality education leads to lower levels of graduate employability, which increases the burden on the whole system to look after highly qualified and unemployed youth.

Various types of skills are acquired by graduates over the course of their degree programmes, such as technical, motivational, adaptive, socio-cultural and innovative (Manninen & Hobrough, 2000). A primary study across 5 European countries revealed the dominance of productive and technical (domain knowledge) skills over all other skills acquired by graduates at HEIs. This does not mean that other skills should be neglected or looked down upon, but the importance of domain knowledge for graduates was found to be paramount in increasing their employability (Ajit & P.B., 2013). Furthermore, the alignment with industry expectations was also found to be at par with institutional offerings, and no differences or mismatches were found (Manninen & Hobrough, 2000). However, the Indian higher education system and the job market, on the other hand, are far from achieving the balance between supply and demand. The blame game for the shortage of skilled graduates continues to be a debatable topic amongst all key stakeholders. At the university level failure of institutions to imbibe relevant skills has been consistently discussed and criticised (Harvey, 2001); lecturers are also often blamed for not taking initiative out of their discipline-specific experience (de la Harpe et al., 2009), the failure of government to provide environment conducive for autonomy of HEIs in India (Prakash, 2011) and lack of communication form the industry (Rosenberg et al., 2012) are matters of concern for youth unemployment. Thus, one must understand that the aforementioned issues will not be rectified within a month or a year since; interests of various stakeholders are fulfilled within the ambit of their duties and responsibilities. Therefore, the study hypothesises that Massive Open Online Courses (MOOCs) might help relieve the pressure from HEIs to deliver high-quality education to all sections of the undergraduate level. The organised sector demands quality education, and the MOOC learning and development model might be the key to reducing the knowledge and skill gaps that hamper employability.

1.3 Knowledge gap: The premise of a skill gap

In today's fast-paced and technologically evolving world, one of the crucial challenges for HEIs is to provide a platform for quality education that is accessible equally to all sections of society. Employability is defined as "*a set of achievements—skills, understandings and personal attributes—that make graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy*" (Yorke, 2006). In the Indian context we have identified the issues that have plagued graduates' employability across all job sectors. Experts have held HEIs responsible for academia-industry expectation mismatch, stagnant and outdated higher education curricula and lack of institutional capacity leading to a skill gap (Casner-Lotto, 2006; Arum & Roska, 2011). The lack of domain knowledge in graduates reflects the state of quality education and rigour offered by HEIs (Rhew et al., 2019). Most desired and researched skills by industry and academia are teamwork and leadership, analytical skills/technical proficiency (Azevedo et al. 2012; Bennett 2002; Liebenberg et al., 2015; Cegielski & Jones-Farmer, 2016), soft skills (Azevedo et al., 2012; Matsouka & Mihail, 2016; Bennett, 2002; McArthur et al., 2017) and problem-solving skills etc. Rhew et al., (2019). The point is that there are numerous skills that a student acquires during their degree programme. However, specific skills or gaps in their knowledge could not be filled due to a lack of institutional support, old pedagogical methods and a stagnant curriculum, which hampers the quality of graduates. We believe MOOCs can be used as a turning point for supporting institutions of low quality and infrastructure such that all students could acquire job ready knowledge and skills via certification courses which can be attached to their degree programmes for credit.

1.4 Evolution of MOOCs

Innovation in education is a well-knit result of creating and dispersing new educational tools, instructional methodologies and technologies (Foray & Raffo, 2014). The standardised procedures and rules of this trade have been stagnant throughout history, which has hampered growth and change. Instructor-driven face-to-face delivery of lectures, forms of assessments (primarily formative and summative), and limited accessibility of quality education to deprived sections of society have consistently shaped the foundation of this sector. Thus, over a period of time, with evolution of technology and rapid globalisation, the concept of distance education came into practice, which dates to the mid-19th century when Sir Issac Pitman began teaching shorthand to students via mailing postcards (Schulte, 2011). Major reforms to the distance education system were first brought in by the U.S. schools, colleges and universities, which harvested upon the rapid growth of computers during mid-1970s for research purposes. In 1994, an online platform called Multimedia Education Resource for Learning and Online Teaching (MERLOT) came into existence via California State University, which provided almost free e-learning resources for higher education to its students. Similarly, the formations of Public Library of Science (PLOS) and the Budapest Open Access Initiative in 1990s were two of the major initiatives that laid the foundations of OERs (Bliss & Smith, 2017). But, In 1999, the Massachusetts Institute of Technology (MIT) swept the floor with the idea of MIT OpenCoursWare (MIT OCW); which allowed its users to freely engage in retaining, reusing, revising, remixing and redistributing (5Rs) the educational content (Bliss & Smith, 2017). Since then the number of mega institutions offering distance education to students across nations has increased spuriously. Innovation in technology allowed for cheaper accessibility and affordability of the internet and computers played a crucial role in achieving the goals and objectives of OERs, which laid the foundation stone for MOOCs in the last decade. Earlier, we didn’t have the means and infrastructure to support such change, but now we have moved one step further with a goal of reaching to hundreds and thousands of students live at a particular time. The MOOCs model runs now in parallel to the OERs for macro level learning in distance education by applications of connectivism and generativism learning theories for technology-enhanced learning environments (Steffens, 2015).

1.5 MOOCs overview

MOOCs are web-based information systems (WBIS) created using web technologies to disseminate learning and information via virtual interactions of teachers/facilitators and students. They cater to the e-learning domain in the real world and offer live class-like study experiences despite geographical proximity. They offer flexible and convenient learning to all sections of society using digital content which can be downloaded with ease (Bralić & Divjak, 2018). The term was coined by Dave Cormier after the course “connectivism and connective knowledge” (CCK08) successfully attracted 2200 online students led by George Siemens and Stephen Downes (Baturay, 2015). MOOCs on the sidelines of innovation in education technology have emerged as one of the most successful and widespread model for the dissipation of knowledge and learning through the use of online e-learning platforms (Jordan, 2015). It is observed that during the initial years of exploratory research on MOOCs, the majority of the researchers divulged more about apprehending the impact, paradox, learning, feasibility, performance evaluation effectiveness, etc. of the concept. Major emphases on learning theories and new conceptual foundations (Gasevic et al., 2014) have rigorously been researched, leading to the culmination of key traits and characteristics of MOOCs. Since its inception, the concept has been a part of academic dialogue amongst scholars who view it as a form of ‘disruptive innovation’ (Flynn, 2013; Yuan & Powell, 2013). Presumably, the authors believe that MOOCs wield the power to disturb the make-up of our current educational system by changing the roles of student-teacher interaction and technology (Flynn, 2013), which is true if we understand how one complements the other in the presence of rapid technological advancements. On the other hand, scepticism looms over the same as few authors believe that the evolution of MOOCs from OERs is nothing more than a technological shift and it does not suffice the characteristics of disruptive innovation as mentioned in literature (Al-Imarah & Shields, 2018; Kursun, 2016). Perelman (2014) viewed MOOCs as a symptom of disruption, not a significant cause, since, according to him, the academic bureaucracy believes that broadcasting online lectures can only put on a masquerade threat to the existing institutional norms and state of affairs in education; nothing substantial. We, however, believe in the more positive aspects of MOOCs and vouch for their effective integration in the form of supplementary aid to all higher education institutions lacking in delivering quality education, industry-relevant skills and knowledge.

1.6 Effective integration of MOOCs to address knowledge and/or skill gaps

The MOOCs system in India has been up and running since 2012 (mooKIT-IIT Kanpur) but we are majorly lagging behind other countries in terms of effective integration and spread of its services across the mammoth size of our education system. In addition to NPTEL, mooKIT and IITB-X the government of India launched the SWAYAM platform in 2016, which is the culmination point for different institutions offering MOOCs in India. The platform houses MOOCs from organisations such as IGNOU, NPTEL, consortium for Educational Communication (CEC), AICTE, NCERT, IIM-B, NITTT and NIOS (Swayam Central, 2020). The number of student enrolment is vast but the completion rates are low. The courses prepared by the instructors are specific to their domain expertise and are limited to a few streams of higher education, such as science and technology, management, commerce, etc. The latent power that MOOCs wield in providing cheap and high-quality skill-development courses in India is not fully utilised by HEIs. A small fraction of tier-1 institutions have contributed to MOOC development, albeit a vast number of initiatives have been launched by the government of India. Thus, effective integration of MOOCs is necessary for the higher education sector to improve our rankings with regard to delivering quality education to the masses.

1.7 Selection of students as the key stakeholder of higher education

Higher education curriculum development in a post-modern society is a prerequisite for a collective effort from all the stakeholders involved at various stages of its development. For the efficient functioning of an institution, stakeholders are expected to personally identify themselves with their roles and responsibilities and work with due diligence and compliance, bearing trust in the system. In the present scenario, industry competitiveness has also led to a push for greater accountability on the parts of each party involved in developing an effective curriculum. According to the stakeholder theory (Freeman & McVea, 2001), the success of any institution is mainly dependent upon the active involvement of its key stakeholders in the decision-making processes. HEIs witness both active and passive involvement from stakeholders such as the government, board of trustees, parents, faculty, staff, communities and students (Avci et al., 2015). However, mere identification does not meet the needs of the curriculum development team to prioritise the inputs received from their end. It is also a matter of institutional capabilities, competence, and subjectivity in management to discern the weight given to their inputs. One of the most famous theories for stakeholder identification and prioritising their inputs was propounded by Mitchell et al. (1997) via 'The stakeholder salience model', which is based upon three social phenomena (power, legitimacy and urgency) and identification of seven types of stakeholders with distinctive identities see Figure 1. In the framework, power is defined as the exertion of influence of one actor over the other exercising their stronghold; legitimacy refers to desired actions to be taken by an organisation in lieu of societal expectations; and urgency refers to stakeholders active participation in institutional meetings and committees (Leisyte & Westerheijden, 2014). The stakeholders are divided based on the attributes they possess; three of these have single attributes, while the other three have two attributes, and the last one has the influence of all three. At the bottom-most level, latent stakeholders are present, which might take the roles of demanding, dormant or discretionary stakeholders for example, employers could be considered as latent stakeholders with legitimacy attributes only since they might not have the power and urgency to aid the curriculum development process (Leisyte & Westerheijden, 2014). It is the responsibility of HEIs to create an inclusive atmosphere for industry professionals and employers to actively participate in the exercise, which will eventually bridge the gap between the industry and academia. The expectant stakeholders are the ones who possess the combination of two of the three attributes, such as social communities; they might possess legitimacy and urgency, but at times, they are shunned from the power circle of decision-making (Avci et al., 2015) reducing themselves to dependent stakeholders.

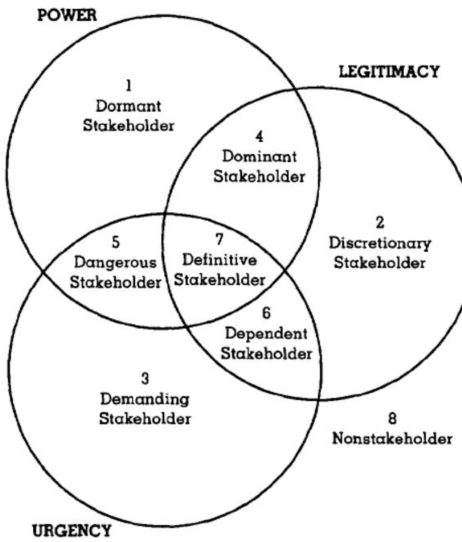

Fig. 1.1 Stakeholder identification and salience typology (Mitchell et al., 1997, p. 874)

Similarly, if a stakeholder such as the government wields both power and urgency (dangerous stakeholder) to initiate reforms in the curriculum development process, it might lead to a haphazard development process and degrade the whole exercise's quality. The definitive stakeholders are the ones that dominate over all three attributes for example, donors and administrators have a say in the strategic, financial and academic matters of curriculum development. They are legitimate individuals who have the power and urgency to influence decision making at every stage.

Chapleo and Simms (2010); Alves et al. (2010); Kettunen (2015); Beerkens and Udam (2017) deployed the aforementioned framework for studies in stakeholder management, analysis of their relationships and degree of engagement. Literature on stakeholder identification is well developed in the context of curriculum development and has been researched in multiple settings and fields. For example Virgolesi et al. (2019) identified students, nurses, managers, educators and academics as key stakeholders for developing a nursing baccalaureate curriculum; in another study, Vamos et al. (2018) developed an online health literacy curriculum for German universities while interviewing students and domain experts; Alexander and Hjortsø (2019) conducted a study on participatory curriculum development and critically analysed the relationship between key stakeholders namely, faculty deans, department heads, students, senior lecturers, private CEOs and staff. Further, in a major study conducted to distinguish between the engagement levels of stakeholders involved at various curriculum development stages Meyer and Bushney (2008) identified 18 types of stakeholders. Even though stakeholder identification is subjective and contextually dependent, students were always seen at the centre of the curriculum development process but the degree of their influence varied greatly depending upon institutional maturity and autonomy. Since our study is focused on students' perceptions, we will not go into in-depth discussing about the power and sphere of influence of other stakeholders such as employers, administration, parents, communities, etc. Analogous with Mitchell's stakeholder typology, we can see how students' role in curriculum development is ascertained. In a study conducted by Leisyte and Westerheijden (2014) it was found that out of the seven European countries studied, only the UK and the Netherlands had placed students in the definitive stakeholder position, which highlights the fact that that there is limited attention given to students' voice and opinions in the formation of study programmes across borders. It is crucial to reiterate the importance of students as primary stakeholders because it is the social, moral and ethical obligation of educational institutions to provide aid for their holistic development. Students should be allowed the freedom to possess all three attributes in a way that defines their role in the curriculum development process. They should be given the power to let their opinions and suggestions be heard, which will positively impact students' perceptions about their institution and instil a sense of belongingness. They should not be considered only as latent stakeholders or ones who are essential on papers and perceptions but are not acted upon. In countries where the power distance is high with rigid hierarchical structures, it automatically becomes difficult for students to approach reforms and change. It should be the duty of governments and institutions to call for such actions that improve student engagement and provide their input with the power to be heard and acted upon. But, a combination of only two attributes might land them in a partial state of expectancy; rather, a balance between students' power, legitimacy and urgency is needed to exploit their full potential in the curriculum development process thereby placing them in a definitive position to assert their rights.

1.8 Use of perception in the current study

A branch of cognitive psychology involves understanding perception as human beings' ability to process information via sensory organs to make sense of decision-making processes and the outside world (Eysenck & Keane, 2015). It is a matter of high subjectivity based upon context-oriented driving forces such as moods, emotions, environment pre-conceived notions, etc., which are isomorphic to the presumptions our brain makes to surpass the natural ambiguities rising from sensory evidence (Eysenck & Brysbaert, 2018). The influence of perceptions on human decisions has long been investigated and explored in multiple settings, Epstein (1994) observed two ways of apprehending reality, i.e., experiential and intuitive while the latter one being easier to comprehend and act upon during complex situations, the experiential method has emerged as a more rational mode of decision making. Further, the rise of analytical thinking in recent years had successfully subjugated decision-making processes and emerged as the epitome of rationality (Slovic et al., 2005). Therefore, in the backdrop of the current study, it is compelling to capture the perception of students about the MOOC system of e-learning in Indian universities.

1.9 Conceptual frameworks referred for study

A substantial number of models, frameworks, and guidelines have been developed for enhancing and assuring quality in e-learning for example quality improvement framework (Inglis et al., 2002) based on principles of good practice, Benchmarks for success in internet-based distance education (The Institute of Higher Education Policy), Universitas 21 global quality framework (Chua & Lam, 2007) for assessing the quality of online courses, Proactive evaluation framework (Sims et al., 2002) for focussing on the decision-making in relation to the interaction between disciplinary content, learning outcomes and online computer-based learning environment, common framework for e-learning quality (Andersson & Grönlund, 2009) to assess the quality parameters in e-learning, e-learning quality framework (Jung, 2011) etc. The aforementioned frameworks' guides the researchers to understand the quality parameters associated with e-learning.

However, for the current study we are trying to understand the perceptions of students about already established e-learning systems at the universities. The quality of e-learning courses should be of much importance for universities since they amount to credit points in the curriculum, according to the New Education Policy, 2020. At this point, it becomes crucial to understand the issues or barriers that the students face when dealing with online courses; thus, an 'E-quality framework' (Masoumi, 2010) is taken as a theoretical base for our current study (Fig. 1.2). The e-quality framework is constructed with three levels in which 113 'benchmarks' are categorized and sorted into 29 'sub-factors' and seven main 'factors'/ building-blocks. The benchmarks characterize and exemplify the very sub-factors and factors. These factors represent a cluster of related benchmarks that are mostly centred on a specific aspect of e-learning settings. The e-quality framework has been used in various studies such as assessing quality in virtual institutions (Masoumi & Lindström, 2012); understanding contextual challenges in online distance education (Dilan & Fernandez, 2015); quality improvement in virtual higher education (Mahdiuon et al., 2017).

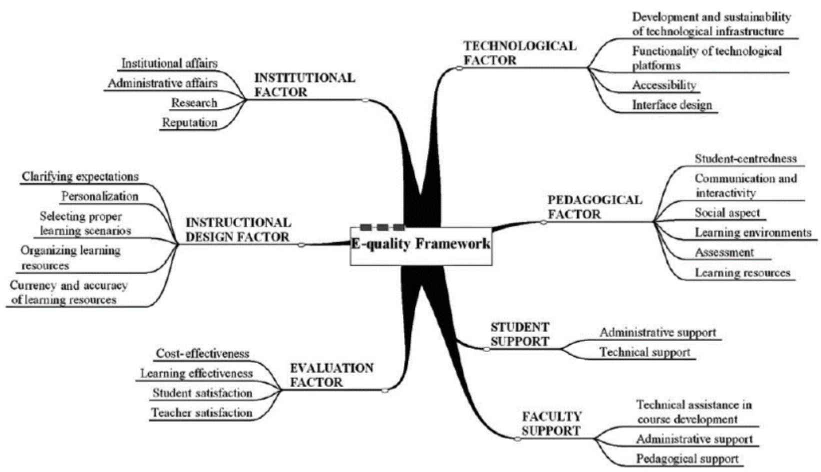

Fig. 1.2 E-Quality Framework (Original source (Masoumi, 2010))

The current study lays its foundations in these factors which not only affect the quality of e-learning but also cause much larger problems in the online learning education system such as massive dropout rates (Hew & Cheung, 2014); lack of student motivation and intention to adapt to new technology (Ma & Lee, 2018a); asynchronous nature of majority MOOCs (Alario-Hoyos, 2014); low perceived value compared to university degrees (Rosendale, 2017) and doubts regarding the credibility of such courses in the employment market (Trehan et al., 2017) etc.

1.10 Organization of Thesis

Chapter 1 (Introduction) – This chapter will include an in-depth introduction to the topic of the study. A thorough examination of the higher education scenario in India will follow along with an in-depth explanation of the current state of the e-learning system in the country. The role of MOOCs in education will be explained along with the exploration of their hidden potential to act as a credible source of skill improvement among engineering graduates in India. The challenges associated with bridging the skill gap and knowledge gap will be examined from a purely student perspective since they are the key and primary stakeholders of education in the country.

Chapter 2 (Literature Review) – This chapter will cover an in-depth review of related literature to the topic, along with the exploration of gaps and problems in the literature pertaining mainly to student issues with MOOCs. The section will cover an in-depth analysis of past studies and explore gaps which will be addressed as objectives for the current study.

Chapter 3 (Methodology) – Once the gaps are identified and the research objectives are formulated, the study will focus on a mixed method methodology for achieving its objective. A blend of qualitative and quantitative methods will yield a set of comprehensive results. Each objective caters to a different methodology depending upon the achievement of the objective.

Chapter 4 (Results) – The results for each objective will be separately published in the study. The study is conducted in multiple phases and the results will flow from 1 phase to another for holistic understanding.

Chapter 5 (Conclusion, Future Scope and Impact) – This section will cover the overall conclusion of the study's results. It will cover recommendations for universities, policymakers, and students on different levels. It will also cover the future scope of the study and a description of the social impact of the research conducted. References – The reference section will be written according to the APA guidelines.

Chapter 2

Literature Review

The review of related literature is carried out in two parts according to the objectives of the study, which will be discussed later in this section. Analysing multiple frameworks like the one mentioned in (fig.1.1) gave us a head start for figuring out critical factors involved with MOOCs' quality and are crucial from students' viewpoints. The study also focuses on understanding students' perceptions about the role of critical factors in university curriculum development. The rationale behind the selection of students as primary stakeholders of education is mentioned in multiple studies that believe in their impact on education quality and best practices (KHADIJA, 2022; Oerlemans, 2007; Surman & Tóth, 2020).

2.1 Part 1

In order to select the key factors for curriculum development, we explored literature that helped us understand not only their importance but also their constituent factors. Holistically viewing, various factors such as curriculum alignment, benchmarking, structure and design are well-established in the literature but due to their boundary-less nature and subjective contextual interpretations, it had always been difficult for authors to view their constituent parts separately. For example, from a layman's point of view, it is easy to understand that benchmarking of the curriculum must be done in order to lay the foundations for higher standards of quality education but questions such as, how does an institution define benchmarking? Is it only meant for programme content, institutional standards or rankings? It still needs to be answered in the first place. Thus, we look at all constituent parts of these factors not holistically but individually and try to comprehend their role in shaping major factors and, finally an outcome-based and student-centred curriculum.

2.2 Curriculum Benchmarking

In the never-ending race to attract quality students and try to stay ahead of their peer groups, institutions use benchmarking as a tool to deduce their national and international rankings for comparing, assessing and improving their institutional offerings (Shin & Toutkoushian, 2011). Jackson and Lund (2000) described benchmarking as a ‘quality process’ fostering excellence through adopting best practices as it gradually surfaces performance gaps and unearths’ other institutions' processes and systems to recognise relative strengths and weaknesses for continuous self-improvement. Curriculum benchmarking involves Quality Assurance (QA) and Quality Enhancement (QE) (Biggs and Tang, 2011, p.266), which have evolved over a period of time on the sidelines of Biggs ‘constructive alignment theory’ for the development of an outcome-based curriculum ensuring discretionary self-evaluation of their own aims and objectives. Benchmarking of course content and structure as supported by Lau et al. (2018), necessitates its importance for both internal and external reviews focusing on various active processes at the programme level for continuous quality refinement; therefore, all courses must be benchmarked with institutions of higher level of ranking-based upon their competence and strength of academic resources. Furthermore, management institutions and B-schools strive for international accreditations and affiliations (CIPD, Association of MBA’s, AACSB), which allows them to be a part of the niche in high quality, standardised, research-focused and future outcomes-oriented institutions (Tasopoulou and Tsiotras, 2017) thus, benchmarking with institutions who have achieved these affiliations gradually aims to rank higher both nationally and internationally on certified platforms run by recognised agencies. Various developed countries such as Australia, the UK and the USA have successfully applied Higher Education Quality Frameworks (HEQF) using their own models and frameworks for quality improvement via benchmarking activities. These models act as an aid for establishing a continuous cycle of 'self-improvement and self-development' (Henderson Smart et al., 2006).

2.3 Assessment Mechanism

Assessment in higher education is defined as "the systematic collection, review and use of information about educational programmes undertaken for the purpose of improving student learning and development" (Palomba and Banta, 1999, p.4). It involves explicit and publicly established expectations, proper evaluation criteria, grading standards, systematic collection, review and interpretation of evidence to decide how students' performance corresponds to teachers' expectations, as well as applying those results to help them improve, develop and maximise their learning. Assessments are useful in guiding students to improve and develop their knowledge and skills but also for monitoring and continually improving the quality of academic courses (Pereira et al., 2015) It can significantly capture students' entire experience of learning and behaviour (Bloxham & Boyd, 2007) via different means of engagement with study materials. It is highly common in the climate of higher education to come across two general forms of assessment, i.e., formative and summative, which explicitly describe the range of assessment tasks and functions. However, the assessment mechanism is stuck in a vicious cycle of academic debate as soon as we acknowledge the conception of students as self-assessors of their work (Boud & Falchikov, 2006) or teachers as the traditional controlling authority for the edification of students. Therefore, we have tried to explore three types of assessments, i.e., alternative assessment, diagnostic assessment, and integrative assessment, which link directly to students' preconceptions of assessment in the context of higher education.

2.3.1 Integrative Assessment

It is a form of assessment that focuses strictly on tasks for future learning rather than facilitating and testing current learning through the use of formative and summative assessments (Crisp, 2012). It allows for students and teachers to have greater clarity pertaining to specific tasks and reward systems with shared expectations from both ends. It involves ‘integrative learning’ used in amalgamating knowledge and skills from multiple cross-disciplinary areas thus, advancing cognitive thrust of individuals (Elizabeth et al., 2012).

2.3.2 Alternative Assessment

Divulging from the traditional forms of assessment such as true/false tests, short essays and multiple choices-based tests; this is a form of assessment where students can apply knowledge in different ways on the basis of constructive and performance-based assessments. Use of evaluation rubrics for student assessment of learning outcomes is widely used in this form of assessment (Montgomery, 2002). It is used for students who have slow learning capabilities or are at less than par cognitive levels by their class standards. It also involves portfolio assessment where students can self-reflect on their own progress and learning by creating individual portfolios of short- and long-term learning goals, achievements and assessment.

2.3.3 Diagnostic Assessment

This form of assessment is remotely used and underutilised in higher education (Benseman and Sutton, 2008), it encompasses the crux from prior learning and needs of individuals to build upon future goals and objectives. Used primarily for the purpose of recognition of prior learning, it can also aid in the development of student portfolios where teachers could easily determine individuals’ strengths, weaknesses, knowledge and skill levels prior to assessment.

