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Industry 4.0 and Higher Education: An Evaluation of Barriers Affecting Master's in Business Administration Enrolments Using a Grey Incidence Analysis

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ABSTRACT Higher education confers numerous benefits both to the individual and to society, including higher earnings, lower rates of unemployment and government dependency, an increased tax base, and greater civic engagement. Access to higher education remains a challenge for many families. The emergence of Industry 4.0 will not only affect technological changes but also people in the labour market. As such, higher education institutions with academic responsibilities of formally training students to better adapt to such changes are not left out. Since the introduction of the Master of Business Administration (MBA) in the United States of America in 1908 and over one hundred years of history, this prestigious programme has suffered a rapid decline in enrolments worldwide. Thus, it has gradually lost its value under the current industrial revolution. This paper evaluates and prioritizes barriers affecting the decline in international MBA enrolments. Understanding the key barriers to MBA enrolments regarding the dynamics will contribute to the successful implementation of those barriers. With scarce information, this study innovatively applies the grey incidence analysis (GIA) method to prioritizing the identified barriers. When applied, this method provided a robust prediction of results. For international MBA enrolments decline, the barrier ''employment difficulties'' (H3) should receive much attention from policymakers because it scored the highest among the barriers ranked. Further, other important barriers that should be considered are ''lack of entrepreneurship skills'' (H11), ''high cost'' (H10), ''longer payback duration'' (H1), ''10 yr. ROI'' (H9), and ''lack of data analytic skills'' (H7). Therefore, during the formulation and implementation of policy to address these prioritized barriers, scarce resources must be committed to them. This paper also contributes to the literature a first-hand, formal study on the prioritization of barriers to international MBA enrolments.

INDEX TERMS Grey incidence analysis, higher education, MBA enrolment, MBA barriers prioritization.

I. INTRODUCTION

Research has shown that the inception of the Fourth Industrial Revolution (Industry 4.0), which is characterized by the internet of things (IoT), internet of service, cyber-physical systems, big data, smart systems and analytics, artificial intelligence (AI), and robotics and cloud manufacturing, has had an unprecedented global impact across all industries [1]. Unlike the previous three industrial revolutions (Industry 1.0, Industry 2.0, and Industry 3.0) [2], although the synergistic effect of this recent industrialization is not limited to traditional manufacturing or production industries, it is limited to higher education institutions and human workers [3], and high levels of knowledge and competence are required [4]. However, research has focused on global industrialization trends that correspond to higher educational institutions, and a major stakeholder responsible for knowledge production is insufficient.

About Industry 4.0, the human-based workforce is tasked with exhibiting certain skills, irrespective of the field of specialty. The skills include critical thinking, creativity, data analytics, and problem-solving. As a result of this dynamic

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shift, the challenges in academia to address these gaps are perceptible. Academia is engrossed in revamping its educational curriculum to incorporate and reflect on new technologies, concepts, and paradigms. Recent studies have shown that Master of Business Administration (MBA) enrolment is declining with a double-digit percentage drop. In 2018, the top-ten business schools combined saw an average drop in the number of MBA applications of about 3,400, which is a 5.9% reduction in candidates from 57,311 in 2017 to 53,907. The Michigan Ross School experienced the worst drop, with an 8.5% decline from 3,485 to 3,188 applications. Harvard experienced a 4.5% decline in applications, the Haas School of Business at the University of California at Berkeley experienced a 7.5% decline, Wharton saw a 6.7% decline, and Stanford saw a 4.6% decline. Yale lost nearly 591 applications in one year, and a recent report showed that the MIT Sloan School saw a 6.5% decline in applications for 2018–2019 [5] with many reasons given for this decline, such as its high cost versus return on investment (ROI) and the shortfall of analytics in curricula [6].

Regarding international MBA enrolment, the University of Pennsylvania's Wharton School saw a fall in its 2019 intake to 5,905, which is down 5.4% from 2018 and 11.8% overall. It also has a correspondingly lower international student intake of 30% over the same period. However, many unanswered questions remain, such as the following: how do we address these gaps? What are the barriers? How do we prioritize these barriers under resource scarcity? How do we account for decision uncertainties and limited information? Higher education is a right, and millions of children today are not receiving this right.

To better understand why so many children are missing out on their right to quality education will require a better understanding of the complexity of the barriers hindering children's access to and completion of higher education. Analysis of the obstacles, constraints, and barriers faced by children who are out of school and not receiving an education helps build a better understanding of the issue and its complexity. When addressing these questions, this paper identifies the barriers to MBA international enrolment and adopts the grey incidence analysis (GIA) method as the most suitable and robust method to prioritize these barriers for strategic decision-making.

The grey systems theory was first introduced in 1980 by Julong Deng [7]. For a decision-making system in a heterogeneous environment in which data is uncertain, insufficient, unquantifiable, and incomplete, grey systems theory is a modelling phenomenon that takes advantage of such problems [8]. Many decision-making methods have been employed to account for uncertainties and vagueness in decision judgement, such as the fuzzy theory of Zadeh, stochastic programming of Sengupta, and the grey theory of Deng [9]. Other applications focus on a hybrid of two or more methods. Recently, a two-step fuzzy approach was proposed according to Addae *et al.* (2019) to prioritize the barriers as a multi-criteria decision-making tool. However, the scholarly research attempting to distinguish between the grey systems and fuzzy theories demonstrates that the grey systems theory can deal with a small data sample size, and the latter is sub-divided into the following four major applicable areas: GIA, grey cluster, grey decision-making, and grey prediction [8].