2.4 Curriculum Structure and Design

The modus operandi of structuring and designing the curriculum dictates the end results for an academic institutions' accomplishment of goals and objectives. It should be taken into account that structuring a curriculum or a programme should not be driven principally by tradition or convenience or by the preferences and wishes of individuals (Oliver et al., 2008), achieving an effective structure requires an investment of time, energy and expertise. The investment is important to maximise the educational experiences for each student, especially in a world that is experiencing ever more rapid changes in knowledge creation, technological advancements and cultural mores. The fundamental step in designing the structure is creating a repository of knowledge, skills and attitudes that graduates will need for their future and deciding upon how the achievement of these outcomes will be measured (Oliver et al., 2008). The use of taxonomies in higher education has always been fruitful for curriculum development, defining learning objectives, creating effective assessments and adding value to the process of knowledge creation and critical thinking, etc. (Sawad et al., 2017). With the inception of the new Bloom's Taxonomy of Educational Objectives in 2002, various authors have banked upon its cognitive domain (Raykova et al., 2011; Gottipati and Shankararaman, 2017) for articulation of student learning goals, developing effective course design, competencies and assessments. Congruence of educational objectives and unit assessments in set sequence of knowledge comprehension, analysis, synthesis and evaluation were accomplished. Lucas and Mladenovic (2009) studied the effective deployment of "Structure of Observed Learning Outcomes" (SOLO) taxonomy to identify variations between students' and lecturers' expectations in higher education. The results of their study explicitly indicated a perception mis-match between both the groups and recommendations for inculcation of students' conceptions of learning and their account of epistemological beliefs were clearly highlighted. Under the influence of market forces and institutional peer pressure for delivering high quality education, business schools have rigorously strived for equipping their students with both theoretical and practical aspects of learning and knowledge (Barnett, 2009). Students learn in different ways (Pashler et al., 2009) and various factors such as learners’ maturity, motivation, orientation towards learning and instructional methodology, i.e., pedagogy or andragogy affects their learning outcomes (Muduli et al., 2018). Thus, the importance of proposing the right approach and methods for teaching while designing an effective curriculum structure is an absolute necessity. Higher education is often distinguished with two forms of teaching methodologies, i.e., pedagogy and andragogy, but selecting the right mix or selecting one over the other had never been well researched and justified (Noor et al., 2012). Pedagogy in higher education is defined as a teacher driven philosophy where the students are comfortably dependent upon teachers who take full control of their learning needs, assessment requirements and performance evaluation, etc. (Kaynardağ, 2017). It is driven with little or no scope for student expectations or aspirations, a rigid methodology overflowing with institutional rules and regulations at the core of its operations. However, the institutions of the 21st century are moving towards an andragogy approach which encompasses the philosophy of learner-centred and self-directed learning driven by internal motivation and mature expectations from a group of individuals who are highly competent in driving their own learning outcomes (Fornaciari & Lund Dean, 2014). Andragogy provides adult learners’ a chance to self reflect and act upon their personal goals and objectives; it gives them a platform to calibrate their expectations with the institutional offerings. Therefore, ensuring enough flexibility to students’ for streamlining their learning and development should always lie in the defining boundaries of curriculum structure and its design. Additionally, stakeholder participation is crucial at every stage of the curriculum development process and their inputs must not be equivocal. An inclusive curriculum structure is one which has room for un-biased opinions of all stakeholders, which requires thorough debate and perusal before any concluding judgements should be passed (Vamos et al., 2018).

2.5 Student Feedback and Support Services

Student feedback and support services at HEIs act as a backbone in developing and reinforcing the educational turf for a salubrious tie between the students and teachers. The adequacy of these services throughout the different stages of student-teacher interaction is highly important in maintaining a positive atmosphere of institutional belonging whilst providing individuals a chance to nurture and develop healthy relationships with their institution (Penn-Edwards & Donnison, 2011). Carless and Boud (2018) described feedback as "a process by which information is collected from various sources and used in enhancing student learning and work strategies" which imbibes every ounce of experience generated out of the perceptions about teaching and pedagogy, student support services, academic environment and infrastructure, etc. Myriad forms and types of feedbacks are collected by institutions in multiple settings (Hattie and Timperley, 2007) but it had routinely been considered as a ritual which is accompanied by a standardised questionnaire divulging descriptive review of student responses often accessible only to the head of the department or senior committee members for a namesake review process (Richardson, 2005). Since majority of feedback processes at an institution are developed in-house, lack of scrutiny and due diligence by the competent authorities hails for stagnant institutional, educators' and students' growth (Deeley et al., 2019). Literature is brimming with the importance of timely delivery of high-quality student feedback and its positive impact on student learning outcomes (Gartland et al., 2016; Van der Kleij et al., 2015) however, limited research is available studying the impact of accessibility to these services upon overall student performance.

2.6 Curriculum Alignment

Alignment of curriculum aims and objectives with stakeholders' expectations has significant impact on the curriculum design and evaluation process (Zhao et al., 2017). Effective aims and objectives should depict a clear image of different levels of components in a curriculum for a more guided approach towards planning, implementation and execution (Andrich, 2002). The alliance between the aims and objectives in developing an effective curriculum is important in defining clear and specific objectives while defining student learning outcomes. Kazepides (1989) pointed towards the importance of teachers' and designers' abilities to augment the curriculum in a way that the students can look upon the aims and objectives as a constant reference towards their individual goals. Furthermore, a well-articulated choice of words for the formation of curriculum objectives allows for a concise analysis and judgement which, students can easily interpret in relation to their desired learning outcomes (Hughes, 2014). Alignment of curriculum with industry standards and skill requirements is the serious need of the hour for development of an efficient and outcome-based curriculum (Omar et al., 2015). In plight of scarcity in global talent and rising population levels leading to tougher competition in the job market; a well-planned, thought of and executed curriculum will have a decisive impact on the employability of fresh graduates (Oliver, 2013). To put the matters into perspective, technical universities, Information Technology (IT) and engineering colleges are advised to consistently pursue changes in technological advancements and industry demands to keep the employability levels of their graduates at par with their competition. According to Olson (2015), the skill requirements of the industry outpace the existing production capacity of educational systems by great margins thus, creating a global crisis of talent shortage. Thus, corporates are advised to play influential roles in developing the curriculum whilst networking with faculty members and advisory committees (Olson, 2015).

2.7 Part 2

Student issues with MOOCs can be numerous depending on the country, context, location, accessibility and other developmental factors. However, for the current study, we have focused on the factors that might affect the usability and integration of MOOCs in the Indian higher education system. Also, it is crucial to note that some of the issues might seem as barriers because they behave differently depending on the context.

2.8 Language Barrier

One of the oldest issues within the MOOC scenario is the barrier of language (Gul et al., 2018) associated with the medium of instruction and teaching pedagogy. Even though English might be considered the lingua franca, there are countries such as Brazil or China where English is not used in major fashion at universities and colleges (Liu, 2010). At present, all major global platforms such as Edx® or Coursera® have begun translating MOOCs with sub-scripts of other languages; however, the level of comfort amongst the learners is bleak. Students have highlighted their discomfort with the accent and pronunciation of foreign instructors, which makes them feel alienated at certain times (Liyanagunawardena et al., 2014). They have raised concerns over the struggle to cope with the speed, short abbreviations, and tone of the language, which results in students watching the same video repeatedly to grasp the concepts (Jones, 2014), thus hampering productivity.

2.9 Technological Barrier

Massive problems arise when technology starts acting as a deterrent for something it was supposed to enhance in the first place (Rhoads, 2015). The use of technology has been well-researched in the context of MOOCs and the challenges it brings with its advancements. For students, it is a major challenge because, even though it is safe to assume that students accessing MOOCs would be competent with new technology, there might be grey areas in developing countries where students lack skills and awareness of such mediums of teaching and learning (Ma & Lee, 2018b). In one way or another other it affects students' intention to use and accept MOOCs as an aid to traditional learning methods (Henderikx et al., 2018, Zulkifli et al., 2020). The lack of appropriate technological infrastructure refrains students from getting connected with the latest advancements in education on the global level (Leontyeva, 2018). MOOCs require high-speed internet connections for buffering and downloading, but the lack of such connectivity affects students' motivation to access e-learning platforms for learning and development purposes.

2.10 Overload of Information

Students have often complained about the overload and segmentation of information from MOOCs (Chen et al., 2011; Khalid et al., 2021). There is no standardised framework for MOOC development, and the instructors are generally free to design and prepare course information and material based on their own individual experiences and comfort. An issue of expectation mismatch becomes quite real between MOOCs and students when there is information overload on discussion forums along with hefty course readings (Chen et al., 2011). For asynchronous MOOCs, the repetition of ideas on such discussion forums is common via multiple threads of discussions, leading to the segmentation of the core message (Fischer, 2014). This issue is still not deeply researched and often neglected when addressing student issues related to MOOCs.

2.11 Discussion Forums

MOOC discussion forums are mainly in asynchronous mode, depending upon the course and service provider (Li et al., 2018). They are expected to encourage peer learning and improve commitment in a lax learning environment (Zhang et al., 2016, Galikyan et al., 2021). Teaching hundreds and thousands of students online at the same time brings challenges in all sorts of forms, shapes and figures. Students have often failed to engage in the discussion forums due to the overwhelming participation of their peers (Onah et al., 2014), thus restraining themselves from such indulgence. A feeling of alienation in such discussion forums is quite robust, and students’ tendency to actively participate is dependent upon instructor-led engagements only (Bali, 2014). Little or no regard towards peer-to-peer and instructor-student associations severely affects the effectiveness of MOOCs in the long run (Naidu, 2017).

2.12 Student Support and Feedback Systems

Feedback is crucial for every learning endeavour to become fruitful and is considered as the bedrock of all systems to function effectively. Without appropriate student support and quality feedback, students are often found to be losing interest in MOOCs (Gregori et al., 2018, Kasch et al., 2021) adding to higher attrition rates (Veletsianos, 2013). An effective student support system is crucial in improving MOOC quality and instructional design, whereas timely feedback helps to augment student interest over a period of time (Alario-Hoyos, 2014). The central premise is to stay connected to students whilst responding to their queries in an appropriate manner which is supportive and conducive to student learning. The lack of such support systems eventually hampers MOOCs effectiveness and students' motivation to continue with MOOCs (Gregori et al., 2018).

2.13 Ambiguous Assignments and Peer Assessments

Course assessments are built on multiple factors such as the type and nature of the course, the duration of the course, the complexities involved in the course and, majorly, the number of student enrolments in the MOOC (Muñoz-Merino et al., 2015; Gamage et al., 2021). Reilly et al. (2014) examined the automated essay scoring (AES) tool for grading assignments and found inefficiencies in its accuracy when compared to instructor-led grading. Peer review in itself is highly ambiguous, and it is hard to track the quality of subjective grading and interpretations. Students often do not agree with peer-reviewed grades (Admiraal et al., 2015) and are found to skip assessments (Eriksson et al., 2017). Ambiguity in designing assessments is also a major concern for students because of misleading and unclear course expectations (Khan et al., 2017), which will lead to more dropouts in the future.

2.14 Design and Quality of MOOCs

Much has been said about how a MOOC should be designed and what quality parameters are good enough to judge upon the effectiveness of a MOOC (Lowenthal & Hodges, 2015). Trying to sum up quality is a complicated process that demands the right selection of epistemological, methodological, and theoretical pre-conditions (Ghislandi, 2016; Stracke & Trisolini, 2021). The quality of MOOCs could be bifurcated into concepts, i.e. quality assurance and quality enhancement. In the recent past, there has been an increase in the number of universities offering MOOCs as part of credit programmes (Bordoloi et al., 2020), but the awareness and adoption rates are still low in terms of the total number of universities offering credit exchange. Students have also raised concerns about the quality of MOOCs, encompassing the effectiveness of instructional design, course material and appropriateness of content since it directly influences their satisfaction levels towards a MOOC (Albelbisi & Yusop, 2019). Quality enhancement is the umbrella term for parameters concerned with MOOC instructional design, development and delivery at an institutional level (Ghislandi, 2016). Student perception about the quality of a MOOC could take various forms where instructional quality is associated with the effectiveness of teaching methods and overall course design (Fianu et al., 2018) and is a significant predictor of student satisfaction (Pilli & Admiraal, 2017). The issue with the design of MOOCs makes it harder for students to select the right type of MOOC for their academic development. Thus, designing an effective MOOC is hard and requires a balance of appropriate pedagogical approaches, understanding student motivation, investment in material resources and creating active learning environments (Wang et al., 2019).

2.15 Credibility of MOOCs Certificates in Job Market

Studies are now beginning to emerge which are focusing on instilling the credibility of MOOC certificates in the employment market (Rivas et al., 2020). The debate around the value of a MOOC certificate in the eyes of the recruiter and a student's perceived value of that certificate in the job market is leading us to several unanswered questions (Rivas et al., 2020). The distinction is still not clear since the credibility of MOOCs in the employment market mainly affects university students, and there is an existing gap between industry-university expectations (Wells et al., 2009). Furthermore, the value of using online certifications for the up-skilling of the workforce is a topic which also lacks serious investigation by researchers (Santandreu Calonge et al., 2019).

2.16 Teaching and Pedagogy

Students have often shown discomfort with the teaching approach of instructors who deliver online classes. Effective teaching reflects a holistic learning experience; instructor intervention at the stages of attraction, orientation, interaction and consolidation is deemed necessary to improve effectiveness in teaching MOOCs (Wong, 2016). Innovative use of technology is found to stimulate new approaches for online learning and student collaboration (Liu et al., 2014). Learning via a connectivist approach in the case of cMOOCs allows for cognitive connections to be made from available learning materials and peer-to-peer interactions (Mackness et al., 2013). On the other hand, xMOOCs offer a more synchronised form of learning where instructions are ordered in the mainstream fashion of a learn-test-learn repeat cycle. Instructors often get confused in selecting the right pedagogical approach for their course (Armellini & Rodriguez, 2016), and a lack of pedagogical innovations is leading MOOCs towards a passive medium of knowledge acquisition (Parr, 2013).

2.17 Research Gaps

Despite the growing set of global literature on MOOCs and various dimensions of e-learning, a very limited focus is being laid down on understanding the perception of the primary stakeholder of education, i.e. students in India. Limited studies have explored the importance of developing a well-balanced higher education curriculum from a student's perspective, where MOOCs are now an integral part of curriculum design and content. Also, there are no previous studies that have explored the relationships between student issues among MOOCs, which gives rise to larger problems in the e-learning education system. In the Indian context, there have been limited studies that have explored the effects of the integration of MOOCs in the higher education system from students' perspectives. Furthermore, scant literature is available on the role of MOOCs in addressing the knowledge gap among graduates and the perception of students regarding it.

2.18 Research Questions

RQ1: Why is there a need to understand the MOOCs and e-learning systems in India?

In order to gauge the quality of education, development and progress in India, particularly with respect to e-learning interventions, it is crucial to understand the scope of its challenges. Furthermore, it is crucial because the importance of online learning and MOOCs is reiterated multiple times in the National Education Policy 2020 (NEP 2020) and also for the growing importance and acceptance of MOOCs in the higher education systems across the globe.

RQ2: Why is there a need to understand students' perceptions of curriculum development in India?

Students are at the core of every education system. It is crucial to value their opinions and perceptions about any policy intervention an academic institution wishes to implement. As per the guidelines of NEP 2020, the introduction of MOOCs after COVID-19 as a formal credit-securing mechanism revolutionised new learning and teaching methods. Thus, it is important to understand the effect of such interventions and the value of their opinions to make the policy intervention more effective.

RQ3: What possible issues students might face with MOOCs?

Since the e-learning intervention is primarily aimed at students primarily, it is crucial to understand students' issues with MOOCs. Even though a huge number of issues have been studied in the past when it comes to MOOCs they have primarily been explored in isolation. In the Indian context, it is important to bring these issues together and understand from students' perspectives how they can influence larger problems in the e-learning education system in the country.

RQ4: What might be the effect of introducing for-credit MOOCs in the higher education system?

Policy intervention often fails if proper progress and feedback are not gauged at the right time. The for-credit mechanism for MOOCs in India must be examined to understand the loopholes or misalignment with student expectations. Deeper insights into the efficiency of the e-learning system are required in order to recommend processes for successful policy execution.

2.19 Research Objectives

1. To examine the factors affecting higher education curriculum development from a primary stakeholder, i.e. students' perspective.

2. To examine the issues of students with MOOCs and analyse the relationships between these issues.

3. To examine a rational way of selecting an e-learning platform for MOOCs.

4. To understand students’ perceptions about the role of MOOCs in addressing the knowledge gap and employability issues.

Chapter 3

Research Methodology

3.1 Research Approach

The study used a mixed-method approach, i.e., a combination of qualitative and quantitative techniques. Separate techniques were used to achieve all the objectives, capturing deeper snapshots of the problem and analysing the perception status of our participants. The study is based on the perceptions of primary stakeholders (students) only and is explorative and observational in the sense that it captures the essence of the problem from different angles. The sample size selection for all objectives and techniques and their required justification is mentioned in Appendix-1. A detailed explanation of each sample size selection is given using individual objective-based methodology.

(Phase 1)

The study was conducted in multiple phases and focused only on the key stakeholder perspective i.e. students, where the process of data collection and results drove the study in a peculiar direction. In the preliminary stage, after an extensive literature review, we conducted a quantitative analysis of student perception of higher education curriculum development, which led us to identify factors that should be at the centre of developing an effective higher education curriculum (*viz.* Analytical Hierarchy Process, AHP). The methodology pertaining to the same is explained in section 3.1.

(Phase 2)

Deriving results from AHP we understood that student support services and feedback, along with curriculum structure and design, are the two most important aspects of curriculum development for students. Academic and personal support should be embedded in the curriculum, and a focus on course content, means of teaching, and stakeholder opinion in designing the curriculum are crucial factors for developing an inclusive curriculum. We then decided to delve deeper into the role MOOCs are playing in the curriculum as they were embedded for credit after the guidelines of NEP 2020. Before we moved ahead, we were inclined to understand student issues with MOOCs and also explore plausible relationships between these issues that were found to have a direct, indirect or transitive effect on one another. The study then applies another quantitative tool, (Total interpretive structural modelling with polarity) TISM-P, to examine the relationships between existing student issues with MOOCs. Extensive literature research allowed us to ascertain 9 detrimental student issues with MOOCs (chapter 2, 2.6-2.14), which drive larger problems in the online learning education systems.

(Phase 3)

Research is an ongoing process of inquiry and probing into deeper layers of human consciousness; thus, after the preliminary phase of quantitative data analysis, we began conducting qualitative semi-structured in-depth interviews. The student interviews were aimed at examining the role of MOOCs in filling the knowledge gap via self-directed learning and probing the intrinsic and extrinsic value of placing MOOCs for credit in higher education curriculums (*Viz.* Epistemic network analysis ENA). However, during the interviews, it was observed that for the majority of the students, the government-run e-learning platform SWAYAM was of minimal value and importance. We wanted to dig deeper into this issue and decided to conduct another phase of our study simultaneously which led to some intriguing results.

(Phase 4)

The optimal method of selection of an e-learning platform (viz. Analytical Network Process - Decision making trial and evaluation laboratory, ANP-DEMATEL) was examined side by side because the majority of the responses during our interviews accounted for a lack of usage and knowledge about the government-run SWAYAM platform for e-learning in India, the reasons for which were corroborated towards the end from the interviews. It was clear from this phase that engineering students particularly refrained from using the government-funded SWAYAM platform for e-learning activities.

Each objective has been achieved from a separate methodology as explained in the forthcoming sections and their results will be followed in chapter 4 and compiled in conclusion and implications.

3.2 Research Objective 1

To examine the factors affecting higher education curriculum development from a primary stakeholder, i.e. students' perspective.

The rationale, process and results for the current objective are comprehensively adapted from a previous published work by the author (Khera & Pawar, 2021), which is a part of the original work in this thesis.

Use of AHP as a decision-making tool and its feasibility for current study.

Decision-making is a process of identifying (clear, measurable, realistic and time-dependent goals), evaluating their importance, applying various techniques/theories such as (game theory, multi-voting, conjoint analysis, heuristic methods, etc.) and re-evaluation of our actions (Doya, 2008). However, there is no one fixed approach towards this process, it is still advisable for decision-makers to carefully apprehend the nature of their problems be it tactical, analytical, perceptual, emotional etc. before making decisive judgements. Multi-Criteria Decision Making (MCDM) or Multi-

Criteria Decision Analysis (MCDA) techniques such as PROMETHEE, Simple Multi-Attribute Rating Technique (SMART) etc. as part of operations research are used in myriad different fields such as economics, mathematics, information systems, etc. (Batagarawa et al., 2015). As part of the above-mentioned cohort, the technique used in this paper 'Analytical Hierarchy Process (AHP)' developed by Saaty (1980) had successfully stood the test of time and critical review from experts over its feasibility in multi-criteria decision-making. Mathematical modelling and science go hand in hand acting as proponents of measurement, validity and quantification for all perceived tangible factors. However, knowing techniques such as AHP to measure the intangible factors in any decision-making process by the act of modelling, analysing and prioritising the related criteria and alternative/attributes, e.g., perception, feelings and emotions, etc., could open up new avenues in research for theoretical and conceptual foundations (Saaty, 2008). Thus, considering the feasibility of the study where perceptions are being evaluated, AHP is recommended and backed by relevant literature (Sato, 2004; Kim et al., 2017; Gumus, 2017). Based upon individual judgements, AHP uses the general theory of priority ratio scale measurements which can be implemented for both the qualitative and quantitative factors on the same platform (Kukrety et al., 2013). The problem statements based upon judgements from decision-makers are decomposed into a hierarchy allowing perceptions to be recorded on different levels of the decision-making process (Ahmad & Hussain, 2016). Another important feature of AHP is its ability to check for inconsistencies albeit supporting group decision-making for relative individual pairwise comparisons thus, reducing biases in decision-making. Therefore, using AHP for the current study is much more feasible in compiling results based on subjective individual interpretations of human perception.

The aim of this objective is to understand what students of higher education think about their own curriculum at the university level. The study uses the AHP technique to delve deeper into the most important factors according to students which should be addressed by policymakers and higher education curriculum development experts.

A questionnaire-based survey was conducted on 80 students studying in final year (5th semester) engineering courses at a public university in Delhi at the time of their convenience. There is no fixed requirement in AHP to determine the sample size of its respondents, and the primary reason for this leniency lies in its ability to record responses on a relative scale measuring the intensity of perceived importance where Internal Consistency (IC) and validation of responses has been proven to be achieved under sample sizes of as less than 20 respondents (Al-Harbi, 2001; Kil et al., 2016). A 60% response rate was achieved, after thorough examination and removal of redundant questionnaires. 40 were selected for final analysis following Saaty's (2008) step-by-step procedure mentioned below.

3.2.1 Step-by step procedure of AHP used in the present study

Step 1: Creating hierarchy structure for evaluation

Saaty (1980) described hierarchy as a stratified system of cataloguing ideas or things where each element except for the goal of the hierarchy falls under a level and is a substitute for other elements in the levels above. Once the goal is set, the construction of a hierarchy is the primary step in delineating the attributes (level 1) and their connections with sub-factors (level 2) for schematic comprehension (see Fig. 3.1). For the purpose of this study supporting literature in relation to the important factors involved in the process of curriculum development led to the selection of 5 key attributes (curriculum benchmarking, curriculum structure and design, assessment mechanism, student feedback and support services and curriculum alignment). Following the lead, various sub-factors were ascertained elucidating upon the role of each of the attributes in the context of higher education curriculum development. All the attributes and sub-factors were coded for better comprehension and data analysis (see Table 3.1)

Table 3.1 Coding of attributes and sub-factors

Hierarchy				
Goal: To understand the perception of students around the importance of factors involved in curriculum development (CD)				
Curriculum Benchmarking	Curriculum structure and design (CSD)	Assessment Mechanism (AM)	Curriculum Alignment (CA)	Student support and feedback (SSF)
Benchmarking with institutions on higher level of national and international rankings (CB_IH)	Curriculum content (CSD_CC)	Integrative assessment (AM_IG)	Alignment of mission and objectives of the curriculum with student learning outcomes (CA_SLO)	Accessibility to student feedback and support services (SSF_ASF)
Benchmarking of course content and structure (CB_CS)	Theoretical framework and use of taxonomies (CSD_TFT)	Alternative assessment (AM_AL)	Alignment with national and international standards (CA_NIS)	Method and means of delivering feedback (SSF_MM)
Benchmarking with national standards and higher education quality frameworks (CB_NS)	Teaching principle and means (CSD_TPM)	Diagnostic assessment (AM_DG)	Alignment with industry standards and skill needs (CA_ISS)	Timely and quality information about student learning (SSF_TQ)
	Stakeholder opinion and consent (CSD_SO)			

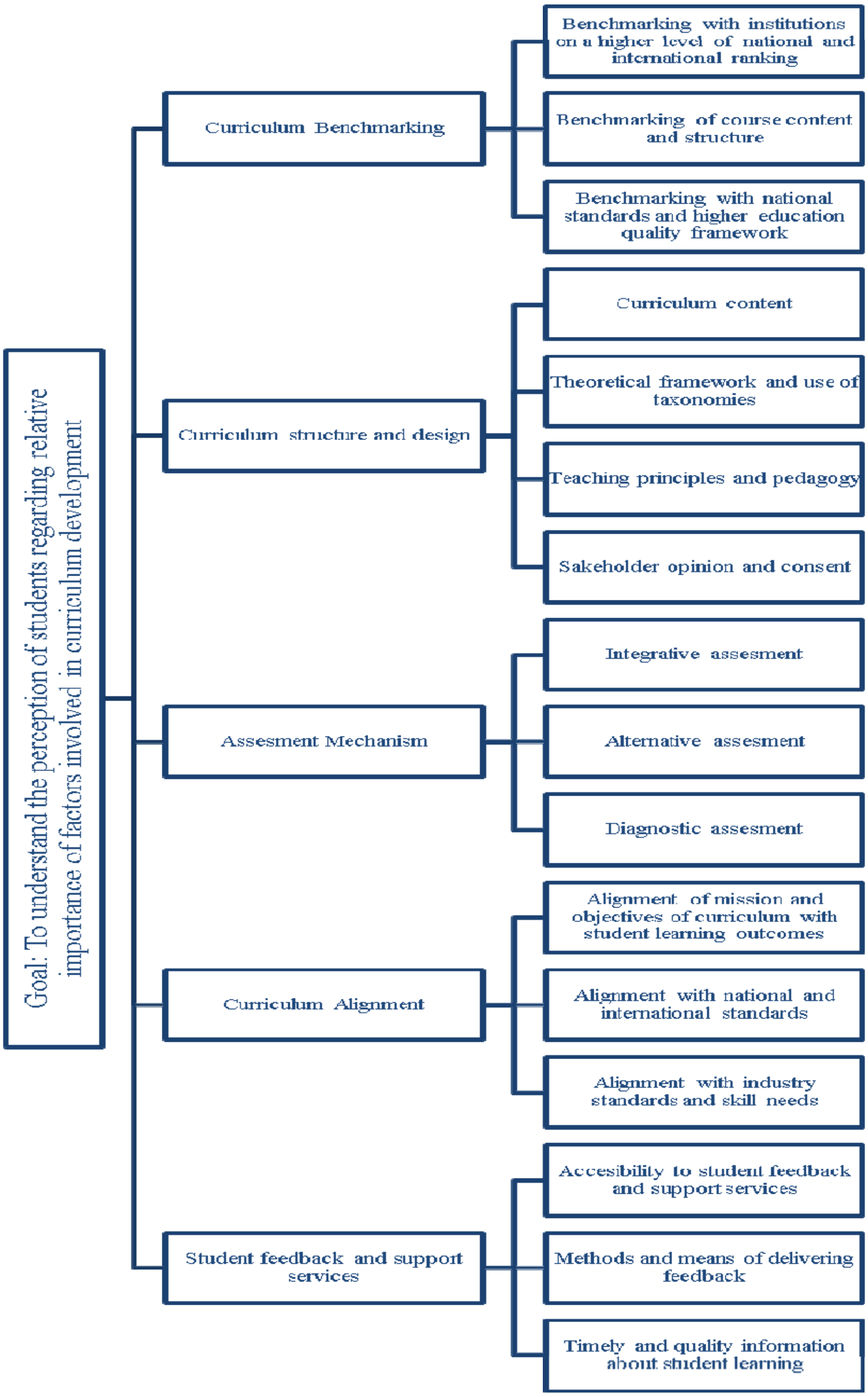

Fig 3.1 AHP hierarchical model for decision making

Step 2: Data collection and construction of Pair-wise comparison matrices

The questionnaires were administered manually for a better and effective response rate. The questions were asked on the relative scale as shown in Table 3.2 and a quick background about the study was verbally given to the participants. A consent form was also signed by all the participants before filling up the questionnaire. The participants were made aware of the terminology used in the questionnaire and a quick 10-minute discussion round was held for clarification of doubts. It took approximately 45 minutes for the whole process to complete and MS-Excel® was used for analysis. The scale used is pre-defined and adapted from the original study; the intensity of importance in the scale is preferred to be between (1 and 9) since it is a matter of subjective preferences and opinions.

Once the data was collected, the numbers of matrices to be constructed for pair-wise comparisons were finalised, i.e., for each individual response, 6 matrices (1 for comparison on levels 1 and 5 for sub-factor comparisons on level 2) were constructed, amounting to 240 in the end for 40 responses. The number of factors (n) to be compared in tandem with the formula n*(n–1)/2 helped us ascertain the number of comparisons for each individual matrix (see Table 3.3).

The calculations involved in ranking attributes and checking for consistency of the judgements are mentioned below as an example for level 1. The same steps were repeated to analyse level 2 of the hierarchy, and the results are tabulated in Chapter 4, Table 4.2.

Table 3.2 Scale of relative importance adapted from the original study (Saaty, 1980)

Intensity of Importance	Definition	Explanation
1	Equal importance	Two attributes contributing equally to objective
3	Moderate importance of one over another	Experience and judgement slightly favour one activity over another
5	Essential or strong importance	Experience and judgement strongly favour one activity over another
7	Very strong importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgements	Compromise
Reciprocals	If activity i has one of the above non-zero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	Assumption
Rational i.e., 1.1, 1.5, 2.5	Ratios arising from scale	May not be of significant value when comparing with contrasting activities but it could still indicate the relative importance of the activities

Table 3.3 Comparison table

Number of Factors	1	2	3	4	5	6	n
Number of Comparisons	0	1	3	6	10	15	$n(n-1)/2$

To begin with, we had (n=5) factors on level 1 that were required to be compared, therefore a 5X5 matrix was made on the basis of 10 responses recorded from the questionnaire. The diagonal elements of the matrix are 1 since it is a relative comparison. Now, in order to fill up the upper triangular area of the matrices, i.e., above the diagonal, it is crucial to follow two underlying rules:

i) If the response value in the scale is on the left side of 1, actual value needs to be inserted in the matrix.

ii) If the response value in the scale is on the right side of 1, reciprocal value needs to be inserted in the matrix.

The bottom triangular area was filled with reciprocal values of the upper triangular matrix see, table 3.4.

Table 3.4 Sample response in matrix form (upper diagonal) and reciprocal values in the matrix

1	1/4	1/6	1/6	1/7
4	**1**	1/5	1/7	1/4
6	5	**1**	1/3	2
6	7	3	**1**	4
7	4	1/2	1/4	**1**

In case of multiple judgements from respondents it is hard to collate all the responses thus, AHP approves the use of numerous methods to set weights for the attributes and sub-factors in the hierarchy such as, geometric mean, weighted arithmetic mean, consensus and vote, etc. (Condon et al., 2003). For the current study, weighted geometric means were calculated for all the responses and pair-wise matrices were constructed for both the levels in lieu of the answers complied from questionnaires. The matrix in Tables 3.5 and 3.6 represents results only for level 1 of the hierarchy, which is a consolidated matrix of geometric means calculated for all the respondents. Further steps involved in determining the consistency and validity of their results are shown via numeric calculations.

Step 3: Normalisation of matrix, construction of priority vectors and ranking

Responses for the pair-wise comparison matrix were tabulated, and each entry was divided by the column sum to obtain a normalised matrix. The priority vector was calculated by taking the average of each row in the normalised matrix, which was further used to check for inconsistencies in the respondents' judgements. At this stage, we get to rank the attributes according to their relative weights.

Table 3.5 Consolidated weighted geometric mean computations for pair-wise comparisons (level 1)

Determinants of CD	(CB)	(CSD)	(AM)	(CA)	(SSF)
(CB)	**1**	0.5	0.81	0.66	0.39
(CSD)	1.99	**1**	1.77	1.05	0.54
(AM)	1.24	0.56	**1**	0.73	0.51
(CA)	1.51	0.95	1.37	**1**	0.72
(SSF)	2.60	1.85	1.97	1.38	**1**
Column Sum	8.34	4.86	6.92	4.82	3.16

Table 3.6 Normalised matrix for (level 1) responses

Determinants of CD	(CB)	(CSD)	(AM)	(CA)	(SSF)	Priority Vector	Rank
(CB)	0.12	0.1	0.12	0.14	0.11	0.12	5
(CSD)	0.24	0.21	0.26	0.22	0.17	0.22	2
(AM)	0.15	0.12	0.14	0.15	0.16	0.14	4
(CA)	0.18	0.2	0.2	0.21	0.23	0.20	3
(SSF)	0.31	0.38	0.28	0.29	0.32	0.32	1

Step 4: Consistency check

Once the relative weights are obtained, we can also check for inconsistencies in the judgements using the principal Eigen value. AHP uses the transitivity property where a matrix is said to be consistent if $a_{ij}*a_{jk} = a_{ik}$ for all *i*, *j* and *k*, but since human judgement and perception is involved, the property doesn't hold to be true. Thus, an eigenvector of order n with λ max as the largest Eigen value is calculated to satisfy the matrix where λ max ≥ n is always a true indicator of consistency check for the judgements (Yusof and Salleh, 2013). To calculate the value of λ max column sum of each factor is multiplied with the corresponding priority vector and summed up together as shown below.

λ max = 1.0008 + 1.0692 + 0.9688 + 0.964 + 1.0112 = 5.014 ≥ 5

Consistency Index (CI) is calculated using the value of λ max which was further used to calculate the Consistency Ratio (CR) to evaluate the amount of deviation in responses. Randomness Index (RI) which is the average random consistency index of 500 matrices developed by Yadav and Jayswal (2013). Once the value of λ max ≥ *n* is derived, the consistency ratio is calculated to ensure the results are <10%. To avoid undue errors in calculations, it is highly recommended that the consistency ratio is calculated for all the individual responses and for each matrix developed for its corresponding question before using the weighted geometric mean method for generating the consolidated matrix. The random index value is fixed and used directly from Table 3.7 as derived by Saaty.

$CI = \frac{(\lambda \max - n)}{(n-1)} = 5.014\text{-}5/4 = 0.003$

Table 3.7 Values of random index

n	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

CR = *CI/RI* = 0.003/1.12 = 0.002<0.1

Thus, the consolidated matrix is valid and consistent for (level 1)

The steps mentioned above are a representation of the research process. The rest of the results for level 2 were obtained using the same methodology, and a consolidation of both level 1 and level 2 results is mentioned in Chapter 4.

3.3 Research Objective 2

To examine the issues of students with MOOCs and analyse the relationships between these issues.

The rationale, process and results for the current objective are comprehensively adapted from a previous published work by the author (Khera & Pawar, 2024), which is a part of the original work in this thesis.

Our study aims to draw interconnecting lines among student issues using a total interpretive structural modelling with polarity (TISM-P) model, which is an extended and improvised arm of interpretive structural modelling (ISM) developed by J. Warfield in 1974 (Warfield, 1974). The use of ISM has been voluminous over the years, and it has successfully assisted theory building in answering the 'what' and 'how' questions while explaining the driver-dependence relationships among factors. What the causal relationship among factors and how it is formed is well captured by ISM, whereas TISM, as purported by Sushil (2012), emphasises answering the 'why' question (why one factor influences another?), yielding in more interpretive power to complex hierarchical models. TISM has readily gained acceptance in the last decade and researchers have extensively used it for theory building, hypothesis testing, modelling and conceptualising ill-structured mental models and ideas from real-life scenarios. As human beings, we often tend to create mental models of problems and issues surrounding us but, with an increase in the number of influencing factors, the ability of an individual to comprehend the value of such interrelations gets fatigued. TISM helps researchers streamline that process and follows up with a hierarchical model of our cognitive connections, emphasising interpretations from direct and transitive relationships (Kumar & Barua, 2022). The applicability of TISM is increasing with time, and the scale of its horizon is expanding to various fields such as supply chain management, operations and information management, strategic performance management, sustainable supply chain development, and emotional intelligence etc. In the context of higher education, TISM has been previously used to understand the challenges of management education (Mahajan et al., 2015) and to create a model of benchmarking for higher education (Yeravdekar & Behl, 2017). Talib and Rahman (2020) used the technique to model the barriers to the growth of higher education institutions (HEIs), whereas Fathi et al. (2019) focused on teamwork training in HEIs. Coming down to the latest development in the TISM technique, an element of polarity was introduced by Sushil (2018) to extend the functioning and novelty of its application; in other words, an aggregated view was presented incorporating the positive and negative influence of factors over one another. The extension, i.e. (TISM-P), allows the individual to capture the positive and/or negative influence of one factor over the other, furnishing a better picture of the behaviour of a model or a system. The application of TISM-P is relatively new, and the literature is still in its emerging forms; hence, as our primary research aim, we look forward to applying the extended version of TISM from students' perspective, which would encourage instructors, e-learning platforms and policymakers to analyse the behaviour of student issues related to MOOCs holistically.

3.3.1 Factor validation

Once the student issues were identified from the literature, it was deemed necessary to validate them by a group of experts from the academia and education-technology industry. Judgemental sampling was used to identify (N=40) such experts. The experts from the academia (N=35) were seasoned faculties running at least one MOOC on a global e-learning platform or a government-funded MOOC offering platform in India. In contrast, the industry experts (N=5) were developers of indigenous e-learning platforms. A t-test for hypothesis testing was applied to capture the experts' opinions.

H(0): Null: No significant difference exists between the observed mean and specified mean for attribute Fn.

H(A): Alternate: Significant difference exists between the observed mean and specified mean for attribute Fn. (N=9)

A questionnaire was prepared using a five-point Likert scale and exercised online. While testing the value of 3.5 was used (Singh et al., 2019) for factor verification and the results are displayed in (Table 3.8).

Table 3.8 *t*-Test analysis of factors (N=40)

S.No	Factors	Test Value = 3.5			
		Mean	Std. Deviation	*t* Value	Result
1	Language Barrier	3.87	0.563	3.368	**Significant**
2	Technological Barrier	4.47	0.505	12.13	**Significant**
3	Overload of Information	3.87	0.822	2.845	**Significant**
4	Discussion Forum	4.32	0.474	10.933	**Significant**
5	Student Support and Feedback Systems	4.45	0.503	11.925	**Significant**
6	Ambiguous Assignments and Peer Assessments	3.8	0.516	3.674	**Significant**
7	Design and Quality of MOOCs	4.65	0.483	15.057	**Significant**
8	Credibility of MOOCs Certificates in Job Market	3.57	0.5	0.884	**Significant**
9	Teaching and Pedagogy	4.45	0.503	11.925	**Significant**

*Significant if the calculated t-statistic value > t-critical value (2-tailed)

3.3.2 TISM-P application

The data for TISM-P was collected from a technical university where MOOCs are an integral part of their higher education curriculum ordinance, bearing transferable credits towards successful completion. The students selected for filling out the questionnaire were taken from a cohort of 3rd year (first-semester) engineering students who had completed at least one MOOC as part of their credit transfer programme. The participants were voluntarily asked to complete the survey because of the complexity involved in the process, and convenience sampling was used. However, due to the hybrid mode of teaching, initially, the response rate was extremely low, but upon formal request from their mentors, we were able to get hold of (n=180) students who were willing to fill up the questionnaire. The questionnaires selected for analysis were (n=149) after removing inconsistent responses. We used the TISM questionnaire for simultaneous transitivity checks coupled with polarity approximations to gather student responses. An online meeting was scheduled, and the students were briefed about the process in detail; it took approximately 45 minutes for everyone to fill up the questionnaire. Adding polarity is an extension to the original TISM technique, and the steps involved in the advanced version are mentioned in Fig. 3.2, and the illustrations for our research are shortly followed after.

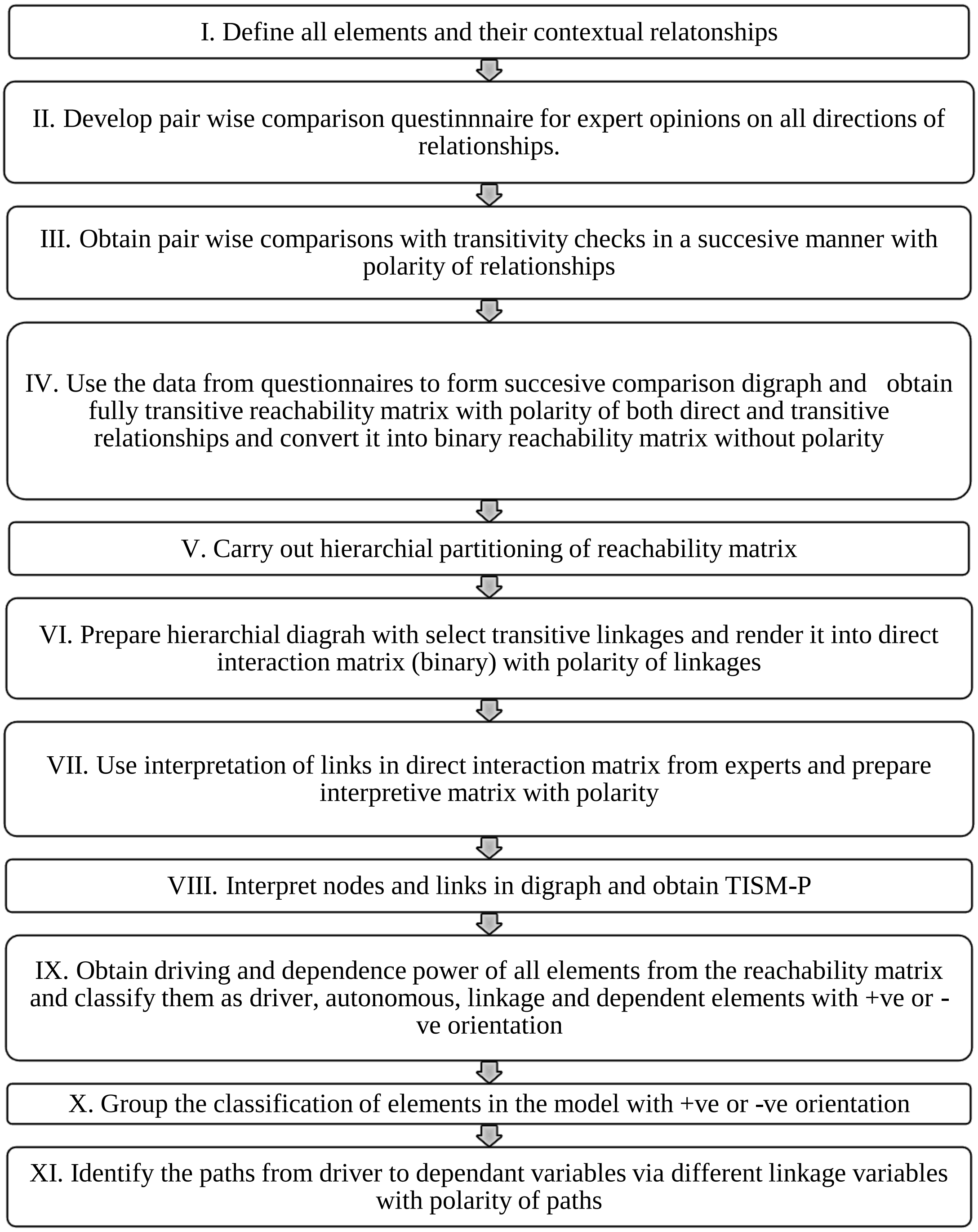

Fig. 3.2 Steps involved in TISM-P adapted from (Sushil, 2018)

Step 1: The contextual definition and brief explanation of the issues were laid down after thoroughly reviewing the associated literature. The issues identified from students' perspectives affect MOOC integration, effectiveness, dropouts and student motivation etc. in a number of ways. Table 3.9 offers insight into establishing the contextual relationship for paired comparisons with polarity (+ve or –ve) and for interpreting the influence of one factor over the other.

Table 3.9 Defining the contextual relationship between student issues

Issue No.	Student Issues with MOOCs	Contextual relationship	Interpretation
1	Language Barrier	Issue A will influence issue B (positively or negatively	How or in What way will the issue A influence issue B?
2	Technological Barrier		
3	Overload of Information		
4	Discussion Forum		
5	Student Support and Feedback System		
6	Ambiguous Assignments and Peer Assessments		
7	Design and Quality of MOOCs		
8	Credibility of MOOCs Certificates in Job market		
9	Teaching and Pedagogy		

Step 2: A TISM-P questionnaire was developed for paired comparison and simultaneous transitivity checks (Sushi, 2017). The paired comparisons were made in the order 1,2; 2,3; 3,4....; 8,9 by individual students. To collate all responses for the reachability matrix, we followed with the work of Prasad and Suri (2011) to set up a threshold of 70 per cent for direct comparisons and 50 per cent for transitive comparisons. If more than 70 per cent of the responses (direct) were ‘Yes’ for a particular comparison, then the response was taken as 1; otherwise, 0 in the final reachability matrix Table 3.10. The process was followed similarly for transitive comparisons too. The questionnaire captures the direction of the relationship as forward (i→j), backward (j→i), both (i=j) and no relationship (0). The polarity of direct relations (+ve or –ve) was also taken into consideration at this stage.

Table 3.10 Final reachability matrix

Student Issues	1	2	3	4	5	6	7	8	9
1	1	0	0	1	0	0	0	0	0
2	0	1	0	0	1	0	1	0	0
3	0	0	1	1	0	0	0	0	0
4	0	0	1	1	1	0	0	0	0
5	0	0	0	1	1	1	0	0	0
6	0	0	0	0	0	1	1	0	0
7	0	0	0	0	0	1	1	1	0
8	0	0	0	0	0	0	1	1	1
9	0	0	0	0	0	0	0	1	1

Step 3: Transitivity is defined as the relation between any such three elements such that if i influence j and j influences k then i is bound to influence k. In the case of transitive relations, the polarity was justified according to the logic of polarity from the previous relationship. For example: if i→j is +ve and j→k is -ve, then i→k would become –ve (Sushil, 2018). As mentioned in the previous step, the direct pair comparisons were done by students, and afterward, the transitivity check was performed by authors in MS-Excel®. The polarity of the relationship was specified before the creation of the transitive reachability matrix and successive comparison digraph.

Step 4: To visualize direct pair comparisons and transitivity checks with polarity, a successive comparison digraph in Fig. 3.3 is portrayed along with a transitive reachability matrix with polarity in Table 3.11. For easy identification and effective visualisation, the comparisons were marked on the digraph and colour-coded along with the entries of +1, -1 or 0 in the reachability matrix with polarity. Finally, all the entries in the reachability matrix (+1, -1 or 0) were converted into 1 or 0 entries as presented in Table 3.12 in the form of a transitive reachability matrix without polarity.

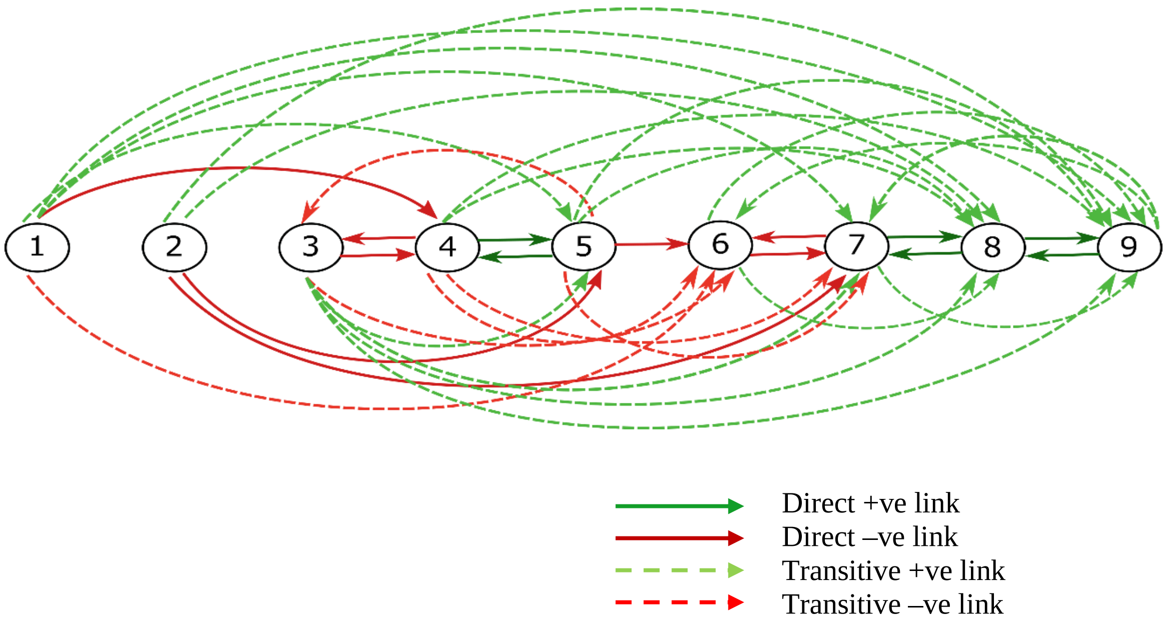

Fig. 3.3 Successive comparison digraph with direct and transitive links with polarity of relationships

Table 3.11 Transitive reachability matrix with polarity of relationships

	Student Issues	1	2	3	4	5	6	7	8	9	Driving Power +ve	Driving Power -ve
	1	1	0	0	-1	+1*	-1*	+1*	+1*	+1*	4	2
	2	0	1	0	0	-1	0	-1	+1*	+1*	2	2
	3	0	0	1	-1	+1*	-1*	+1*	+1*	+1*	4	2
	4	0	0	-1	1	+1	-1*	-1*	+1*	+1*	3	3
	5	0	0	-1*	+1	1	+1	-1*	+1*	+1*	3	3
	6	0	0	0	0	0	1	-1	+1*	+1*	2	1
	7	0	0	0	0	0	-1	1	+1	+1*	2	1
	8	0	0	0	0	0	0	+1	1	+1	2	0
	9	0	0	0	0	0	+1*	+1*	+1	1	3	0
Dependence Power	+ve	0	0	0	1	3	2	4	8	8		
	-ve	0	0	2	2	1	4	4	0	0		

Table 3.12 Transitive reachability matrix

Student Issues	1	2	3	4	5	6	7	8	9	Driving Power
1	1	0	0	1	1*	1*	1*	1*	1*	7
2	0	1	0	0	1	0	1	1*	1*	5
3	0	0	1	1	1*	1*	1*	1*	1*	7
4	0	0	1	1	1	1*	1*	1*	1*	7
5	0	0	1*	1	1	1	1*	1*	1*	7
6	0	0	0	0	0	1	1	1*	1*	4
7	0	0	0	0	0	1	1	1	1*	4
8	0	0	0	0	0	0	1	1	1	3
9	0	0	0	0	0	1*	1*	1	1	4
Dependence Power	1	1	3	4	5	7	9	9	9	

* Transitive Relations

Step 5: The matrix from Table 3.12 is used as the final matrix for hierarchical partitioning. The original ISM/TISM methodology was followed to derive the reachability set, antecedent set and intersection set. The process is iterative and allows us to divide and categorise the student issues into different levels systematically. The student issues having the same reachability and antecedent set are selected for the highest level, and the rest of the levels are attained after iteratively removing previous issues. The illustration of the process is given in Appendix-II, and the results of the level partitioning of student issues are shown in Table 3.13.