With a system analysis functionality [10], the GIA is a robust method that analyses relationships between the characteristic index and observation index because it takes into account the degree of relevance of the factors in an evaluation system. It works on the principle that the closeness of a relationship is judged depending on the degree of relevance according to similarities in the geometrical patterns of sequence curves [11]; for example, the more similar the curve, the higher the degree of closeness [8]. The key motivation of this research is as follows:

- This research has adopted the GIA method in higher education because GIA gained popularity based on findings made according to [12].
- To the best of the authors' knowledge, concerning the prioritization of the barriers to international MBA enrolment using the GIA method, no such formal contribution has been found. However, in other fields, GIA has been employed in classification and ranking studies [13].
- This study further recommends the policy recommendation for improving the enrolment in higher education by reducing the barriers.

The remainder of the paper is organized as follows: Section 2 highlights the background to Industry 4.0 and higher education; Section 3 identifies the barriers to MBA enrolment; Section 4 prioritizes the barrier to enrolment using the GIA method; Section 5 presents the calculated results and analysis; and Sections 6 and 7 provide the discussion and conclusion, respectively.

II. BACKGROUND

A. INDUSTRY 4.0

Industry 4.0 relates to various contemporary concepts, including IoT, big data, smart factories, interconnected supply chains, corporate social responsibility, and human needs adaptation, among others [14]. It concerns businesses using automation and data exchange in the manufacturing of service processes and technologies, such as cloud computing and the IoT. Changes in market demand and emerging technological possibilities for future manufacturing activities are among the major drivers of Industry 4.0 [15].

Many countries are now entering the phase of Industry 4.0 in which the interconnections of smart machines and intelligent robots are generating big volumes of indispensable data. Big data technologies and initiatives are emerging to analyse and exploit this data to improve strategic decision-making processes [16]. Hence, the use of data analytics by companies is increasing every year. In addition to furthering industrial development using technological development, this change is possible with Education 4.0, which can improve industrial development [17]. Introducing the

teaching factory concept will improve Industry 4.0's growth and development [18].

Fundamentally, the main objective of Industry 4.0 is to fortify and expand the long-term competitiveness of organizations by increasing the flexibility and efficiency of production through communication, information, and intelligence [19]. Additionally, it encourages sustainability with value chain processes of organizations using sustainable approaches, such as smart sources of energy, to promote being environmentally sustainable [20]. Various researchers have observed and analysed evolving business models in Industry 4.0 that are widely driven by smart data when designing new products and services [21], and they have discussed the complexity and value of Industry 4.0. Industry 4.0 offers opportunities for sustainable development across the world, such as energy and supply chain sustainability [22]. It is no wonder that the beginning of Industry 4.0 is considered the focal point for innovation and growth in the digital economy. However, it has brought fast and significant challenges, and organizations that cannot deliver smart solutions to customers will be left behind. To leverage all the new innovative technologies, organizations must rethink and reshape their business processes and skills.

The literature confirms that skills and job profiles are one of the most crucial challenges [23]. There is an essential need to develop skills in preparation for the requirements of the future. The literature highlighted not only the necessary consolidation of existing skills in professional profiles but also the unavoidable creation of new ones to successfully manage digitalization trends [24]. If Industry 4.0 is to become the standard in production, it will be necessary not only to select the profiles of those who have the expertise to work in such an environment but also to better understand and implement the skills that will satisfy the demand of the future workforce. There is limited understanding in the literature regarding the skills required to work in Industry 4.0, particularly from the perspective of the industry and its management. Previous work on professional skills related to Industry 4.0 is oriented towards personality profiles for recruitment purposes rather than skills that can be developed in education.

B. INDUSTRY 4.0 AND HIGHER EDUCATION

Based on the literature, higher education is considered one of the key drivers of growth performance, prosperity, and competitiveness in national and global economies [25]. Through university-industry connections, the creation of a quality workforce, the boosting of innovation, the upskilling of existing workforces, and an increase in employability, higher education can increase skills in the knowledge-based economy of Industry 4.0 [26]. The link between education and society is often considered one-way because education is expected to adjust to the economic and political trends rather than oppose them and stand for something different [27]. MBA studies need to be improved to cover the latest changes brought by the demands of Industry 4.0. Improved technology and innovations are key requirements for an improved curriculum of MBA programs to reduce barriers to education.

Industry 4.0 requires managers, engineers, technicians, and workers with abilities and competencies in the following key enabling technologies (KET): big data, cloud computing, IoT, 3D printing, augmented reality, simulations, etc. [28]. However, the skills provided by the current academic curricula of higher education degrees do not satisfy the current demand of Industry 4.0 [29]. The higher education system must provide the industry with graduates who have skills and competencies that meet the requirements and needs of an era in which many things are interconnected and automated [30]. For instance, the main goal of higher education is to ensure the quality of learning via teaching. The purpose is to enable the students and human capital in general, to update and shape their knowledge through research and development and sustain the improvement of societies through service.