Table 3.13 List of student issues and their levels in TISM-P

Issue No.	Student Issues with MOOCs	Levels in TISM-P	
1	Language Barrier	III	
2	Technological Barrier	III	
3	Overload of Information	II	
4	Discussion Forum	II	
5	Student Support and Feedback System	II	
6	Ambiguous Assignments and Peer Assessment	I	
7	Design and Quality of MOOCs	I	
8	Credibility of MOOCs Certificates in Job market	I	
9	Teaching and Pedagogy	I	

Step 6: The student issues numbering '1' to '9' are arranged in hierarchical order after level partitioning in the form of a digraph in Fig. 3.4. It is important to note that only prominent transitive links having distinct influence are retained for the final digraph (after model validation by experts). The rest of the links were dropped out to avoid unnecessary crowding. Now, a binary interaction matrix with polarity (Table 3.14) is made using the final digraph from Fig. 3.4.

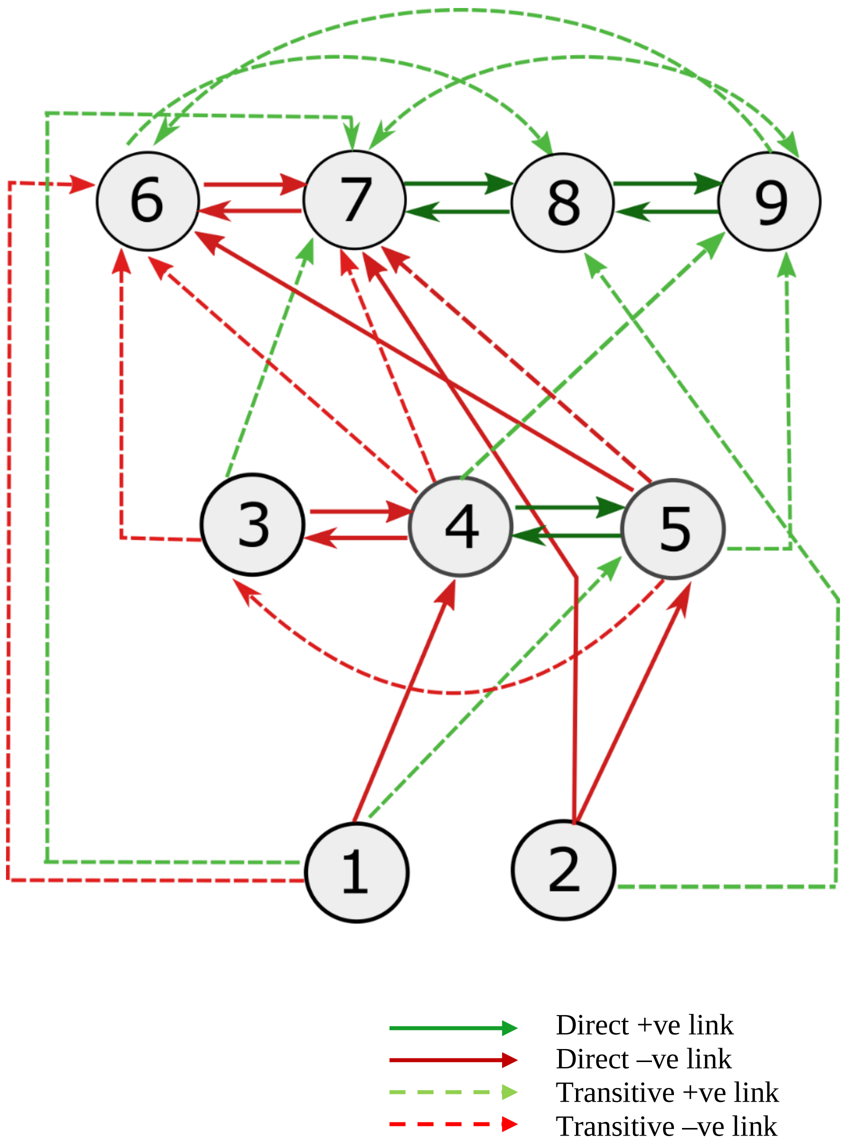

Fig. 3.4 Diagraph after hierarchical partitioning with polarity linkages

Step 7: Student opinions were used to convert all +1 and -1 entries from the binary matrix into an interpretive matrix in Table 3.15. The interpretation for each link is given. For example, language barrier (1) has a direct and negative influence on students' intention to participate in discussion forums (4), etc.

Table 3.14 Binary interaction matrix

Student Issues	1	2	3	4	5	6	7	8	9
1	-	0	0	-1	+1*	-1*	+1*	0	0
2	0	-	0	0	-1	0	-1	+1*	0
3	0	0	-	-1	0	-1*	+1*	0	0
4	0	0	-1	-	+1	-1*	-1*	0	+1*
5	0	0	-1*	+1	-	+1	-1*	0	+1*
6	0	0	0	0	0	-	-1	+1*	0
7	0	0	0	0	0	-1	-	+1	+1*
8	0	0	0	0	0	0	+1	-	+1
9	0	0	0	0	0	+1*	+1*	+1	-

Step 8: The interpretation of both nodes and links from the hierarchical digraph and binary interaction matrix with polarity gives the final TISM-P model of student issues with MOOCs in Fig. 3.5.

Step 9: The driving and dependence power from the transitive reachability matrix (Table 3.12) are part of a technique called Matrice d'Impacts croises-multipication applique´ an classment MICMAC analysis (Jothimani et al., 2015). MICMAC analysis is used to analyse the driver-dependence relationship among factors over one another (Fig. 3.6). The two-dimensional graph is divided into four quadrants. The first quadrant consists of autonomous criteria, which has a low driver and dependence power; the second quadrant represents the dependent criteria, which has low driving power and high dependence power; the third quadrant is made up of linkage criteria, which has high driving and dependence powers, and the last quadrant represents the driver criteria which has high driving power and low dependence powers. The polarity of each student issue was interpreted from the transitive reachability matrix in Table 3.11.

Step 10: The results from MICMAC analysis (Fig. 3.6) are overlayed upon the TISM-P model as depicted in Fig. 3.7. The model briefs upon the classification of student issues with MOOCs along with +ve and –ve orientation in the form of driver-dependent relationships.

Table 3.15 Interpretive matrix

Student Issues	1	2	3	4	5	6	7	8	9
1	-	-	-	Affects students' ability to participate	Affects students' ability to seek support	Increased ambiguity due to lack of discussions	Quality gets affected due to inefficient discussion forums, student support and ambiguous assigements	-	-
2	-	-	-	-	Technological issues might affect feedback systems effectiveness	-	Technological issues will affect quality of MOOC	Technological issues will affect the quality in turn lowering the credibility of the course	-
3	-	-	-	Reduced efficiency	-	Information overload will reduce discusson efficiency thus increasing ambiguity	Information overload will lower the quality of MOOC via multiple issues	-	-
4	-	-	Multiple discussion threads	-	Effective feedback is possible	Reduced ambiguity in assignments via support	Quality of MOOC will increase with lower ambiguity in assignments and better understanding of peer assesment	-	Inputs to teaching pedagogy via effective fedback systems
5	-	-	Effective student suppport system will help reduce information overload	Easy to approach and attend to student queries and issues	-	Effective feedback systems and student support will help reduce ambiguity in assignments	Reduced ambiguity in assignments and updated information about peer assesment will help increase quality of MOOC	-	Effective feedback will help instructors improve teaching pedagogy with time
6	-	-	-	-	-	-	Lowers	Increased ambiguity of assignments will lower the quality of MOOC thus hampering credibility	-
7	-	-	-	-	-	Reduces	-	Higher the quality better the credibility	Effective quality of MOOC leads to improved teaching pedagogy
8	-	-	-	-	-	-	Better credibility perceives a high quality MOOC	-	Credible MOOC will have effective teaching pedagogy
9	-	-	-	-	-	Effective teaching pedagogy leads to reduction in ambiguities	Effective teaching pedagogy leads to improved quality of MOOC	Positive influence on credibility	-

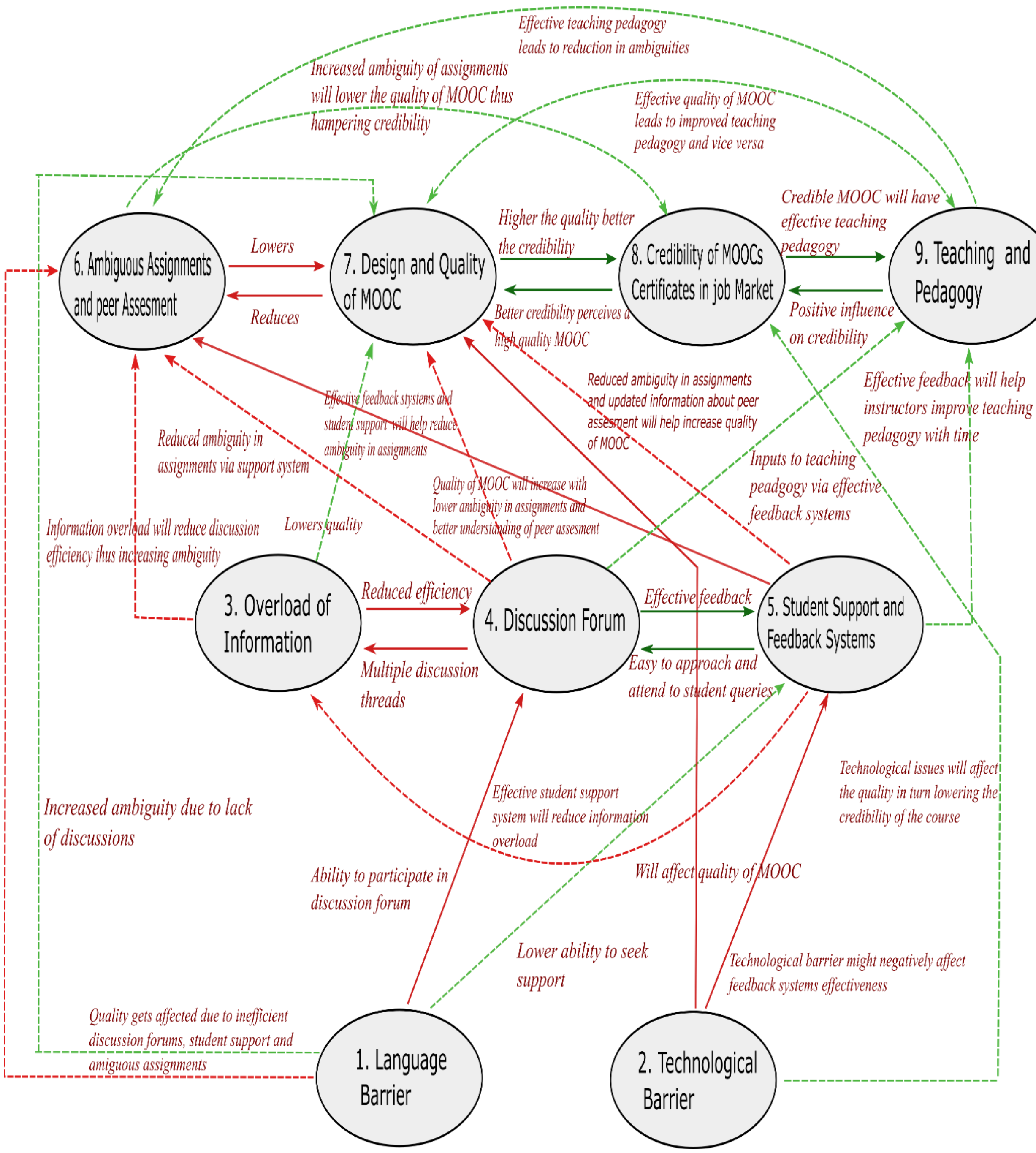

Fig. 3.5 TISM-P model for student issues with MOOCs

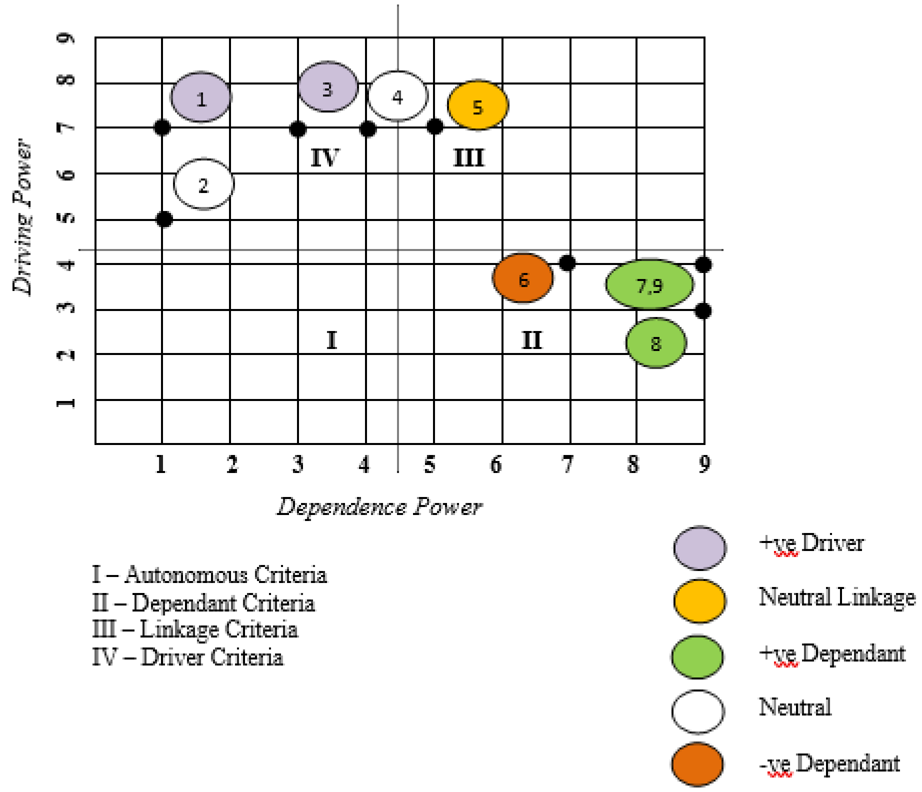

Fig. 3.6 MICMAC analysis of student issues with MOOCs

Step 11: The driver factors are used to trace out the +ve and –ve paths of student issues in reaching the outcome issue through intermediate factors (Table 3.16). It will aid in reflecting upon the need to control the impact of driver factors on outcome variables.

Table 3.16 Flow and nature of paths

Driver Factors	Path through factors	Polarity of path
Language Barrier	Discussion Forum	+ve
	Student Support and Feedback Services	+ve
Technological Barrier	Student Support and Feedback Services	-ve
Overload of Information	Discussion Forum	+ve
Discussion Forum	Student Support and Feedback Services	+ve

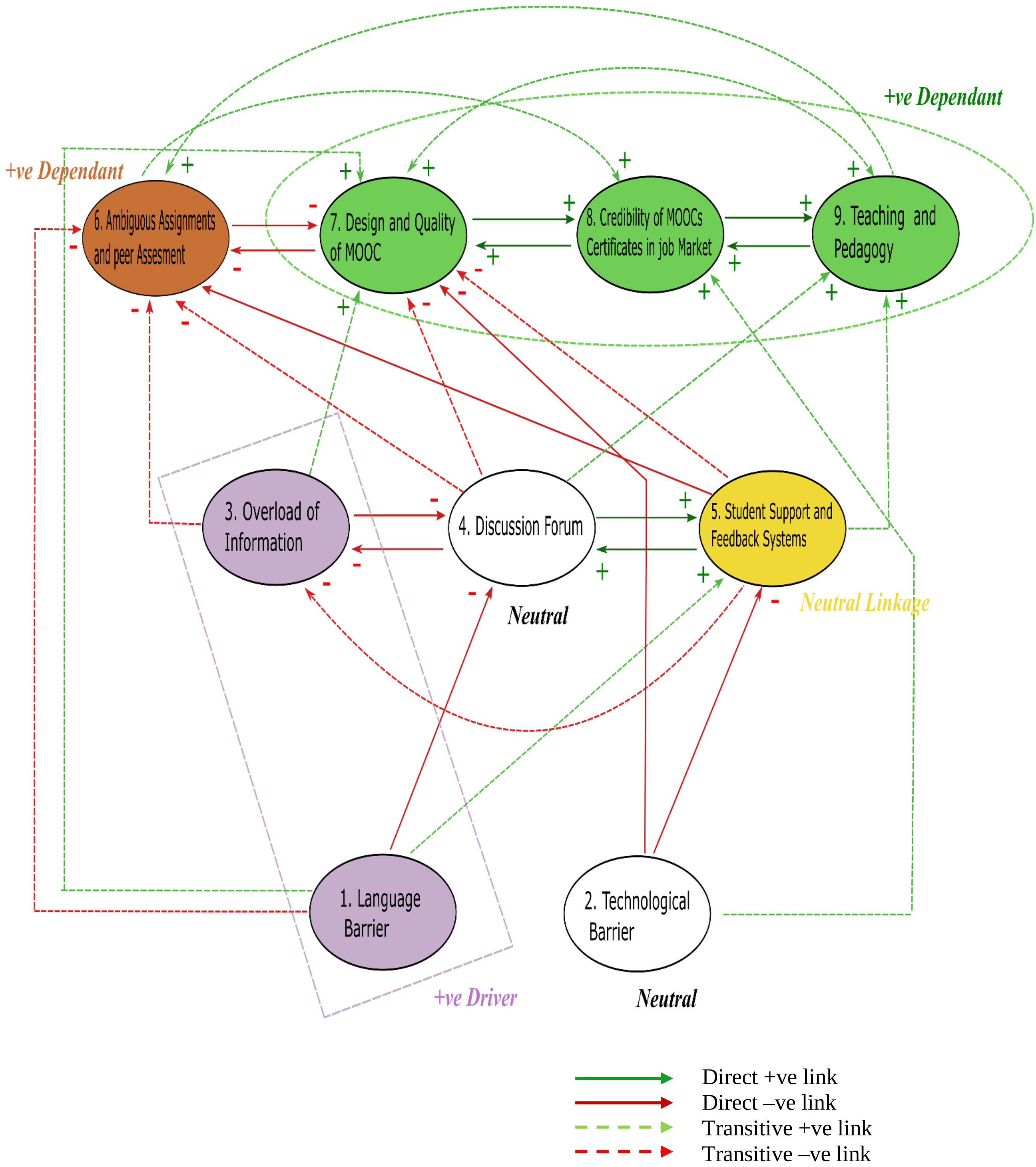

Fig. 3.7 TISM-P model overlayed upon MICMAC analysis

3.3.3 Model validation

Once the hierarchical model was developed, it was important to vet the information in the model with the panel of experts contacted earlier in factor validation. They had already taken part in the study and thus had a better idea of comprehending the nature of the work. A total of 39 linkages (Table 3.17) were formed in the original model and were tested for validation. It ideally depends upon the researchers' discretion to remove unnecessary transitive linkages to avoid over-crowding in the model (Agrawal, 2020; Sushil, 2018). We, however, consulted with expert opinions, and all 39 linkages were validated using hypothesis testing with a *t*-test. The final model was constructed whilst retaining the 30 most influential linkages. 39 questions were developed on a 5-point Likert scale questionnaire from strongly disagree to strongly agree for the test.

Hi(0): Null: No significant difference exists between the observed mean and specified mean in respective factor linkage.

Hi(A): Alternate: Significant difference exists between the observed mean and specified mean in respective factor linkage.

Ms-Excel® was used to collate the responses, and a test value of 3.5 was used; results are shown in Table 3.17.

Table 3.17 Hypothesis testing result (N=40)

S.No.	Factor Link	Mean	Std. Deviation	t-Value	Accept/Reject*
1	1-4	4.08	0.730	4.939	**Accept**
2	1-5	4.70	0.464	1.635	**Accept**
3	1-6	3.58	0.747	5.925	**Accept**
4	1-7	3.85	0.662	3.343	**Accept**
5	1-8	1.63	0.490	-2.425	**Reject**
6	1-9	1.20	0.405	-3.591	**Reject**
7	2-5	4.65	0.483	1.506	**Accept**
8	2-7	3.98	0.660	4.506	**Accept**
9	2-8	4.45	0.504	1.193	**Accept**
10	2-9	1.35	0.700	-1.1943	**Reject**

11	3-4	4.03	0.530	6.2	**Accept**
12	3-5	1.50	0.506	-2.498	**Reject**
13	3-6	4.05	0.904	3.846	**Accept**
14	3-7	4.35	0.770	6.985	**Accept**
15	3-8	1.68	0.474	-2.44	**Reject**
16	3-9	1.65	0.483	-2.422	**Reject**
17	4-3	4.55	0.504	1.318	**Accept**
18	4-5	4.20	0.564	7.851	**Accept**
19	4-6	4.45	0.504	1.193	**Accept**
20	4-7	4.18	0.594	7.13	**Accept**
21	4-8	1.18	0.385	-3.83	**Reject**
22	4-9	4.50	0.506	1.249	**Accept**
23	5-3	4.55	0.504	1.318	**Accept**
24	5-4	4.60	0.496	1.402	**Accept**
25	5-6	4.23	0.620	7.349	**Accept**
26	5-7	4.28	0.554	8.789	**Accept**
27	5-8	1.80	0.464	-2.317	**Reject**
28	5-9	4.43	0.501	1.162	**Accept**
29	6-7	4.13	0.648	6.052	**Accept**
30	6-8	4.28	0.554	8.789	**Accept**
31	6-9	1.05	0.221	-7.02	**Reject**
32	7-6	4.35	0.622	8.64	**Accept**
33	7-8	4.25	0.588	8.062	**Accept**
34	7-9	4.50	0.555	1.14	**Accept**
35	8-7	4.33	0.572	9.061	**Accept**
36	8-9	4.35	0.622	8.64	**Accept**
37	9-6	4.43	0.501	1.162	**Accept**
38	9-7	4.23	0.768	5.993	**Accept**
39	9-8	4.40	0.632	9	**Accept**

3.4 Research Objective 3

To examine a rational way of selecting an e-learning platform for MOOCs.

3.4.1 Decision-making for MOOCs platform selection

The processes of decision-making are rooted in the permutations and combinations of its affecting factors. The detrimental factors may vary according to the time, place, or situation, which might positively or negatively affect the decision-making process. For first-time learners, selecting the ideal platform for MOOCs is intertwined with course selection and vice-versa. Both are indistinguishable since the attributes crucial for selecting a course factor directly into the decision-making process for selecting a platform. These attributes help the decision-maker compare and evaluate similar courses on multiple platforms. Thus, all platforms offer variations in specific course-related attributes to distinguish between these courses. We believe the literature is missing a significant distinction between the evaluation and ranking of course-related attributes and the evaluation and ranking of attributes related to the e-learning platforms for optimal selection of such platforms. Literature is majorly replete with authors' works on selecting and evaluating attributes related to e-learning platforms using various MADM techniques, thus, neglecting the other part (Su et al., 2016; Islas-Pérez et al., 2015; Jain et al., 2015). Garg (2017a, 2017b) tried multiple approaches to obtain the ranking of factors necessary for optimal e-learning website selection and evaluation. In both his work, he evaluated a combination of quality sub-factors (functionality, usability, efficiency, reliability, maintainability, etc.) and e-learning specific sub-factors (personalization, system content, ease of learning community, etc.) using various MADM methods from a general and holistic perspective (Garg 2017a). In perpetuation of his work, Garg and Jain (2017) used the aforementioned factors to select the most rational e-learning website for 'C programming language'. On the other hand, Jain et al., (2015) evaluated 21 e-learning websites based on criteria such as complete content, right and understandable content, personalization, security, navigation, interactivity, and user interface.

However, we believe evaluating an e-learning website and selecting are two highly diverse approaches and require individual attention to their processes. To better apprehend this process, we have developed a decision tree (Fig. 3.8) for MOOC platform selection for first-time learners/students. The decision tree allows us to visualize a rough but logical mental process for MOOCs platform selection in a picturesque form. Garg (2017a, 2017b,) tried to collate two different decision-making processes in his research, leaving a significant gap in rational MOOCs platform selection. Choosing the right platform for the course is one side of the coin, and deciding to stay after selection is the other side. He had missed this crucial distinction in his work and has provided a ranking for a holistic set of factors while merging selection and evaluation attributes. The differentiation is not clear in the decision-making process; for example, efficiency, reliability, maintainability, personalization, and system content are attributes that a learner experiences only after a decision to select a particular platform has been made first. A new learner has no possible way of evaluating these parameters from the face of the website's user interface since a decision to select the course from a platform must be made first to reach the critical stage of feature evaluation. Jain et al., (2015) also evaluated attributes such as completeness of the content, interactivity, and personalization that a prospective learner can only experience after the decision to select a particular e-learning platform had already been made. One cannot deny the importance of these attributes for e-learning websites, but, we believe that they are well suited for the post-process of evaluation and decision-making to stay with the e-learning platform. Personal experience and confrontation with these attributes are helpful for a prospective learner to decide whether to stay with the e-learning platform or switch from it. This grey area has led us to believe that the factors affecting both processes are different and should be evaluated using different MADM approaches. All primary MOOCs providing platforms have similar course-related attributes that are accessible to a prospective learner before selecting the course and the platform. These are available on most websites to help learners make knowledgeable decisions. In our present case, we aim to capture the dependencies (both inner and outer) of attributes crucial for selecting the right course and platform for MOOCs from new learners' perspectives. The approach is best suited for ranking the attributes and alternatives simultaneously.

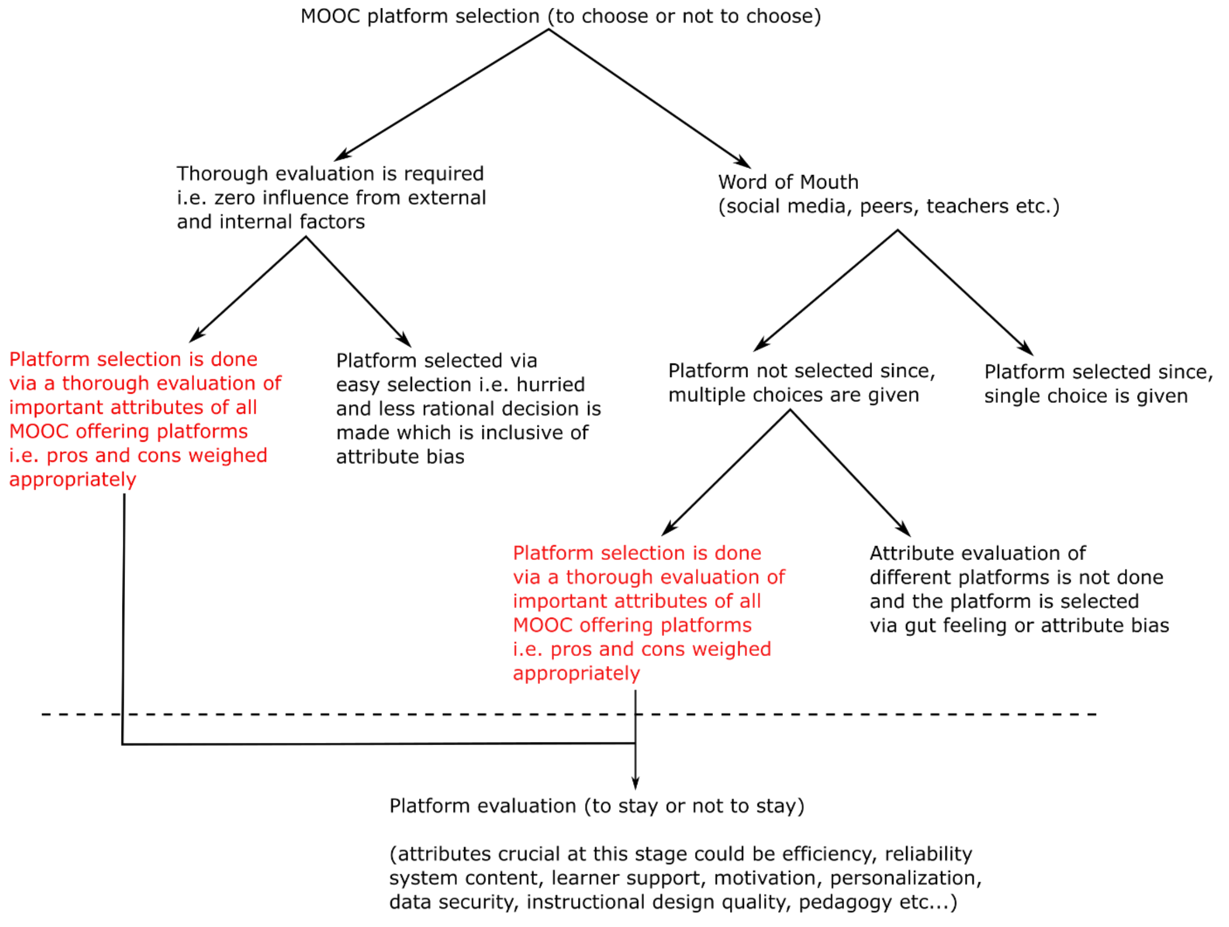

Fig. 3.8 Decision tree for MOOCs platform selection

3.4.2 Why a hybrid MADM approach?

MADM methods are broadly divided into two categories i.e., the objective and subjective weighing methods. Each method has a set of prerequisites that should be checked before selecting the appropriate method. The subjective methods include expert or majority opinions, and the technique is based upon different weighing approaches such as the eigenvector method and weighted least square method, etc. (Wang & Lee, 2009). They are often time-consuming and get tedious with the increasing number of participants and attributes. The attributes entail different weights due to diverse opinions, and subjective techniques are majorly used in cases of opinion conflict (Chen et al., 2003). Some subjective techniques include fixed-point allocation, direct rating, simple multi-attribute rating technique (SMART), SIMOS method, AHP, (Analytical Network Process) ANP, Delphi, etc. On the other hand, the objective weighting methods solve problems mathematically without considering the decision makers' preferences (Penadés-Plà et al., 2016). It is based upon complex data used to determine the criteria weights obtained mainly from the data in a decision matrix. Some of the most notable objective weighting methods are the entropy method and multiple objective programming methods, Criteria Importance Through Inter-criteria Correlation, (CRITIC) Simultaneous Evaluation of Criteria and Alternatives, (SECA), Statistical Variance Procedure (SVP), etc.

We have selected the approach called the hybrid MADM approach with multiple classifications. Depending upon the goal, interaction with the decision-maker, criteria, limitations, and type of data available, authors have combined subjective and objective weighing approaches to compensate for each other's shortcomings (Vavrek, 2019; Zoraghi et al., 2013). Since none of the methods claim to be robust enough to capture all facets of human decision-making (Asadabadi et al., 2019), multiple studies have combined two or more objective and subjective methods individually. In our context, we have used a variation of a well-defined and sturdy causal dependency model i.e., (DEMATEL-ANP) inner dependency variation. The conjunction of both techniques has garnered the attention of decision-makers since, it additionally offers multiple model-based alterations such as network relation map of ANP, inner dependency in ANP, cluster weighted ANP and DEMATEL based ANP (DANP) for solving different problems (Gölcük & Baykasoğlu, 2016). ANP takes care of inner and outer dependencies and self-feedback in a decision-making model, but in some instances, the pairwise comparisons often become meaningless for inner dependencies (Baykasoğlu & Golcuk, 2015). Consequently, DEMATEL is required for handling the inner dependency in the supermatrix of an ANP model. Thus, analogous to previous studies (Buyukozkan & Cifci, 2012; Bakeshlou et al., 2014; Tseng, 2011), we have decided to use this variation of DEMATEL-ANP since for our framework (Fig. 3.9) the pairwise comparisons for handling the inner dependencies using only ANP technique might be problematic.

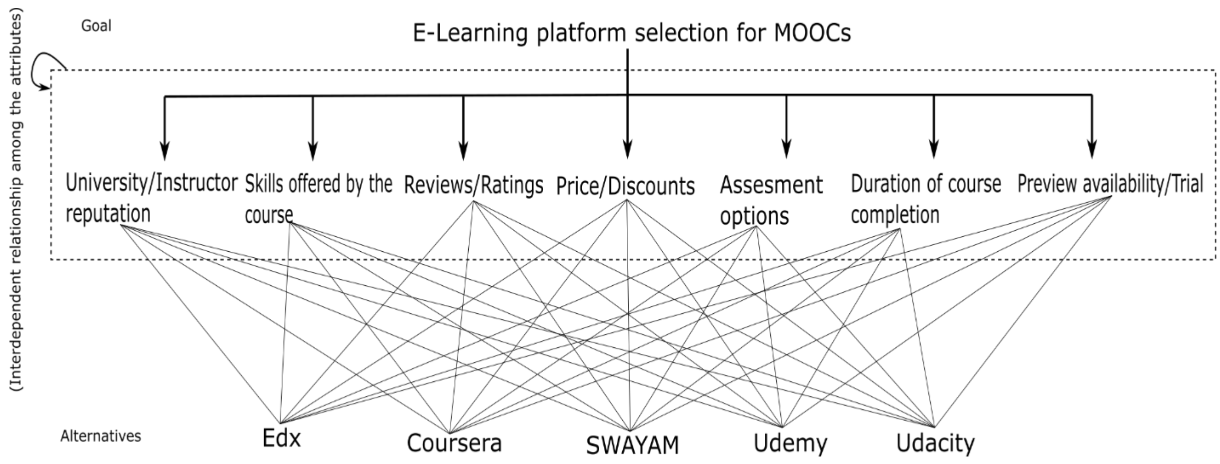

Fig. 3.9 The framework for rational selection of MOOCs platforms

3.4.3 Combined DEMATEL-ANP inner dependency model

A batch of second-year (third-semester) engineering students were selected from a public university in Delhi and were selected via purposive sampling and informed consent was taken from all the participants before participating in the study. Since none of the previous works had elicited the importance of evaluating the attributes related to MOOCs in selecting the e-learning platforms, the students were asked to take part in a short pilot survey before taking part in the actual study. Due to the university working in a hybrid mode, an online meeting was scheduled and the students were asked an open-ended question to mention the most crucial attributes of MOOCs (for selection purposes) available to them on e-learning platforms. Prima facie seven main attributes (university/instructor reputation, skills offered by the course, reviews/ratings, price/discounts, preview availability/trial, duration of course completion and assessment options) were mentioned and discussed by the students, upon which they would have decided for platform selection. These attributes were selected for the study and the (DEMATEL-ANP) questionnaires were prepared accordingly.

Also, the primary reason for our decision to select this particular batch was that it consisted of the maximum number of students who were yet to take the university option for credit transfer via completing MOOCs. The credit transfer via MOOCs is an additional option for students who do not wish to attend the regular lectures at the university. According to the undergraduate and post-graduate level university curriculum, the students are supposed to take the MOOCs from a list of platforms not limited to edX, Coursera, SWAYAM (Indigenous), Udemy, and Udacity. These platforms were highlighted because the university has a professional tie-up with most of these platforms for delivering two ‘paid courses’ for free to all the students enrolled in various degree programs at the university (an initiative due to COVID-19). Furthermore, the SWAYAM platform was included because it is an indigenous e-learning platform mandated by the Ministry of Education and the New Education Policy 2020. The platform is funded by the government and appeals to the larger consortium of public and private universities in the country. Since the university was functioning in a hybrid mode, the process was explicitly explained to all the participants via an online meeting and after a 10-minute question and answer session, a total of 76 responses were collected in the next 45 minutes. The data collected was sorted and filtered out for injudicious decisions leaving us with (n=68) proper responses to evaluate. The eight responses which were not selected were either incomplete or filled with ill intent. A step-by-step methodology for ANP-DEMATEL techniques is presented below, followed by the results in section 4.3.

The Battele Memorial Institute in Geneva is the birthplace of the DEMATEL (Çelikbilek & Adıgüzel Tüylü, 2019) and the technique has been extensively used for depicting a picturesque representation of causal relations amongst factors important in decision-making. It proposes the degree and impact of interrelations among influential factors with the help of a four-quadrant influential relation map (IRM) or network relation map (NRM) (Chen et al., 2018).

The original DEMATEL has the following steps:

Step 1: Create a group direct influence matrix Z: In order to determine the relation between n factors (F): $\{F_1, F_2, F_3\ F_4 \ldots\ldots. F_n\}$ with r expert respondents in a group (E): $\{E_1, E_2, E_3\ E_4 \ldots\ldots. E_r\}$, the decision makers are required to mark the direct influence of factor F_i on factor F_j. For direct comparison, an integer scale is used i.e. no influence (0), low influence (1), medium influence (2), high influence (3), and very high influence (4). The individual direct influence matrix $Z_k = [\mathcal{Z}_{ij}^k]_{n\times n}$ formed by the Kth expert will have all principal diagonal elements as zero where $\mathcal{Z}_{ij}^k$ is the judgement of decision maker E_k. Finally, in order to obtain the group influence matrix we aggregate the opinions of r experts'. The group matrix Z = $[\mathcal{Z}_{ij}]_{n\times n}$ is obtained as:

$$\mathcal{Z}_{ij} = \frac{1}{r}\sum_{k=1}^{r} \mathcal{Z}_{ij}^k \qquad i, j = 1,2,3 \ldots . n. \qquad \text{(Eqn. 3.1)}$$

Step 2: Establish the normalized direct influence matrix (X): There are several ways of normalizing a matrix such as linear max-min, max, logarithmic, vector and sum etc. (Kosareva et al., 2018). In case of DEMATEL several authors have used the largest row or column sum as the standard for normalization (Si et al., 2018; Yazdi, 2020). Therefore, to normalize the matrix Z we have also used a similar approach:

$$\mathrm{X} = \frac{\mathrm{Z}}{S} \qquad \text{(Eqn. 3.2)}$$

$$S = \max\left(\max_{1\le i\le n} \sum_{j=1}^{n} \mathcal{Z}_{ij}, \max_{1\le j\le n} \sum_{i=1}^{n} \mathcal{Z}_{ij} \right) \qquad \text{(Eqn. 3.3)}$$

Thus, having all the principal diagonal elements as zero and solving for Eqn. 3.2 we get all the values of the normalized matrix X between 0 and 1.

Step 3: A total relation matrix T = $[t_{ij}]_{n\times n}$ is constructed using the normalized matrix X and an identity matrix I. The matrix T depicts the overall influence of one factor over the other and vice-versa.

$$T = X + X^2 + X^3 + X^4 + \dots . + X^h = X(I - X)^{-1} \quad \text{(Eqn. 3.4)}$$

Where, h→ ∞

Step 4: The influential relation map (IRM) is produced with the help of two vectors r and c which represents the sum of rows and columns of the total relation matrix T.

$$\boldsymbol{r} = [r_i]_{n\times 1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1}$$

(Eqn. 3.5)

$$\boldsymbol{c} = [c_j]_{1\times n} = \left[\sum_{i=1}^{n} t_{ij}\right]_{1\times n}$$

Both r_i and c_j sum up the direct influence relationships where, r_i is the ith row sum of the matrix T illustrating the sum of both direct and indirect impacts that factor F_i has on other factors. c_j is the jth column sum of all the direct and indirect impacts that factor F_j is receiving from other factors.

Now, to illustrate it on a graph (see figure 1) let us take i = j i, j ∈ $\{1,2, \dots . n\}$. The vector (r + c) on the horizontal axis is called 'prominence', which indicates the total level of influence (given and received) by factor i on/by other factors. The vertical axis vector (r − c) is called the 'relation' which exhibits the net effect a factor has on the system. The positive value of $(r_i - c_i)$ indicates that factor F_i has a net positive influence on other factors, thereby making it a part of the cause group or 'dispatchers' and if $(r_i - c_i)$ indicates a negative value then factor F_i is being influenced by other factors in the group also known as the effect group or 'receivers' (Wu, 2008).

A threshold value α is selected by taking the average of the final total relation matrix T or after discussion with domain experts. The value helps the decision maker to eliminate the minor effects in the system and prevent overcrowding. Only the values more than the threshold value are selected to form the IRM.

Analytical Network Process (ANP)

ANP is an extension of AHP provided by Saaty (2004) to overcome the impediments related to factor interdependencies and feedback. The DNAP method combines both methods at the stage of matrix normalization in ANP.

Step 5: Construction of an unweighted supermatrix (W) – The initial steps in ANP are the same as in AHP. Using the Saaty (1-9) scale of relative importance we can get the priority values of criteria with respect to goal and alternatives with respect to the criteria. Once the priority values are derived an unweighted supermatrix could be constructed. But, before we reach the weighted supermatrix (W_w) the integration of DEMATEL is necessary in the form of an inner dependency matrix. This is crucial since ANP is not capable of capturing the inner dependency at certain times. The pairwise comparisons for outer dependency are quite easy to relate and comprehend by experts but in the case of inner dependencies, the comparisons seem to make no sense for the respondent.

Step 6: Construction of total relation (alpha cut matrix) for inner dependencies – Obtaining the alpha cut matrix is necessary because influential values less than the threshold value are not required for the supermatrix. Thus, the values below the threshold need to be cut from the total relation matrix (T) and converted to 0. Then, to be able to use (T) in the supermatrix it must be first normalized and then transposed. To normalize the matrix the row sums are calculated using the Eqn. 3.6.

$$T = \begin{bmatrix} t_{11} & \cdots & t_{1j} & \cdots & t_{1n} \\ \vdots & & \vdots & & \vdots \\ t_{i1} & \cdots & t_{ij} & \cdots & t_{in} \\ \vdots & & \vdots & & \vdots \\ t_{n1} & \cdots & t_{nj} & \cdots & t_{nn} \end{bmatrix}$$

$$T = \begin{bmatrix} t_{11} & \cdots & t_{1j} & \cdots & t_{1n} \\ \vdots & & \vdots & & \vdots \\ t_{i1} & \cdots & t_{ij} & \cdots & t_{in} \\ \vdots & & \vdots & & \vdots \\ t_{n1} & \cdots & t_{nj} & \cdots & t_{nn} \end{bmatrix} \begin{matrix} \rightarrow d_1 = \sum_{j=1}^{n} t_{1j} \\ \rightarrow d_i = \sum_{j=1}^{n} t_{ij} \\ \rightarrow d_n = \sum_{j=1}^{n} t_{nj} \end{matrix} \qquad \text{(Eqn. 3.6)}$$

d_i is the row sum value of the ith row. Each matrix entry is divided by the row sum value where T^{α} is the normalized total relation matrix and $(T^{\alpha})'$ is the transpose.

$$T = \begin{bmatrix} t_{11/}/d_1 & \cdots & t_{1j}/d_1 & \cdots & t_{1n}/d_1 \\ \vdots & & \vdots & & \vdots \\ t_{i1}/d_i & \cdots & t_{ij}/d_i & \cdots & t_{in}/d_i \\ \vdots & & \vdots & & \vdots \\ t_{n1}/d_n & \cdots & t_{nj}/d_n & \cdots & t_{nn}/d_n \end{bmatrix} \qquad \text{(Eqn. 3.7)}$$

$$T^{\alpha} = \begin{bmatrix} t_{11}^{\alpha} & \cdots & t_{1j}^{\alpha} & \cdots & t_{1n}^{\alpha} \\ \vdots & & \vdots & & \vdots \\ t_{i1}^{\alpha} & \cdots & t_{ij}^{\alpha} & \cdots & t_{in}^{\alpha} \\ \vdots & & \vdots & & \vdots \\ t_{n1}^{\alpha} & \cdots & t_{nj}^{\alpha} & \cdots & t_{nn}^{\alpha} \end{bmatrix}$$

$$(T^{\alpha})' = \begin{bmatrix} t_{11}^{\alpha} & \cdots & t_{i1}^{\alpha} & \cdots & t_{n1}^{\alpha} \\ \vdots & & \vdots & & \vdots \\ t_{1j}^{\alpha} & \cdots & t_{ij}^{\alpha} & \cdots & t_{nj}^{\alpha} \\ \vdots & & \vdots & & \vdots \\ t_{1n}^{\alpha} & \cdots & t_{in}^{\alpha} & \cdots & t_{nn}^{\alpha} \end{bmatrix} \qquad \text{(Eqn. 3.8)}$$

Step 7: The matrix $(T^{\alpha})'$ can now be substituted in the supermatrix at appropriate places. The supermatrix is now required to be transformed to make it column stochastic i.e. each column sum is required to be unity. The resultant matrix is the weighted supermatrix (W_w) which is multiplied by itself till the kth (k is a sufficiently large number) power to reach a steady state limiting matrix $(W_w)^*$. This limiting supermatrix (WL) must converge till the kth power in order to obtain the global priority influential vectors i.e. the ANP weights.

3.5 Research Objective 4

To understand students' perceptions about the role of MOOCs in addressing the knowledge gap and employability issues.

The objective is set to explore the perception of students vis-a-vis new policy implementation at multiple technical universities where completion of MOOCs is mandatory for all students of the engineering discipline. One of the segments of the NEP 2020 introduced during COVID-19 recommends MOOCs to be an integral part of 'credit transfer system' for all HEIs in the country. Irrespective of the stream and specialisation of education it is required by universities and other institutions to adapt the policy matter into their course ordinances. The policy aims to provide greater autonomy to students when selecting skill-based courses for self-paced learning alongside core and elective modules received from the university or the affiliating institution. Thus, in the present context it is crucial to study the after-effects of such policy intervention because the institutionalisation of online learning via MOOCs could be challenging and for the students and teachers to transition into. The literature is replete with hybrid learning models, and COVID-19 has already pushed universities towards experimenting with policies that could balance the conventional teaching and learning pedagogies alongside online learning. However, the evaluation of such interventions and their after-effects is not explored in the Indian context and thus, it is crucial for us to understand the perspectives of students at the grassroots level.

The issue lies not in policy formulation since the intent is well appreciated and welcomed by the academic diaspora in the country; but it is an age-old fact that new policy implementation requires close scrutiny and feedback in order to bear fruit. Therefore, in order to understand the picture from the primary stakeholder perspective i.e. students it is crucial to understand the issues and challenges students face with MOOCs and the so-called flexible online learning systems at the universities.

3.5.1 Use of ENA as a tool for analysing student interviews

Epistemic Network Analysis is a tool developed in the field of learning analytics and lays its foundations in the theory of quantitative ethnography. As, tool to model cognitive networks it can be used to model patterns of association in any system characterized by complex network of dynamic relationships amongst some fixed elements.

For the purpose of creating and analysing epistemic network graphs, semi-structured in-depth interviews were conducted and the data was collected from n=73 respondents. However, n=40 responses were coded for the study due to data saturation since it was not required to code similar and repeating responses (Fusch et al., 2015). A batch of 3rd year engineering students was selected using purposive sampling. The prerequisite for appearing in the interview demanded the completion of at least one MOOC to secure credit at the university. The interviews were conducted online (via Google Meet®) over the course of a full semester since, the university was operating on a hybrid mode (due to COVID-19) and it was difficult to convince the participants for a face to face interview in close proximity. The interviews were conducted primarily after working hours at night due to suitable availability of the participants. The interviews were conducted either in Hindi or English language after seeking consent from the participant. The background of the interview was explained to each and every participant thoroughly and a verbal and recorded consent was taken by each participant to let the researchers use their data for analysis and produce results. Strict anonymity and confidentiality was maintained throughout the process. The names were changed for data analysis and input in the ENA online software. The interview questions were open-ended and semi-structured, giving an unobstructed way for various themes to emanate. This interview method enabled participants to express freely the dynamics of their thought process and allowed the researcher to probe on certain occasions seeking clarification for responses. On an average the duration for each interview was 35-50 Minutes.

Once the data was collected in audio recordings the transcripts were made manually by listening to them. The transcripts were prepared in the English language and axial coding was carried out on the manuscripts. To find the level of agreement between both the coders inter rater reliability was found to be k=0.72 (Cohen's kappa). Qualitative data demands deep reflection and meticulous attention to the language, thus recoding can lead to more attuned results (Saldaña, 2013). At the first stage both the authors independently undertook open and axial coding scheme. The results were then collated to discuss the relevance of themes, categories and sub-categories. In the second stage the coding procedure was undertaken again by the researchers and 30 open codes were identified. After obtaining the open codes, the axial coding mechanism was undertaken independently by the two authors to group the similar and related codes together (23) depending upon the emerging patterns as well as the consistency in the responses (Appendix-III).

Modelling networks with ENA (using ENA web Toolkit®)

Step 1: Formatting and Segmentation of data

ENA accepts data in multiple formats the metadata from Excel. The data must be formatted appropriately and coded for the cognitive elements of interest. A snapshot of the edited and formatted metadata is given below in (Fig. 3.10). The table consists of a stanza column (A_Question), unit column (Group_Name), raw data (text, UserName) and code columns (M_Agrade, M_upskilling, M_Career etc.).

LineID	UserName	A_Question	Group_Name	Group_ID	Text	M_Agrade	M_Upskill	M_Career	PS_ROI	PS_Reviev	PS_Influer	KS_Interne	KS_Platfoı
1	Harsh A	1	Env	1	I took the python course because I had interest in machine learning and AI and these techniques require the knowledge of python. But, then I got to know that campus placements are not much for machine learning and AI so, I left it at that spot and learnt the language JAVA since, it is useful for campus placements. I also learnt data structure and analytics since both of them are asked in the campus interviews. I practice these languages and thus, the main motivation was my personal interest, plus to land a good job gain experience and do a masters degree from abroad from a good university.	0	1	1	0	0	0	0	0
2	Vidushi S	1	Auto	2	Ok so sir as you can see and figure out most of my courses are related with data analytics and python and i have deep interest in data analytics and for that i was very curious about this language python and the whole feel of data analytics. So i started off with learning python and R and all the visualization tools and so i took python specialization course from Michigan University and that made my base and thereafter i took the boot camp where they teach how to make the project, 15-20 projects and games in python project and that allowed me to have hands on experience on python and different libraries. After I moved on to the Google certification course for data analytics.	0	1	0	0	0	0	0	0
3	Rishabh J	1	Env	1	ir one of the motivation was Linked In. The motive of making a profile on LinkedIn was to see where seniors are now in their careers. I wanted to understand which courses they did and both of my courses from Coursera were inspired by my seniors. The python course was recommended by everyone since it is important from the job perspective.	0	1	1	0	0	1	0	0
4	Tushar G	1	Elec	3	Sir the first motivation was to acquire some skills to perform well in placements or do some free lancing.	0	1	0	0	1	0	0	0
5	Akash C	1	CS	4	Sir for the course on DS Algo I did it for preparation of placement drive which will happen this year. Rest I did because we had to do two more courses to acquire the college credit points. Introduction to web development was to get a jump start for this topic.	0	1	1	0	0	0	0	0
6	Sparsh S	1	CS	4	Sir I am a computer engineer and we need programming skills and a computer engineer should have to get a decent job. I wasn't to have a start up of my own so having technical skills will definitely help me.	0	1	1	0	0	0	0	0
7	Saurav P	1	ECE	5	Sir I am computer science degree and the first and foremost requirement for me is coding. When I joined college I had little knowledge about C++ and I thought I will start from scratch everything but I saw that a lot of students here had knowledge about it already. I felt I am lagging behind so I took upon these courses to learn fast and not wait for my professors to teach concepts in class.	0	1	1	0	0	0	0	0

Fig. 3.10 Excerpt of the coded log file containing the metadata

ENA looks for relations among elements not just within specific turns of talk but across the turns of talk also. It depends upon the data and the driving question about what relations are important and required to be analysed. ENA allows the user to select the conversations from a particular group or time and look for relations among their turns of talks.

The relationships between elements in ENA can be explicitly specified in the model, but the idea of a stanza is that the elements present in the same stanza are conceptually linked, while elements in different stanzas are not. Elements that co-occur in a stanza are conceptually linked (Dorogovtsev & Mendes, 2013). Thus, the co-occurrences of concepts in a given segment of data is a good indicator of cognitive connections (Zhang et. al., 2022).

Step 2: Creation of adjacency matrices representing co-occurrences of codes in each stanza (***Background workings of ENA Web Toolkit***®)

ENA creates a series of adjacency matrices where each matrix represent co-occurrences of codes in a single stanza. If, the stanzas consist of multiple rows of data ENA collapses all in a single row in new data table (Table 3.18) which contain all codes present in the rows of that stanza. Each code is then summed (binary or weighted). A binary summation assigns 1 to each code that appears at least once in the rows of a stanza and 0 to codes that do not appear. Weighted summation further accumulates each code (Table 3.19).

Table 3.18 Accumulation of coded rows of data into single coded row for each stanza

	M_Agrade	M_Upskilling	M_Career	PS_ROI	PS_Review
	0	1	1	0	0
	0	1	0	0	0
	0	1	1	0	0
	0	1	0	0	1
	0	1	1	0	0
	0	1	1	0	0
Coded rows from a single STANZA 1	0	1	1	0	0
	0	1	1	0	0
	0	1	0	0	0
	0	1	1	0	0
	0	1	1	0	0
	0	1	1	0	0
	0	1	1	0	0
	0	1	1	0	0
	0	1	0	0	0
Stanza (Binary Summation)	0	1	1	0	1
Stanza (Weighted Summation)	0	15	11	0	1

Each stanza now is represented as a single row, to produce adjacency matrix for each stanza. If two codes both occur in the same stanza value of 1 is placed in the cell; cells for codes that do not co-occur receive a 0 (Table 3.19).

Table 3.19 Adjacency matrix representing co-occurrences of codes for stanza 1

STANZA 1	M_Agrade	M_Upskilling	M_Career	PS_ROI	PS_Review
M_Agrade		0	0	0	0
M_Upskilling	0		1	0	1
M_Career	0	1		0	1
PS_ROI	0	0	0		0
PS_Review	0	1	1	0	

Step 3: Accumulation of stanzas

To identify the structure of connections, ENA sums the adjacency matrices for all unit of analysis (*u*) into a cumulative adjacency matrix, C^{U} where each cell C^{U}_{ij} represents the number of stanzas in which both codes I and j were present. In our current data set the unit of analysis is A_Question because we are interested in understanding the interconnections between cumulative responses of students with regards to each question asked in the interview. The full data set has 12 stanzas under A_Question, 25 codes and 420 lines of coded data.

Step 4: Conversion of stanzas into vector form

ENA creates set of cumulative adjacency matrices for all units in the data and each matrix into an adjacency vector V^{U} , by copying the cells from upper diagonal of the matrix row by row into a single vector. These vectors exist in a higher-dimensional space, *V* such that each dimension of *V* represents a pairing of two codes. The position of vector V^{U} represents the cumulative adjacency matrix C^{U} on the dimension corresponding to the unique pairing of codes i and j in *V* given by C^{U}_{ij}.

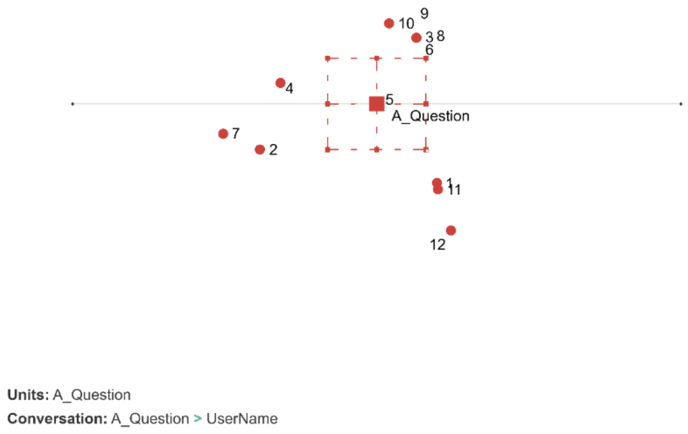

Fig. 3.11 Stanza placement in higher dimensional space in ENA web Toolkit® software (Model 1)

Model 1 in Fig. 3.11 depicts the placement of all the points that relate to a cumulative adjacency matrix for each stanza, which comprises the cumulative responses of 40 students. An explanation of the model and results are given in the next section. ENA allows the user to create various models depending upon the unit types thus, for the current study we will be exploring three models yielding different understanding of student perceptions individually or in group in the results section.

Chapter 4

Results

4.1 Results of Objective 1

A total of 240 individual matrices were constructed from the 40 fit responses to be analysed. The matrices in both the levels with respect to the goal of the study were reduced to one individual matrix and priority ranks were obtained after a thorough consistency check. The steps (section 3.2) involved in the sample calculations for level 1 (table 4.1) responses were replicated for level 2 (table 4.2) responses and the results are tabulated. The weight column holds the principal value in determining the ranks of the factors and sub-factors which clearly iterates the importance of the collective perception of students whilst ranking them in order of preference. Examining the level 1 responses, it was found that the attribute Student Support and Feedback (SSF) services grabbed the most noteworthy priority weight of (31.54%) which ranks it ahead of all the other attributes. It is needless to say that opportunities for students to connect on a more personal and intimate level with their institution could only be achieved by improving student support and feedback services (Pereira et al., 2016). Curriculum Structure and Design (CSD) at 21.7% and Curriculum Alignment (CA) at 20.14% links closely for the second and third position followed by Assessment Mechanism (AM) at 14.38% and Curriculum Benchmarking (CB) at the lowest 11.74%.

Table 4.1 Combined final computations for pair-wise comparisons (level 1)

Determinants of CD	(CB)	(CSD)	(AM)	(CA)	(SSF)	Priority Vector	Rank
(CB)	0.12	0.1	0.12	0.14	0.11	0.12	5
(CSD)	0.24	0.21	0.26	0.22	0.17	0.22	2
(AM)	0.15	0.12	0.14	0.15	0.16	0.14	4
(CA)	0.18	0.2	0.2	0.21	0.23	0.20	3
(SSF)	0.31	0.38	0.28	0.29	0.32	0.32	1

Assessing the sub-factors of CB, the consensus amongst the students topped at 41.4% for the factor benchmarking with national standards and higher education quality frameworks (CB_NS) followed closely by benchmarking of course and structure (CB_CS) at 36%. The least amount of importance was given to benchmarking the curriculum with institutions on a higher level of rankings (CB_IH) at 22.5% thus, in order of preference, prime focus should be given to CB_NS which is necessary to uplift curriculum quality on the national level following set Higher Education Quality (HEQ) frameworks or national guidelines and policies for developing quality higher education systems (McDonald & Van Der Horst, 2007) in the country. Curriculum Structure and Design (CSD) imbibes four main sub-factors, teaching principle and means (CSD_TPM) at 35% was relatively the most important sub-factor which defines the curriculum structure, reiterating students' needs for a more balanced mix of pedagogical and andragogical approach to be applied during their teaching periods. Stakeholders' opinion and consent (CSD_SO) at 24.4% were closely matched with theoretical frameworks and taxonomies (CSD_TFT) at 23.6%. Surprisingly, curriculum content (CSD_CC) took the last place at 16.7% even though it is one of the most crucial aspects of developing a student-centred curriculum. Assessment Mechanism (AM) is used to gauge the educational efficacy of an institution's offerings (Walser, 2015). Diagnostic assessment (AM_DG) topped the rankings with 43% acceptance amongst the students since students continuously relate more towards finding ways to diagnose their weaknesses and frequently committed errors. Alternative assessment (AM_AL) follows quickly at 35.4%, which is not a bad indicator in itself for students who have slow learning capabilities; Integrative Assessment (AM_IG) at 22% is the least preferred mode of assessment. Appraising the accelerated effect of changing socio-economic factors over the job market it is right to say that the graduates of tomorrow must be equipped with the desired industry tailored skill-set. Thus, the sub-factor alignment with industry standards and skill-set (CA_ISS) at 62% has the highest and unmatched acceptance rate amongst the other factors of Curriculum Alignment (CA). Although, alignment of mission, vision and objectives of curriculum with student learning outcomes (CA_SLO) besides alignment with national and international standards (CA_NIS) are known to play their own roles in enhancing institutional quality (Clifford & Montgomery, 2017) they still failed to grab significant attention of the student perceptions. Student Support and Feedback (SSF) services is ranked as the most dominant attribute in developing a student-centred curriculum therefore, unanimously the students vouched for delivery of timely and quality information about student learning (SSF_TQ) at 40% to be closely linked with their accessibility to feedback and support services (SSF_ASF) at 38.23% as the most important sub-factors in expounding the necessity of an integrated system of feedback and support services.

Table 4.2 Combined final computations for pair-wise comparisons (level 2)

Curriculum benchmarking	CB_IH	CB_CS	CB_NS	Priority vector	Lambda max	CR		Rank
CB_IH	1	0.6	0.57	0.22				3
CB_CS	1.6	1	0.83	0.37	3.01	0.01		2
CB_NS	1.76	1.21	1	0.41				1
Column sum	4.44	2.81	2.4					
Curriculum structure and design	CSD_TFT	CSD_CC	CSD_TPM	CSD_SO	Priority vector	Lambda max	CR	
CSD_TFT	1	1.79	0.60	0.84	0.23			3
CSD_CC	0.56	1	0.48	0.84	0.17	4.06	0.02	4
CSD_TPM	1.67	2.10	1	1.35	0.36			1
CSD_SO	1.19	1.19	0.74	1	0.24			2
Column sum	4.42	6.08	2.82	4.03				
Assessment mechanism	AM_IG	AM_AL	AM_DG	Priority vector	Lambda max	CR		
AM_IG	1	0.56	0.54	0.22				3
AM_AL	1.78	1	0.76	0.36	3.01	0.01		2
AM_DG	1.84	1.32	1	0.42				1

Column sum	4.62	2.88	2.3					
Curriculum alignment	CA_SLO	CA_NIS	CA_ISS	Priority vector	Lambda max	CR		
CA_SLO	1	1.57	0.34	0.23				2
CA_NIS	0.64	1	0.27	0.16	3.05	0.04		3
CA_ISS	2.97	3.66	1	0.61				1
Column sum	4.61	6.23	1.61					
Student support and feedback services	SSF_ASF	SSF_MM	SSF_TQ	Priority vector	Lambda max	CR		
SSF_ASF	1	1.81	0.93	0.39				2
SSF_MM	0.55	1	0.55	0.21	3.00	0.00		3
SSF_TQ	1.07	1.81	1	0.40				1
Column sum	2.62	4.62	2.48					

4.2 Results of Objective 2

4.2.1 TISM-P Model

The model (Chapter 3, Fig. 3.5) exhibits substantial insights into the interrelations between the student issues with MOOCs due to the effect of the positive and negative influence of factors over one another. The first factor, i.e., the language barrier, exhibits a direct and negative relationship with the factor discussion forum. If a country doesn't have an indigenously developed platform for offering MOOCs and English is not the medium of instruction in colleges and universities, then the students might not feel comfortable on global platforms (Ding & Shen, 2020), as was found in the case of Turkish MOOCs (Kurt, 2019). Students' ability to participate in discussion forums on global MOOC platforms might be affected due to language acting as a barrier and an issue itself. In such circumstances, students often lack the motivation to participate and might not be comfortable seeking answers to their queries. Furthermore, the language barrier was found to have a negative transitive effect on maintaining, if not increasing, the ambiguity of assignments. This effect flows through two factors, i.e., discussion forums and student support and feedback services. It is important to note whilst interpreting the model that not all transitive linkages will make sense in the real-world application (Sushil & Dinesh, 2022). Only those links and nodes are to be interpreted which carry substantial influence over another factor.

Thus, all transitive linkages were consulted with expert opinions. Therefore, an increasing effect of language as a barrier will bring down the effectiveness of discussion forums, which in turn will increase the ambiguity of student assignments. The presence of a positive transitive link with the design and quality of a MOOC reflects the importance of recognising language as a major barrier since the link is mediated by discussion forums. A high language barrier will negatively affect a student's ability to participate in discussion forums which will eventually lower the quality of any MOOC (Sanchez-Gordon & Luján-Mora, 2020). The Technological barrier has shown a direct and negative relationship with factors 5 and 7. It is important to note that high-speed internet connections and appropriate bandwidth might not be within the reach of all current and prospective students in developing or under-developed countries (Ma & Lee, 2018b, Ramij & Sultana, 2020). The obstructive effects of lack of internet penetration and net neutrality are quite real in tier 2 and 3 cities in such countries (Sambuli, 2016). Students opined that technological barriers have a direct negative effect on reducing the efficiency of feedback systems. Also, the lack of appropriate bandwidth will affect students' ability to access MOOCs since they require high-speed internet connections to load videos and access supporting materials, thus lowering the overall quality. Technology as a student issue also has a positive transitive effect on maintaining the credibility of a course in the market. Increased barriers to technology will lower the quality and, thus, the credibility of the course in the market. An overload of information has a direct negative relation with discussion forums. The results are not new from our findings since, it is already well supported by literature (Chen et al., 2011; Khalid et al., 2021, Zeng et al., 2022). However, a transitive positive relation was found with the design and quality of MOOCs. An overloaded discussion forum is constrained and ineffective, which might have a negative effect on the quality of MOOCs. The negative transitive relationship with factor 6 reiterates the fact that an increase in information overload will negatively affect the discussion forum, which in turn might increase the ambiguity in assignments and negatively affect peer assessment as well. Students felt that the discussion forum had a direct and positive effect on factor 5 and a direct negative effect on factor 3. A well-regulated discussion forum could also serve as a legitimate platform to deliver effective feedback to the instructors and vice-versa (Lowenthal & Dunlap 2020). However, it often becomes too overcrowded in the presence of multiple discussion threads, which could further increase the information overload. The negative transitive effect on factor 6 implies that effective discussion forums will support and ensure more active student feedback and help in reducing ambiguities in understanding assignments via fruitful discussions. The presence of a negative transitive effect on factor 7 tacitly expresses the fact that increased knowledge sharing helps to bank upon the basic premise of MOOCs, i.e. learning via a connectivist approach; thus, a well-regulated discussion forum would also contribute towards the better quality of MOOCs. Finally, the positive transitive relationship with factor 9 states that a well-maintained discussion forum could support instructors to garner real-time student feedback, which might be useful for improving teaching pedagogy. Student support and feedback services are crucial elements within MOOC issues and were found to have a direct positive influence in increasing the effectiveness of a discussion forum (Gamage et al., 2020). Additionally, this effect might lead to a reduction in the overload of information, thereby establishing a negative transitive relationship between factors 5 and 3. Moreover, a direct negative effect of factor 5 on 6 and a negative transitive effect on factor 7 exist. Lack of student support in MOOCs has been shown to have a negative effect on students dropping out of the course (Aldowah et al., 2020). Having an efficient support and feedback system will delimit any barriers between student-teacher interactions, thus, assisting in understanding assignments and peer assessment, further improving the quality of a MOOC. The presence of a positive transitive influence over factor 9 suggests that timely feedback from students might help teachers to make improvements in their teaching pedagogies and also adds to the completeness of a MOOC. Ambiguous assignments and peer assessment both have a direct negative effect on lowering the quality of a MOOC, which also has a positive transitive effect in lowering the credibility of such courses in the employment market. The Design and quality of MOOCs have a direct positive influence on factor 8 and a direct negative influence on factor 6. Generally, a high-quality and seasoned MOOC is famous and credible amongst students and in the job market as well, whereas better quality reduces ambiguity in assignments and peer assessments. Moreover, the positive transitive link with factor 9 highlights the importance of a well-designed MOOC via a direct positive relationship with credibility, i.e. an increase in both will serve as a driving factor for instructors to improve teaching pedagogy over a period of time (Julia & Marco, 2021). The Credibility of MOOCs in the job market has a direct positive relationship both ways forward and backwards. An increase in the credibility of a MOOC implies high quality and effective teaching pedagogy and vice-versa. Teaching and Pedagogy have a direct positive influence on the credibility of MOOCs, and the positive transitive relationship with the quality of a MOOC reveals that an effective teaching pedagogy will improve the quality of a MOOC (Jamebozorg et al., 2022) and also gather credibility in the employment market. Finally, the positive transitive relationship with factor 6 via improved quality of a MOOC will help in reducing any ambiguities in understanding assignments.

4.2.2 MICMAC Analysis

The graph from the analysis (Chapter 3, Fig. 3.6) represents no autonomous factors, which communicates to us the fact that all the factors have some relationship with each other. In quadrant (II) Factors 6, 7, 8 and 9 are major dependant factors in the system. The arrangement points towards the outcome of the model and needs factors with high driving power to trigger them. The credibility of a MOOC certificate in the employment market might not be of concern to other stakeholders, but in certain education systems' where securing a job is hyper-competitive (Pingle & Sharma, 2013; Goglio & Bertolini, 2021)) up-skilling via MOOCs speaks for itself. Also, the teaching pedagogy and design of a MOOC are intertwined with each other and receive the maximum amount of effect from drivers. It is important to note that factor 6 has a negative dependence power due to the nature of the issue itself. The quadrant (IV) is home to four major driving factors i.e. 1, 2, 3 and 4. Factors 1 and 3 are positive drivers in the system with very low dependence. Factors 2 and 4 are neutral in nature, i.e. they have equal amounts of positive and negative driving powers behind them. They will drive the influence but will not take a positive or negative stand. Any change in these issues will bring negative repercussions to other student issues. Finally, the third quadrant makes up the linkage criteria, which consists of factor 5 as a positive linkage. This factor is considered to be of utmost importance and volatility, i.e. they are highly influential and endangered at the same time. It flows both ways, i.e. any change in them will influence the remaining issues and the results of the model, creating a feedback effect (Mahajan et al., 2015).

The overlay of MICMAC analysis over the TISM-P model (Chapter 3, Fig. 3.7) provides us with a clear picture of corresponding factor influence and flow as well. The driver factors 1 and 3 do not have any relationship with each other but are responsible for positively driving the path through the linkage factor in order to reach the dependent factors. Factors 2 and 4 are neutral in nature, i.e. they may influence positively or negatively the linkage factor. Factor 6 is of crucial importance because it is the sole negative dependent factor. For all direct relations, the model has to flow through the dedicated strict paths in order to influence or reach the dependent factors, but for transitive relationships, the paths could be complicated. For example, factor 4 (driver) has a positive transitive relationship with factor 9 (dependent); thus, in order to reach the outcome factor, the path could move via multiple configurations, i.e. 4→5→6→7→8→9; 4→5→9; 4→6→9; 4→7→9; 4→8→9. The issues interact with each other via multiple influences; thus, the nature of the path shall also have multiple inferences depending on the situation in the real world.

4.3 Results of Objective 3

4.3.1 DEMATEL Model results

All the responses were collated in MS-Excel and (Table 4.3) provides us with the average matrix of direct relations. In order to get the normalized matrix (X) (Table 4.4) we had used the formula (section 3, 3.2 and 3.3). The total relation matrix (T) was constructed after multiplication of the normalized matrix with an identity matrix of order (7×7) and using equation (3.4) (Table 4.5). The threshold or α was averaged at **0.183** and all values above the threshold are highlighted bold in the total relation matrix (T).

Table 4.3 Average direct relation matrix

	F1	F2	F3	F4	F5	F6	F7
F1	0	3.04	3.57	0	2.36	1.21	0
F2	0	0	3.71	1.57	0	3	1.71
F3	3.96	3.75	0	1.04	2.54	0	0
F4	0	1.79	1.64	0	0	0	0
F5	0	2.07	0	0	0	0	0
F6	1.07	2.68	2.04	1.21	0	0	3.04
F7	0	0.86	1.86	0	0	1.68	0

Table 4.4 Normalised matrix (X)

	F1	F2	F3	F4	F5	F6	F7
F1	0	0.21	0.25	0	0.17	0.09	0
F2	0	0	0.26	0.11	0	0.21	0.12
F3	0.28	0.26	0	0.07	0.18	0	0
F4	0	0.13	0.12	0	0	0	0
F5	0	0.15	0	0	0	0	0
F6	0.08	0.19	0.14	0.09	0	0	0.21

F7	0	0.06	0.13	0	0	0.12	0

Table 4.5 Total relation matrix (T)

	F1	F2	F3	F4	F5	F6	F7
F1	0.15	**0.47**	**0.47**	0.1	0.27	**0.21**	0.1
F2	0.15	**0.27**	**0.47**	**0.2**	**0.11**	**0.31**	0.22
F3	**0.37**	**0.52**	**0.28**	0.16	**0.29**	0.15	**0.09**
F4	0.06	**0.22**	**0.21**	0.04	0.05	0.06	0.04
F5	0.02	**0.19**	0.07	0.03	0.02	0.04	0.03
F6	**0.19**	**0.41**	**0.38**	0.17	0.1	0.14	**0.29**
F7	0.08	**0.19**	**0.24**	0.05	0.06	0.17	0.06

In order to calculate the influential relation map (IRM) we require the sum of rows and column of the total relation matrix. The sum $(r_i + c_i)$ and difference $(r_i - c_i)$ are calculated using Table 4.6 for determining the net effects and the strength of influences given or received by the factors. The IRM (Fig. 4.1) is plotted by using values from Table 4.6.

Table 4.6 Total relation and relation for each factor based upon the DEMATEL survey

Factor	Code	r	c	$(r_i + c_i)$	$(r_i - c_i)$	Cause/Effect
University/Instructor reputation	F1	1.77	1.03	2.79	0.74	Cause
Skills offered by course	F2	1.73	2.26	3.99	-0.53	Effect
Reviews/Ratings	F3	1.87	2.11	3.98	-0.24	Effect
Price/Discounts	F4	0.68	0.77	1.44	-0.09	Effect

Preview Availability/Trial	F5	0.4	0.89	1.29	-0.49	Effect
Duration of Course Completion	F6	1.68	1.08	2.76	0.6	Cause
Assessment Options	F7	0.86	0.84	1.7	0.02	Cause

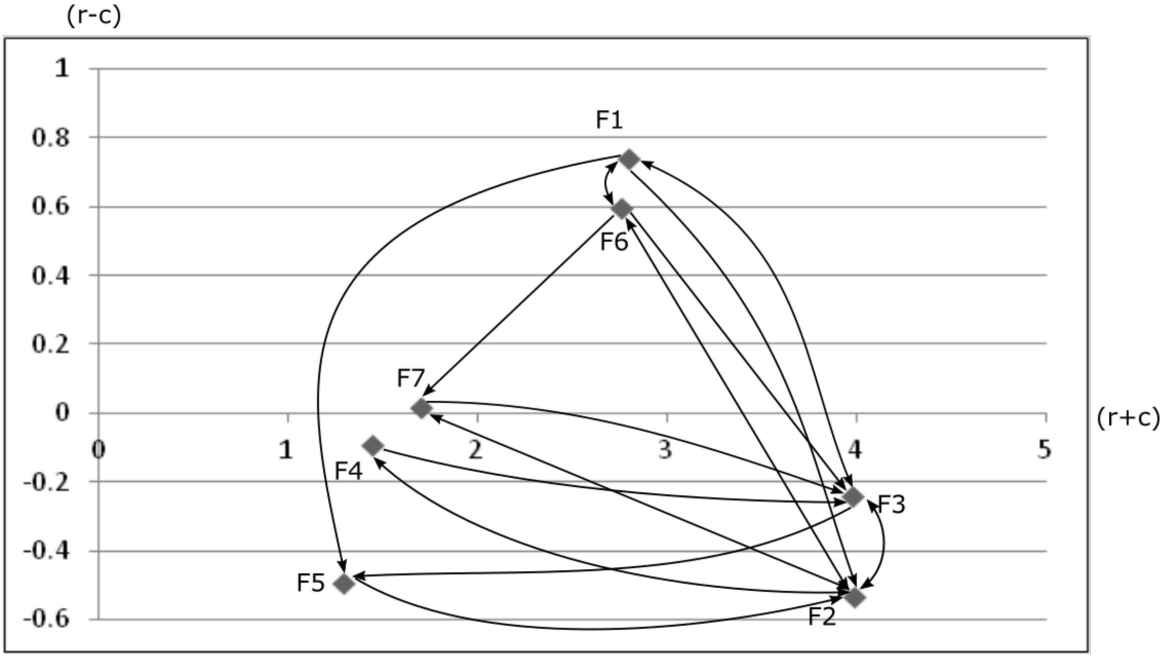

Fig. 4.1 Impact relation map by DEMATEL method

It can be observed from Table 4.6 that the sum for the attribute skills offered by the course has the highest values of ($r_i + c_i$ = 3.99) along with reviews/ratings ($r_i + c_i$ = 3.98) while the sum for the lowest value belongs to the attribute preview availability/trial ($r_i + c_i$ = 1.29) stipulating that the interdependent effects of skills offered by the course is the highest and that of preview availability is lowest while selecting an appropriate platform for MOOCs. Furthermore, all three positive values of ($r_i - c_i$) denotesthe fact that attributes F1 (0.74), F6 (0.60) and F7 (0.02) majorly affect other attributes and are the net causes in the model. The attributes F2, F3, F4 and F5 have negative values of $(r_i - c_i)$ representing the fact that they are affected by other attributes of MOOC platforms.

The IRM is constructed using the values from the total relation matrix. It is purely contingent upon the decision maker or experts to select a threshold value for the total relation matrix. In our case using the total relation matrix α was averaged at 0.183. Only the values above the threshold were selected for the IRM and the causal map clearly states that the attributes F2 and F3 receive the most effect by other attributes thus, they have high interrelation with other attributes. Attribute F1 is the highest causal attribute and F2 and F5 were the highest effect factors and also the most important attributes in the model.

4.3.2 DEMATEL + ANP Results

ANP uses the same steps for pair-wise comparisons at the local and global level as used in AHP. A decision matrix (Table 4.7) could be formed for our model after collating all the results from the respondents and checking for consistency ratios individually. The global level weights obtained in the decision matrix are reflective of students' opinion in prioritizing the relative importance of MOOCs attributes. The order of importance is (F3→F1→F4→F2→F6→F3→F7). The values from the decision matrix are used for obtaining an unweighted supermatrix. However, the values arising out of the inner dependencies in ANP are missing at this stage. Thus, the results from DEMATEL are used to cover all inner dependencies in ANP.

Table 4.7 Decision matrix

Weights	0.15	0.07	0.54	0.09	0.06	0.06	0.03
	F1	F2	F3	F4	F5	F6	F7
A1	0.39	0.27	0.3	0.05	0.35	0.26	0.12
A2	0.29	0.23	0.27	0.05	0.36	0.41	0.11
A3	0.03	0.21	0.03	0.23	0.05	0.03	0.65
A4	0.16	0.17	0.23	0.37	0.12	0.15	0.07
A5	0.13	0.12	0.17	0.31	0.12	0.14	0.05

The alpha cut total relation matrix (Table 4.8) for inner dependencies is derived using results from DEMATEL total relation matrix (T) and equations 3.6,3.7 and 3.8.

Table 4.8 Alpha cut matrix

	F1	F2	F3	F4	F5	F6	F7
F1	0	0.47	0.47	0	0.27	0.21	0
F2	0	0.27	0.47	0.2	0	0.31	0.22
F3	0.37	0.52	0.28	0	0	0	0
F4	0	0.22	0.21	0	0	0	0
F5	0	0.19	0	0	0	0	0
F6	0.19	0.41	0.38	0	0	0	0.29
F7	0	0.19	0.24	0	0	0	0

Table 4.9 Normalised and transposed alpha cut matrix $(T^{\alpha})'$

	F1	F2	F3	F4	F5	F6	F7
F1	0	0	0.25	0	0	0.15	0
F2	0.33	0.18	0.35	0.51	1	0.32	0.44
F3	0.33	0.32	0.19	0.49	0	0.3	0.56

F4	0	0.14	0	0	0	0	0
F5	0.19	0	0.2	0	0	0	0
F6	0.15	0.21	0	0	0	0	0
F7	0	0.15	0	0	0	0.23	0

The normalized and transposed alpha-cut matrix (Table 4.9) is then inserted into the ANP supermatrix (W) (Table 4.10) at the appropriate place to capture the effect of missing inner dependencies. The weighted supermatrix (Table 4.11) is now raised to a sufficiently large power until the matrix converges onto itself (Saaty, 2008). This limit supermatrix (W_L) (Table 4.12) represents the final eigenvector. For the particular case students preferred the alternative 1 i.e. edX as the best platform for online learning and their indigenous platform (SWAYAM) as the least preferred option.

Table 4.10 Unweighted supermatrix (W)

	Goal	F1	F2	F3	F4	F5	F6	F7	A1	A2	A3	A4	A5
Goal	0	0	0	0	0	0	0	0	0	0	0	0	0
F1	0.15	0	0	0.25	0	0	0.15	0	0	0	0	0	0
F2	0.07	0.33	0.18	0.35	0.51	1	0.32	0.44	0	0	0	0	0
F3	0.54	0.33	0.32	0.19	0.49	0	0.3	0.56	0	0	0	0	0
F4	0.09	0	0.14	0	0	0	0	0	0	0	0	0	0
F5	0.06	0.19	0	0.2	0	0	0	0	0	0	0	0	0
F6	0.06	0.15	0.21	0	0	0	0	0	0	0	0	0	0
F7	0.03	0	0.15	0	0	0	0.23	0	0	0	0	0	0
A1	0	0.39	0.27	0.3	0.05	0.35	0.26	0.12	1	0	0	0	0
A2	0	0.29	0.23	0.27	0.05	0.36	0.41	0.11	0	1	0	0	0
A3	0	0.03	0.21	0.03	0.23	0.05	0.03	0.65	0	0	1	0	0
A4	0	0.16	0.17	0.23	0.37	0.12	0.15	0.07	0	0	0	1	0
A5	0	0.13	0.12	0.17	0.31	0.12	0.14	0.05	0	0	0	0	1

Table 4.11 Weighted supermatrix (W_w)

	Goal	F1	F2	F3	F4	F5	F6	F7	A1	A2	A3	A4	A5
Goal	0	0	0	0	0	0	0	0	0	0	0	0	0
F1	0.15	0	0	0.13	0	0	0.08	0	0	0	0	0	0
F2	0.07	0.16	0.09	0.18	0.26	0.5	0.16	0.22	0	0	0	0	0
F3	0.54	0.16	0.16	0.1	0.24	0	0.15	0.28	0	0	0	0	0
F4	0.09	0	0.07	0	0	0	0	0	0	0	0	0	0
F5	0.06	0.1	0	0.1	0	0	0	0	0	0	0	0	0
F6	0.06	0.07	0.11	0	0	0	0	0	0	0	0	0	0
F7	0.03	0	0.07	0	0	0	0.12	0	0	0	0	0	0
A1	0	0.19	0.13	0.15	0.02	0.18	0.13	0.06	1	0	0	0	0
A2	0	0.15	0.12	0.13	0.02	0.18	0.21	0.06	0	1	0	0	0
A3	0	0.02	0.11	0.02	0.11	0.02	0.02	0.32	0	0	1	0	0
A4	0	0.08	0.09	0.11	0.19	0.06	0.08	0.03	0	0	0	1	0
A5	0	0.06	0.06	0.09	0.15	0.06	0.07	0.03	0	0	0	0	1

Table 4.12 Limiting supermatrix (W_L)

	Goal	F1	F2	F3	F4	F5	F6	F7	A1	A2	A3	A4	A5
Goal	0	0	0	0	0	0	0	0	0	0	0	0	0
F1	0	0	0	0	0	0	0	0	0	0	0	0	0
F2	0.01	0	0	0	0	0	0	0	0	0	0	0	0
F3	0	0	0	0	0	0	0	0	0	0	0	0	0
F4	0	0	0	0	0	0	0	0	0	0	0	0	0
F5	0	0	0	0	0	0	0	0	0	0	0	0	0
F6	0	0	0	0	0	0	0	0	0	0	0	0	0
F7	0	0	0	0	0	0	0	0	0	0	0	0	0
A1	**0.28**	0.33	0.26	0.3	0.16	0.3	0.26	0.2	1	0	0	0	0
A2	**0.25**	0.28	0.24	0.26	0.15	0.29	0.32	0.18	0	1	0	0	0
A3	**0.11**	0.08	0.19	0.08	0.18	0.12	0.11	0.39	0	0	1	0	0
A4	**0.19**	0.17	0.18	0.2	0.28	0.15	0.16	0.13	0	0	0	1	0
A5	**0.15**	0.13	0.13	0.15	0.22	0.13	0.13	0.1	0	0	0	0	1

Using the framework provided in Fig. 3.9, the group of students has primarily selected Reviews/Ratings (0.541371) as the most crucial attribute for selecting a course and, thus, the platform itself. The result is consistent with Chakraborty and Biswal (2022) viewpoint on the paramount importance of reviews compared with other informational factors when selecting e-learning platforms. University or instructor reputation (0.145224) is the second attribute that students consider before selecting the course. Rambe and Moeti (2016) highlight that academic elitism prevalent in top universities positively influences the learners' decision to enrol in a MOOC at the pretext of certain factors like perceived institutional greatness, influence and trustworthiness (Rekha et al., 2022). The price of a MOOC (0.09309) is the third important attribute, with little influencing power vested in it. It is worth noting that not all MOOCs are entirely financially free. Certain MOOCs which fall under the paid category tend to be much more scrutinized and evaluated before selection (Surya et al., 2021). Furthermore, the pricing affects the behavioural intention to use MOOCs among learners from different countries (Chaveesuk et al., 2022). It was unanticipated to find skills offered by the course (0.067573) ranking below the importance of the price of a MOOC. Students often look out for value addition and upskilling features before enrolment; either they seek knowledge addition or skill enhancement (Li et al., 2022), depending upon a combination of high-quality course material and instructor skills. Furthermore, it is well-researched that the duration of the course (0.063550) affects the completion rates of the MOOCs (Deng et al., 2020; Khalil & Wong, 2018) but in the present context it has minimal significance to the learner similar to the last two attributes i.e. assessment options (0.055162) and preview availability and trial (0.034030).

Students evaluated the preferences above for each platform and found that edX (0.2796) and Coursera (0.2547) were the two most favoured e-learning platforms. Furthermore, 19.28% of the students opted for the Udemy platform, followed by Udacity at 14.88%. It is crucial to note that SWAYAM is an indigenous e-learning platform backed by the reigning government but still stands last with a popularity rate of about 10.8%. Even with massive funding and policy support, the platform cannot attract the participation of most of the top management institutions in the country. The online courses from National Programme on Technology Enhanced Learning (NPTEL) also run on the SWAYAM platform, which caters to the undergraduate engineering domain only. The success of such collaboration is readily advocated on both e-learning platforms and serves as a support system for millions of undergraduate engineering students across the country (NPTEL, 2022). Thus, we believe that; being primarily driven by a couple of fields of education and limited collaboration with top universities and autonomous institutions within the country could be one of the reasons for the lowest popularity rate among other e-learning platforms.

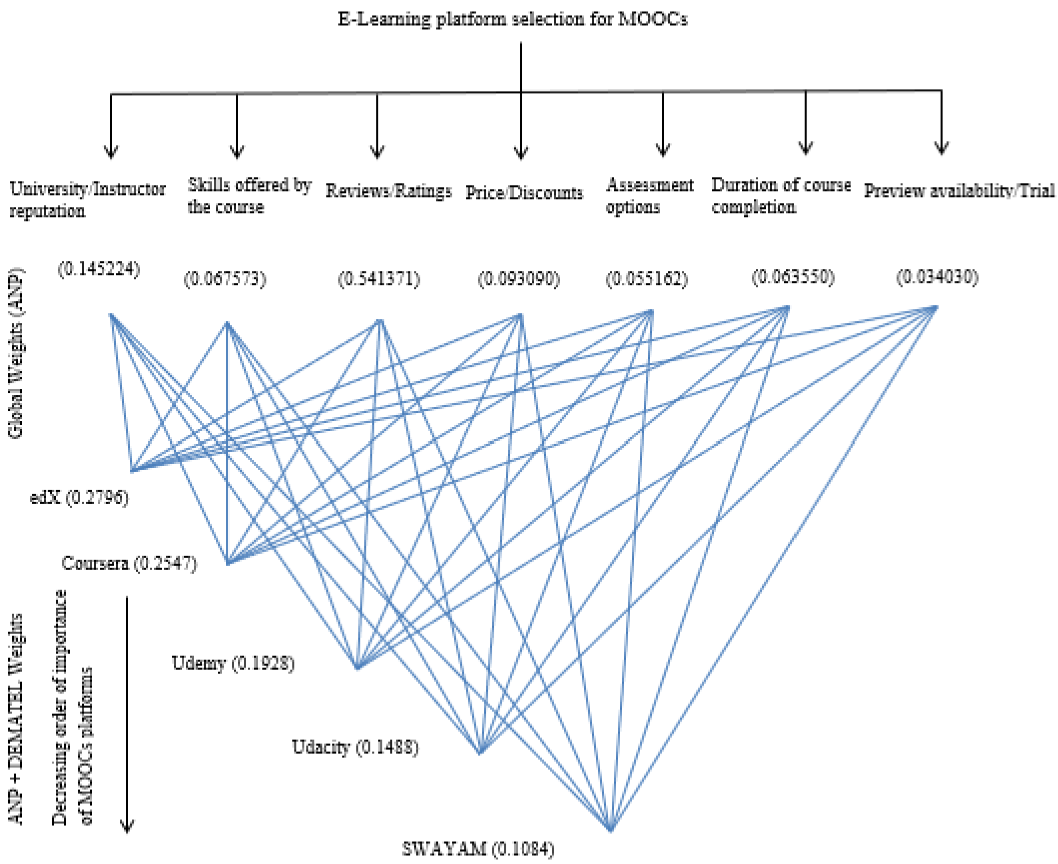

Fig. 4.2 Final model for MOOCs platform selection

4.4 Results Objective 4

4.4.1 **Model 1: Segmentation on the basis of holistic responses of students (n=40)**

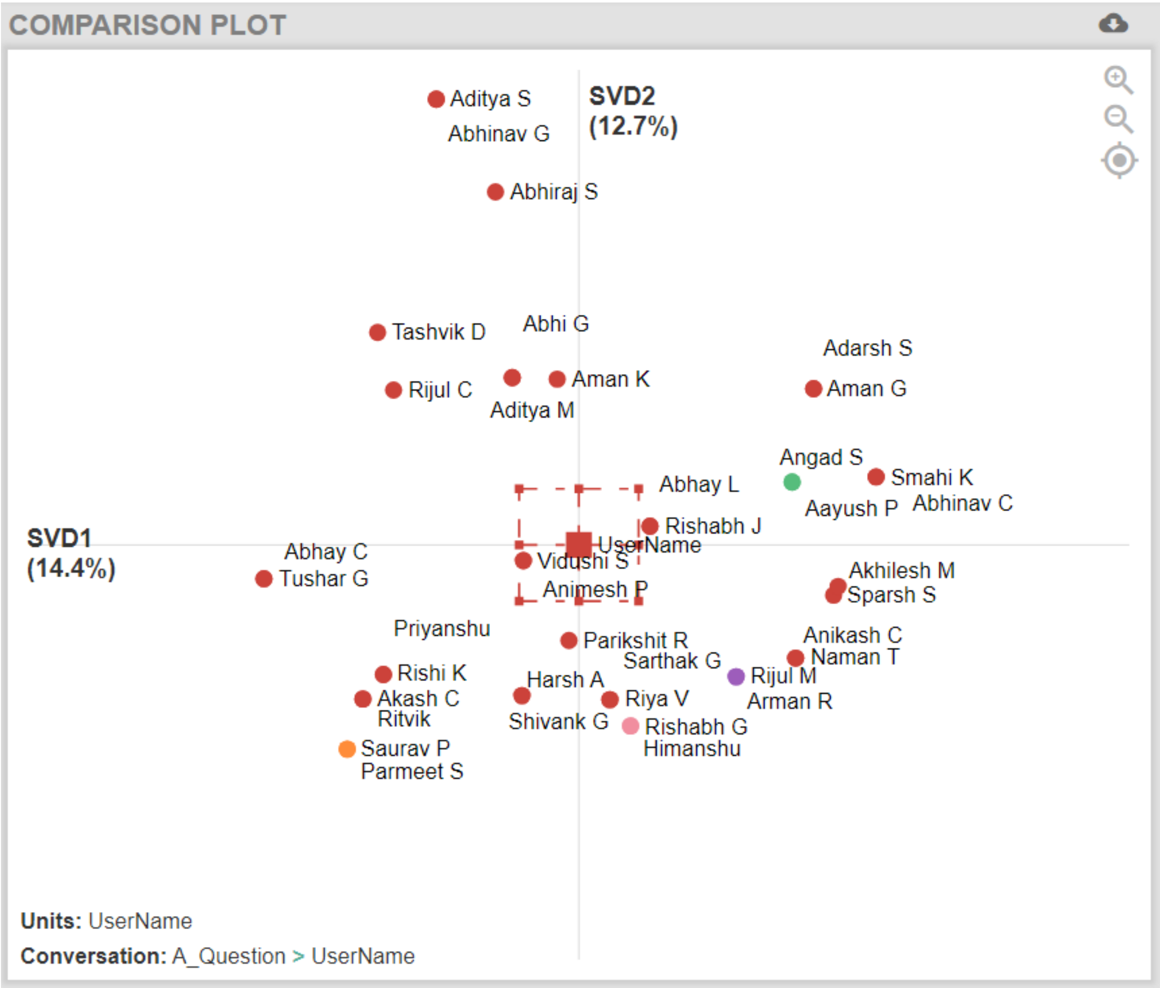

Fig. 4.3 Centroids of each student (n=40) projected in the epistemic space

The current model depicts collaborative network points (centroid dots) for 40 students in the epistemic frame. The ENA space in which the centroids are present is visualized by first and second dimensions i.e. (Statistical variance dimension, SVD, 1), which accounts for 14.4% of variance in the data on the x-axis and (SVD 2) for 12.7% on the y-axis. Further, it can be observed that some of the student centroids appear in groups (coloured for reference: yellow, pink, violet and green), which states that both of them have either similar or the same type of connections with respect to the questions asked in the interview. The mean of the model is at the centre, and the total connections for all the students can be seen by clicking on the square red block (UserName) as shown in Fig. 4.3.

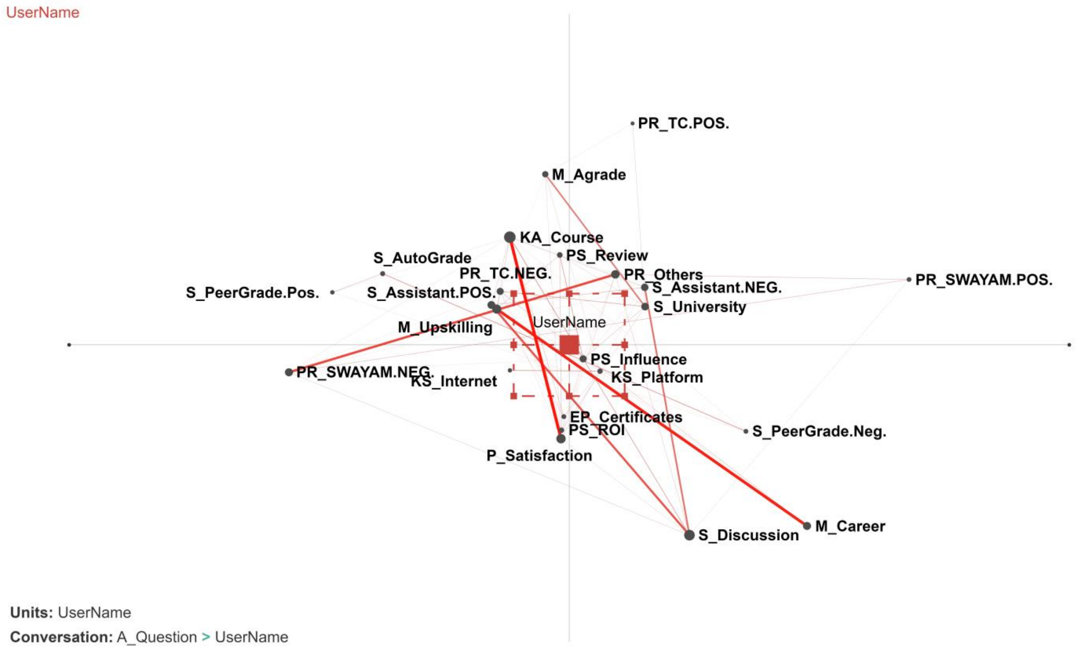

Fig. 4.4 Overall network connections of (n=40) students

The connections depicted in Fig. 4.4 represent the overall cumulative connections for 40 students i.e. the equiload network. The darker lines represent strong connections made between codes, and the thinner line represents connections that are weaker in nature with respect to other codes for example, PR_SWAYAM.Neg has a strong connection with PR_Others, which implies the fact that whenever a student commented on the negative features of the SWAYAM platform a comparison was also made with respect to the positive features of some other e-learning platforms such as NEPTEL or edX or Coursera etc. Example:

"Yes sir I did a course from SWAYAM-NPTEL portal from IIT Kharagpur. The problem with these courses is ***that they are outdated courses***. The way the professors on NPTEL course portray the information, sitting on screen and talking slowly, is quite monotonous and you need to pay more attention to them. If you ***compare SWAYAM***

to Coursera; Coursera has a lot of features for example the UI is better and student support system is better. There are no discussion forums on these courses also. On the other hand the best thing about these SWAYAM courses is that it gave me a chance to appear for a physical examination in order to get the certification. So certificates from NPTEL or SWAYAM have more value than all other online learning platforms. Also considering IITs as top tier colleges in India they can do a much better job."

"No sir ***I have not heard about SWAYAM but heard about NPTEL.*** I have explored some courses from YouTube but never taken a proper course. The knowledge base is good at NPTEL but the user experience on their website is not user ***friendly if compared to Udemy or Coursera. It is out dated.*** Their teaching is good the profiles of professors are good but that is not everything. There is no such checking of our assignments. MCQs are there but you can answer them in multiple attempts. Also, to earn a certificate, you need to give a physical exam which has its pros and cons. The online ecosystem is preferred because it saves a lot of travel time for NPTEL you need to pay some amount and be physically present at the centre to give exam. But this is the best way to test the knowledge and skills of a student. In this online system at university in past 2 years we have seen a very high rise in the grades of the students so you know what is happening in the background."

Similarly, it is also important to note that the connections that are thinner in the model for example, the relationship between EP_Certificate and KS_Platform, might not necessarily yield a meaningful co-occurrence of code or might be one of a relationship that other students do not reiterate:

"There is definitely ***a shortcut method to complete these certificates*** but early on I realized that when it comes to these online courses ***the certification does not matter***. If you have a skill then it is necessary to show them in a project form. Entering them in our CVs do not really help if you do not have the application of required knowledge and skill set. If you get an online certification on merit then only it might contribute to your CV not just by paying or auditing a course."

The relationship exists since it is a part of the same utterance by the student but it gives two unrelated observations which are individually exclusive in nature. On one hand shorter ways to complete a certification course and obtaining a certificate does not entail learning and addition of knowledge for a student and on the other there is no value of certifications in the CV of a student for recruitment purposes since, it is a matter of required knowledge and skill set.

Thus, the model could be interpreted for all the strong and weak connections.

4.4.2 **Model 2 Segmentation on the basis of individual units or User_Name**

In order to understand the process of connections among individual units i.e. students; ENA allows for individual mapping of connections for all 40 students. In order to achieve visualisation of this model, all usernames have been changed in order to maintain the anonymity of the student profiles and responses.

The individual mapping could be interpreted visually in two ways.

1) Each unit as a part of the equiload projection of all – In this visualisation, the model mentioned in Fig. 4.4. is taken as the base, representing the overall projection of co-occurrences for the data (equiload network). The relationship between UserName_Aayush P can be visualised in Fig. 4.5, Where the green connections represent the connections made by Aayush P concerning the overall network of connections. ENA allows us to compare multiple networks in this model and helps us deduce the similarities or differences in patterns of connections. Fig. 4.6, represents another network that has the same connections (S_Assistant.POS and S_Discussion; S_University and M_Agrade; KA_Course and P_Satisfaction) if we compare with connections of Aayush P.

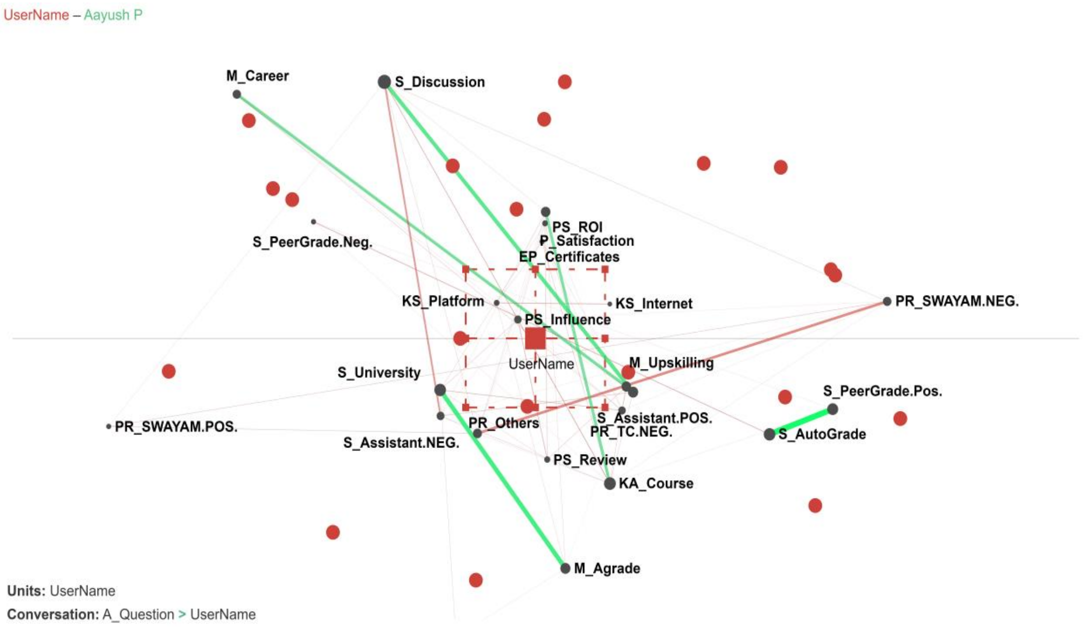

Fig. 4.5 Connections between Aayush P (Green) and the equiload network (Red) of the group

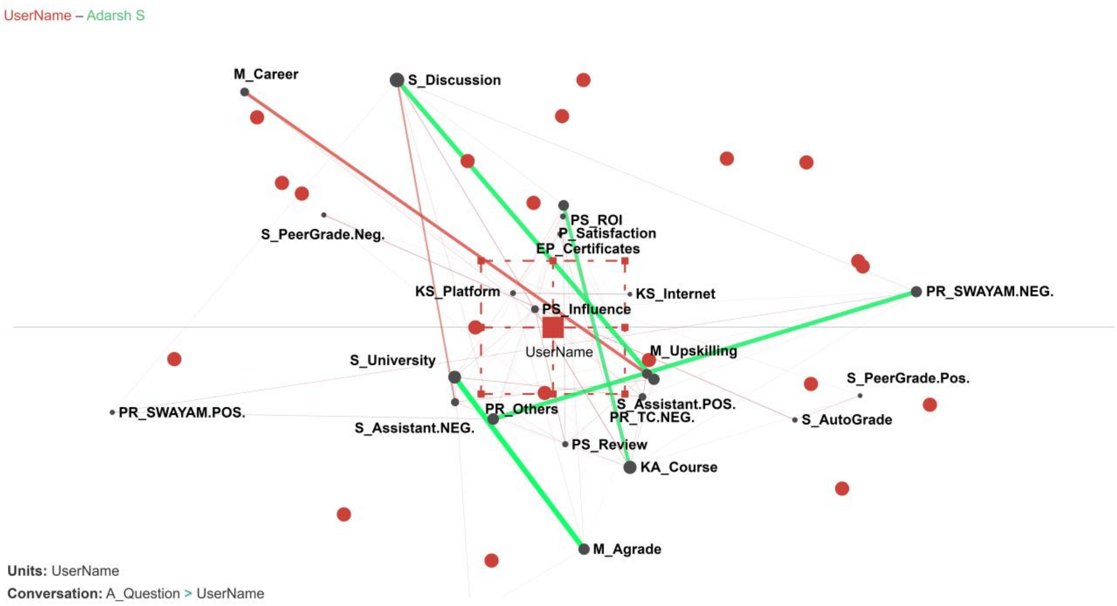

Fig. 4.6 Connections between Adarsh S (Green) and the equiload network (Red) of the group

We can see that the two students (from different engineering streams i.e. Auto and ECE) agree on majority of connections made and the interpretation of these connections is as follows:

- S_Assistant.POS and S_Discussion (Aayush P, Line 323, ECE)

"I ***think coursera's discussion forum is very good because not only the students are interacting over there but the teachers and TAs are also replying over the forums***. One time I was doing the assignment and there was a problem with the assignment I went over to the discussion forum and I realized that the teacher had already initiated the discussion over the same problem earlier. So there was a lot of interaction and the whole discussion helps you dissect the issue to its core. There was no need to search on Google or stackoverflows. Teachers, students ***and TAs were helping us out and the community is great. The response time in my case was very well from the instructor's side. Also lot of healthy discussion were happening on the platform I think more than asking problems students were discussing general issues.***"

- S_Assistant.POS and S_Discussion (Adarsh S, Line 341, Auto)

"***Sir on coursera it was fine since I did not communicate much on the discussion forum but in Udemy it was good experience. I had a lot of doubts and they were all cleared on Udemy within 2-4 hours or max to max 1 day***. On quick lab platform there is a limited access to the platform for a particular amount of time and you need to learn everything in that particular time frame so there doubt support during that time was not that free and there were long queues thus increasing the time gap. So if you want restricted access then one should look out for ways to shorten the queue. ***Students also used to comment and help in discussion forum. There were a lot of healthy discussion going on the platform which were quite long. They were centred mostly around work and did not deviate.***"

Explanation

The two conversations could be easily collated in the context that there was positive and timely support from the teaching assistants on the e-learning platforms which helped the students resolve queries in a timely order since, delay in response from the teaching assistants leads to lack of motivation and frustration among students while learning online. The availability of discussion forums is platform specific. Inefficient discussion forums can often lead to over load of information and multiple discussion threads leads to loss of information within a particular context. The forums on the platforms such as Udemy and Coursera were efficient for the above mentioned students but much detail could not be generalized from the data of only 2 students.

- S_University and M_Agrade (Ayush P, Line 463, ECE)

"***They encourage you to learn but do not necessarily mention about particular courses.*** There is a lot of content you should know but since it is not in the university curriculum they do not teach it. ***They do share material for you to learn more online***. I took two courses as MOOCs during the pandemic which were free from the university. Normally the courses on courser are a little expensive but the university had collaboration and we were getting them for free so I signed them up in my free time. The university should also collaborate with different online platforms and it will help out everyone. ***The 2 MOOC courses I did for credit transfer were taken with the intention of learning and not solely for the purpose of getting an A+ grade."***

- S_University and M_Agrade (Adarsh S, Line 461, Auto)

"***Sir they did not encouraged us to learn from online platforms as such since they sticked only to the curriculum. Thus it was a bit monotonous and we did not feel we are not gaining much knowledge because the teaching was not application based it was mainly bookish.*** To crack an interview we need proper guidance and motivation which was missing at the individual level. Some of the teachers are not easy going. ***The university support for providing us free courses during pandemic was really good. They should also collaborate with other platforms and come up with similar schemes. Also the credit transfer system of MOOCs in our university is flawed. Since, we all did the courses provided to us free of cost from the university and we all did similar courses and cheated ad copied assignments and got A+ grades. MOOC courses are easy to score and it saves time and it eases up the pressure in the semester."***

Explanation

When the students were asked about the perceived support of their university for MOOCs it is observed that there was support from the teachers and the university encouraging students to take on MOOCs but the negative perception of students regarding the quality of teaching and outdated curriculum clearly manifests itself in the conversation. Another flaw in the university system was highlighted with respect to the implementation of MOOCs for credit in the curriculum. Both the students agreed upon the fact that the intention for doing the MOOC course for credit was solely to get A+ grade since it was each to cheat in such courses and produce duplicate or false certificates in order to secure the grade. These statements required deeper probing and our study was able to get to the bottom of the issue in complied responses of 40 students.

2) The second method of interpretation is on the individual level basis for each student. However, this method will only make sense when we have small sample sizes or when individual perceptions matter more than collective ones. Not all student networks are similar in nature and some of them have extremely varied connections in the ENA space such as:

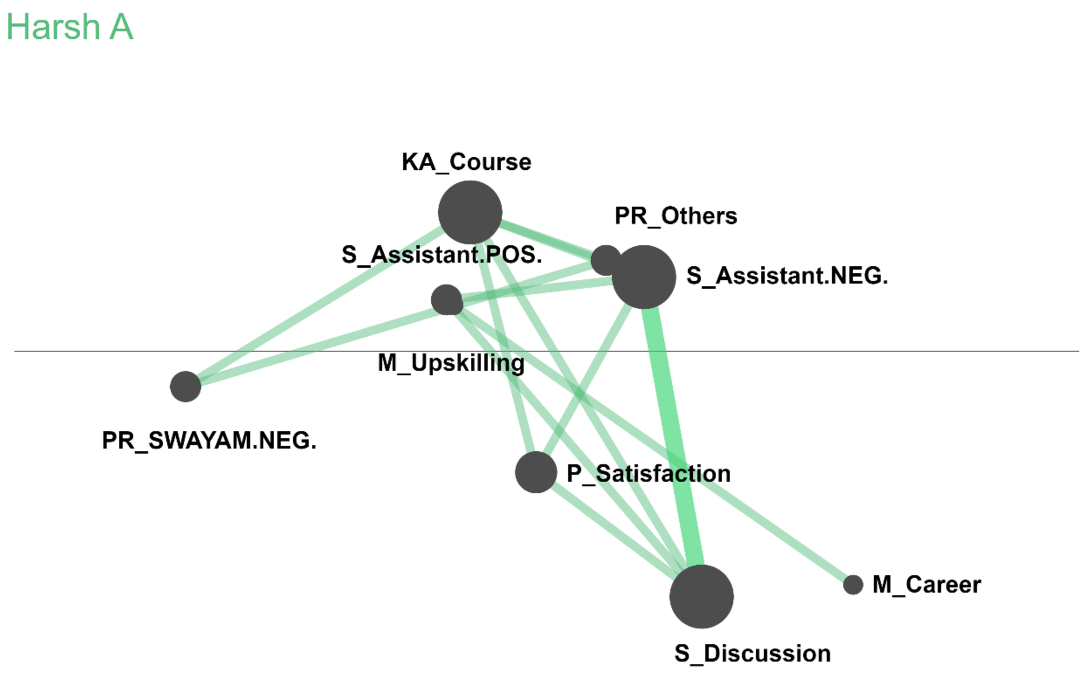

Fig. 4.7 Individual network of student

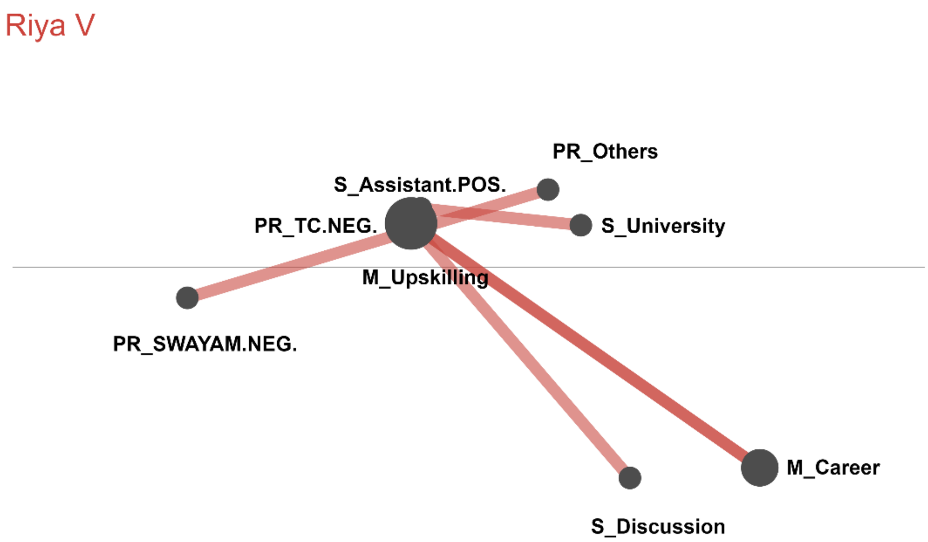

Fig. 4.8 Individual network of student

4.3.3 **Model 3 Group model of different engineering streams (Env, Auto, Mech, CS, ECE)**

In order to generate more interpretive power from the current data it is recommended to compare different groups of student networks namely belonging to (Env, Auto, Mech, CS and ECE) engineering streams.

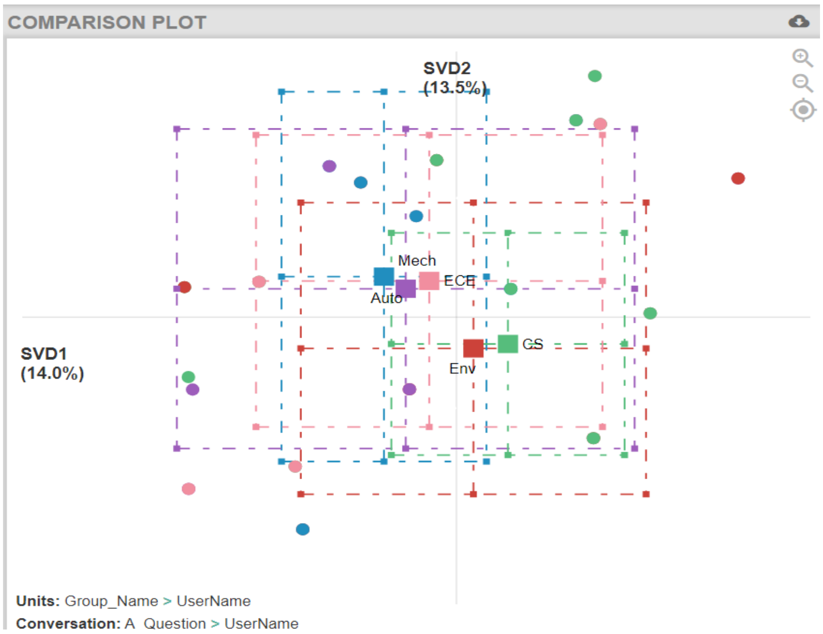

Fig. 4.9 Equiload projections for all groups of students (Env, Auto, Mech, CS and ECE)

The Fig. 4.9 shows a comparison plot for all the groups, with the unit of analysis segregated into Group_Name and then UserName. The colored dots represent the individual student networks belonging to the specific group. The ENA web Toolkit software calculates the statistical tests for comparing all groups.

Summary of T-tests comparisons (Env-Auto)

Along the X axis, a two sample t test assuming unequal variance showed **Env** (mean = 0.28, SD = 3.39, N = 8 **was not** statistically significantly different at the alpha =

0.05 level from **Auto** (mean = -1.19, SD = 1.36, N = 5; t(9.90) = 1.09, p = 0.30, Cohen's d = 0.52).

Along the Y axis, a two sample t test assuming unequal variance showed **Env** (mean = -0.57, SD = 3.18, N = 8 **was not** statistically significantly different at the alpha = 0.05 level from **Auto** (mean = 0.74, SD = 2.72, N = 5; t(9.72) = -0.79, p = 0.45, Cohen's d = 0.43).

Similar comparison was done for other groups as well and the results are tabulated in Table 4.13. It was found that **none of the groups differ** from each other statistically which implies the fact that there exists similarity in the connections made in between all the groups which displays the cohesiveness of the responses and the structure.

Table 4.13 Summary statistics for different groups

Relationship	Axis	Mean[a]	SD[a]	Mean[b]	SD[b]	t-value	p-value	Cohen's d
Env-Mech	x-axis	0.28	3.39	- 0.83	3.59	0.59	0.57	0.32
	y-axis	-0.57	3.18	0.52	2.78	0.68	0.51	0.36
Env-CS	x-axis	0.28	3.39	0.85	3.32	-0.38	0.71	0.17
	y-axis	-.057	3.18	-0.49	3.51	-0.06	0.96	0.02
Env-ECE	x-axis	0.28	3.39	-0.45	3.08	0.43	0.67	0.22
	y-axis	-0.57	3.18	0.66	2.88	0.79	0.45	0.40

4.3.4 Interpretation of major code associations

Qualitative triangulation of ENA Network Models is a key feature of ENA and gives the ability to trace connections in the model back to the original data 'the chats', in this case on which the connections are based. By clicking on the lines between codes we can easily go to all the utterances made in relation to those codes in the ENA software. This feature of ENA allows us to close the interpretive loop. We started with a dataset that was coded for student issues; we used the coded data to create and visualise network models of students based on the co-occurrence of frame elements;

then, if we want to understand the basis for any of the connections in the network models, we can return to the original utterances.

Chapter 5

Conclusion, Future Scope and Social Impact

The study began with understanding the students' perceptions about their own curriculum and an attempt was made to reveal the factors that were of sizeable importance to them. The paramount importance of student support and feedback services and curriculum structure and design (teaching pedagogy, content, framework and taxonomies) was highlighted. In order to understand the student perception and beliefs about the potential of MOOCs to fill the knowledge gaps both qualitative and qualitative measures were undertaken to study the phenomena. It was found that MOOCs could indeed fill the knowledge gaps arising due to low quality of teaching at the university level but a better approach at policy implementation is required. The study finds that the implementation of MOOCs for credit has failed on multiple fronts. The students have devised multiple immoral and cheating pathways for securing credit points and A+ grade for the MOOC unit in the syllabus. These pathways have been allowed to flourish since there is no cross-checking or formal examination to assess the knowledge gain from MOOCs. A culture of cheating and duplication of certificates does not add to the good practices and quality parameters for any university. Nonetheless students appreciated the university intent to provide free courses during COVID-19 but still remained unsatisfied with the engineering syllabus and level of teaching at the university. The study also finds that SWAYAM has an underlying and untapped potential to provide high quality MOOCs if it can venture into more practical and application based MOOCs rather than a reflection of university level education.

According to students the value of certificates obtained from MOOCs is inconsequential in the job market but, comparatively certificates obtained from SWAYAM platform are better as compared to the peer platforms. Students have multiple issues with online courses and in order to improve the experience of online learning it is important to understand these issues in depth. The current study has explored the interrelationships between such issues which cause larger problems in the e-learning environment (student dropouts, lack of motivation etc.). It was found that all the issues interact and influence each other in different ways which requires further probing in research regarding the degree of influence and change in behavior under different circumstances. It is believed that MOOCs do have the potential to fill in the knowledge gaps and produce skilled individuals for the market. Since policy-making and implementation take time, it is advised that higher education institutions that lack in quality of teaching and learning must guide their students and take advantage of the online learning environment whilst continuing to improve on the in-house quality parameters.

5.1 Implications and Recommendations

For Universities

The study highlights the importance of students' perception while developing an inclusive curriculum. They have highlighted curriculum structure and design and student support services with feedback as the most crucial aspects of curriculum development. Our recommendations are aimed at the committee which is responsible for the curriculum development process and at the administrative council which influences policy making at the highest level. Invoking students' interests and acknowledging their voices will help add more value and support in their decision-making capabilities. They will further feel more attached towards their institution and a positive sense of belonging will keep them motivated rejecting any nuances underlying unequal distribution of power in policy making. It is evident from our research that MOOCs help students develop extra knowledge and required skill set to become job ready bu, the universities must enhance their role in the form of more support from multiple MOOCs offering platforms (paid platforms) via collaboration. As highlighted from the results the credit system for MOOCs is deeply flawed at the university level. Students fake and cheat the certificates and there is no cross checking from the university side. This form of practice must not be allowed and cross checking must be involved since it does not add to the benefit of the students and the university intention of providing MOOCs for credit becomes a failure in policy implementation (with respect to new education policy 2020). Further, it is also recommended that universities must ensure appropriate technology and infrastructure support to be provided for creation of MOOCs at a level which matches the top players in the field (i.e. increase in funding is required). For the engineering domain MOOCs on SWAYAM platform consist of mainly theoretical and conceptual knowledge based classroom recorded videos. Application based MOOCs for engineering students are required to fill the knowledge and skill gap at the university level. Creating online content is hard and to keep your viewers engaged takes a lot of effort from the creators. Thus, faculty training for content creation is required at the university level. A balance is required where on the one hand knowledge and certain skills from MOOCs crucial for employment could be inculcated more effectively into the curriculum whilst training teachers for improving content and quality of teaching for MOOCs.

For e-learning platform SWAYAM

The results from our study indicate that SWAYAM platform is the least opted for students while learning through a self-directed and self-paced method. The government run platform is criticised on multiple fronts of teaching pedagogy, user interface and support from the platform. It is crucial to note that SWAYAM is an indigenous e-learning platform backed by government funding but still stands last with a popularity rate of about 10.8%. Thus, the study highlights that structural issues and inefficient policy implementation are the primary reasons for such low popularity rates. Since, it a matter of perception where students are highly likely to compare features of different e-learning platforms it is recommended for the SWAYAM platform to look at the shortcomings with respect to global e-learning platforms such as edX, Coursera and Udemy etc. Discussion forum for students and support from teaching assistants or faculty is a must for all courses on SWAYAM to improve the overall experience of doing a MOOC from the platform. MOOCs on the platform cater primarily to engineering and management students and other fields lack in content thus, it is recommended to incentivize the content creators for the platform via collaboration with universities.

Theoretical contribution

The study used an ‘e-quality framework’ along with some anticipated factors from the literature to understand more about student issues with MOOCs in a formal higher education system. The current study proposes a model which can be used to comprehend interrelations between student issues which cause deeper problems in the online learning system such a massive drop-out rates, lack of motivation to complete the course etc. This form of causal model which explains not only the direct but relationship between transitive links will serve as an addition to the existing literature on MOOCs. This model is subject to further scrutiny in multiple settings of undergraduate and postgraduate education and should also be studied to calculate the degree of effect of one issue over the other. The strength of relationships must be studied further to garner more profound insights into the student issues with MOOCs and online learning systems.

5.2 Limitations of the study and future scope of work

1. Due to the onset of COVID-19, the data collected for the study was conducted in a limited number of government-funded public universities only. The sample for such exploration could be increased in future work to gauge a deeper understanding of the effects of policy implementation.

2. The study is primarily based on students' perceptions as major stakeholders. It is recommended to include the voices of all other stakeholders in education to garner a holistic image of the challenges in the e-learning system in India.

3. Geographical limitations were a significant challenge for the study. Further research work should explore the effects of such national-level policy implementation in a variety of higher education institutions.

4. Our proposed framework in the study is subject to further exploration by methods such as structural equational modelling to discern the degree of influence of one factor over another.

5. The proposed framework is from the perspective of undergraduate students in the engineering domain only. The interpretations and perceptions of students from other higher education domains will yield more profound results on the problem.

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APPENDICES

Appendix-1

Sample size and justification used in the study

S.No.	Objective	Sample Size	Sampling Technique	Reason	Sample
1	To examine the factors affecting higher education curriculum development from a primary stakeholder, i.e. students' perspective.	40	Purposive Sampling	4^{th} year engineering students were selected because they had the most experience with university systems and processes	Public University
2	To examine the issues of students with MOOCs and analyse the relationships between these issues.	149	Purposive Sampling	3^{rd} year engineering students were selected because by this year, students have completed their for-credit MOOC at the university	Public University
3	To analyse the rational way of selecting an e-learning platform for MOOCs.	68	Purposive Sampling	2^{nd} year engineering students were selected because they are new into the system and only those students were selected who had little to no experience with formal MOOC	Public University

				offering platforms.	
4	To understand students' perceptions about the role of MOOCs in addressing the knowledge gap and employability issues of students.	40	Purposive Sampling and Snowball Sampling	3rd Year Engineering students were selected because of their experience with the university for credit programme for MOOCs.	DTU, NSUT and IP students

Appendix-II

Hierarchical partitioning of reachability matrix for MOOCs issues

Student issues	Reachability set	Antecedent set	Intersection set	Level
Iteration-1				
1	1,4,5,6,7,8,9	1	1	
2	2,5,7,8,9	2	2	
3	3,4,5,6,7,8,9	3,4,5	3,4,5	
4	3,4,5,6,7,8,9	1,3,4,5	3,4,5	
5	3,4,5,6,7,8,9	1,2,3,4,5	3,4,5	
6	6,7,8,9	1,3,4,5,6,7,9	6,7,9	
7	6,7,8,9	1,2,3,4,5,6,7,8,9	6,7,8,9	I
8	7,8,9	1,2,3,4,5,6,7,8,9	7,8,9	
9	6,7,8,9	1,2,3,4,5,6,7,8,9	6,7,8,9	I
Iteration-2				
1	1,4,5	1	1	
2	2,5	2	2	
3	3,4,5	3,4,5	3,4,5	II
4	3,4,5	1,3,4,5	3,4,5	II
5	3,4,5	1,2,3,4,5	3,4,5	II
Iteration-3				
1	1	1	1	III
2	2	2	2	III

Appendix-III

Coding book for Epistemic Network Analysis

S.No.	Parent Code	Code	Meaning
1	Motivation	M_Upskilling	The motivation behind doing online courses is to increase in knowledge and upskill students.
2		M_Career	The motivation behind doing online courses is career progression and better job prospects
3	Platform Selection	PS_ROI	The reason for selecting the e-learning platform is the return on investment; no fees course
4		PS_Reviews	The reason for selecting the e-learning platform is platform reviews or course reviews or instructor reviews
5		PS_Influence	The reason for selecting the e-learning platform is peer influence
6	Knowledge Shortcuts	KS_Internet	Shortcuts in completing courses via Internet websites such as GitHub or other similar platforms
7		KS_Platform	Shortcuts in completing courses and obtaining certificates via loopholes in the e-learning platform
8	Platform Support	S_Assistant (POS)	Support was provided for doubts in the form of teaching assistants availability in a positive scenario
9		S_Assistant (NEG)	Support was provided not for doubts in the form of teaching assistants, or if provided, it was a delayed response
10		S_Discussion	Support was provided for doubts via open discussions on the discussion forum on the platform for stimulating knowledge creation
11		S_AutoGrade	Support for assessment checking via autonomous grading depending upon the platform
12		S_PeerGrade	Support for assessment checking via peer grading depending upon the platform

13	Barrier	B_Language	Any form of Language barrier while doing an online course
14		B_Technology	Any form of Technology barrier from the platform while doing an online course
15	Employability Perspective	EP_Certificate	Employability perspective of e-learning certificate obtained after the course
16	Perception	PR_SWAYAM(POS)	Positive Perception about the government-run e-learning platform SWAYAM
17		PR_SWAYAM(NEG)	Negative Perception about the government-run e-learning platform SWAYAM
18		PR_Others	Perception about other private platforms in comparison to SWAYAM
19		KA_Course	Perceived Knowledge addition and feeling of upskilling after the course
20		P_Satisfaction	Overall perceived satisfaction after doing online courses
21	University Support	S_University	Support from the university for doing MOOCs
22		PR_TC(POS)	Perceived positive value of teaching and teacher competency and current curriculum for students in class
23		PR_TC(NEG)	Perceived negative value of teaching and teacher competency and current curriculum for students in class

List of Publications

1. Khera, S. N., & Pawar, H. (2021). Understanding students' perceptions on factors involved in higher education curriculum development: An analytical hierarchy process approach. *International Journal of Management in Education*, *15*(2), 155–178. doi:10.1504/ijmie.2021.10035022 (**SCOPUS 1.6**)

2. Khera, S. N., & Pawar, H. (2024). Modelling student issues with MOOCs using TISM-P linkages. In *Higher Education Quarterly*. Wiley. https://doi.org/10.1111/hequ.12515 (**ESCI, Impact Factor 2.8, SCOPUS 4.5**)

3. Khera, S. N., & Pawar, H. (2025). To choose or not to choose? Decision making while selecting platforms for MOOCs: a hybrid MADM approach. *Open Learning: The Journal of Open, Distance and e-Learning*, 1–20. https://doi.org/10.1080/02680513.2025.2467032 (**ESCI, Impact Factor 3.2, SCOPUS 10.0**)

List of International Conferences

1. Presented research paper titled 'Modelling student issues with MOOCs using TISM-P linkages' and '**won second best paper award'** at the conference SFME - 2022, in collaboration with Arizona State University at the Department of Management Studies, IIT Roorkee.

2. Presented research paper titled 'Frugal Innovation in Higher Education: A Massive Open Online Courses perspective' at the International conference on sustainability, governance, and responsibility held on 23rd and 24th January 2020 at Vivekananda Institute of Professional Studies (VIPS).

3. Presented research paper titled 'Understanding students' perceptions on factors involved in higher education curriculum development: An analytical hierarchy process (AHP) approach' at the 1st International Conference on Business and Management held on March 29th and 30th, 2019 at Delhi School of Management, Delhi Technological University.