Over the last couple of decades, many researchers have highlighted and analysed the efforts and the evolution of higher education through different phases [31]. The privatization of higher education institutions to the internationalization of both students and staff has moved towards international partnerships and cooperation [32]. Nowadays, rapid technological advancement influences how the higher education sector approaches teaching, research, and innovation [27]. The fast revolution in innovation has delivered another model of education [34]. Technology is replacing both physical classes and the teaching and training techniques used in classes. There is a plethora of literature on how teaching methods are changing. Institutions are adopting smart classrooms and embracing online training [35]. One of the largest limitations of higher education is its inability to quickly adapt to the dynamic labour market demands during this era of innovative and rapidly progressive technology [36]. The education system risks failing to conform to the job market's requirements. This risk represents a threat of not being able to supply governments, businesses, and individuals with the indispensable skills that would efficiently bridge the gap between the higher education curricula and the demands of Industry 4.0.

Therefore, higher education is obligated to provide firms with analytically skilled and intelligent individuals who are flexible, innovative, and creative. Subsequently, there is an urgent need to reinvent the higher education curricula to produce students with higher technological skills and competencies that fit into Industry 4.0's working environment [37].

III. BARRIERS IMPEDING INTERNATIONAL MBA ENROLLMENTS

As part of the research contributions of this study, we conducted a literature review on the barriers to MBA enrolment. To the best of the authors' knowledge, studies on the barriers to MBA enrolment are not explicitly available in the literature and are scarce. In an attempt to bridge this gap, the literature on MBA studies was reviewed, and individual barriers were assembled and re-organized. The MBA originates in the

United States and can be dated back to the 20th century [38]. The Industrial Revolution began a corresponding evolution of skilled labour to manage the diverse capacities of machine production rather than manual production. This prompted the adoption of more effective management techniques that combined science and business practices [39]. Since the inception of the MBA programme by Harvard University in 1908, the programme has been subjected to constant discussion to adapt it to society's changing needs. In the 21st century, which has been characterized by the third and fourth industrial revolutions, the traditional MBA has experienced many challenges [40].

An MBA has been praised and touted as one of the best business school programs that provide thorough management training; however, recent criticism has resulted in a loss of interest. Several barriers have been attributed to this recent development, such as employability (H1), skills, the cost (H3) involved in pursuing such a program, the payback (H4) period, and the overall ability to lead a business [37]. Concerning ROI (H5), Grove and Hussey (2014) investigated ROI in MBAs to conclude the effect of the quality of earnings and non-monetary outcomes, such as managerial expectations, self-assessment skills, and satisfaction. However, the monetary expectations of investment in pursuing an MBA degree have always been a major reason for MBA enrolment. Higher education shapes globalization with the deployment of technology.

Consequently, with the outburst of internet computer technology, data analytics is highly sought after by most employers due to its necessity in the job market. Recently, especially with Industry 4.0, data analytics (H6) is increasingly becoming a skill that should be taught as part of the curriculum, and many higher institutions have moved to implement this. As MBAs are an integral part of higher education, this need has become a significant discussion point [41], thereby becoming the main reason for the decline in MBA programme enrolment. The contributions of MBA studies to managers and their applications in the job market have been criticized, especially the relevance of an MBA curriculum and the transfer of knowledge and creativity (H7) skills in meeting the job market's current requirements [42]. In the era of Industry 4.0, graduates with creative skills and the ability to deal with the constantly changing job market are highly sought after by managers. With the traditional MBA curriculum still being taught in schools, modernizing the MBA to meet this criterion is in the discussion.

One of the most well-known factors that influence MBA enrolment in higher institutions is the availability of jobs in the job market and employment (H1), which influence the capacities of graduates. Research has been carried out by institutions such as Forbes Magazine into what accounts for the recent drop in MBA enrolment in higher institutions. The MBA markets operate according to the job market's (H8) supply and demand [43]. We speculated that Industry 4.0, which is characterized by explosive IoT and data analyses, demands special skills that the MBA programme does not currently have in its curriculum. Despite the industrial revolutions, MBA students are still being taught the same way as they were in the 20th century, with few adaptations to the current changes. Even though many higher education institutions have made significant changes to their MBA curriculum, these changes are mostly experimental and have experienced both success and failure. Consequently, adapting to Industry 4.0 (H10) has been a challenge.

Leadership is an important foundation course in most business-related programs, such as an MBA, and it is often included in business programs that are rolled out at higher education institutions. Additionally, leadership is important for organizational growth to successfully improve and promote goods and services through innovation [44]. Accordingly, the paradigm shift towards Industry 4.0 requires managers and employees to exhibit adaptable leadership (H11) characteristics to augment the gap created by the so-called Industry 4.0. The challenge lies in whether an MBA is capable of meeting such demands. Several of our respondents in our research argued that this is not the case, which suggests that this challenge contributes to the MBA losing its value in the job market.

This paper attempts to contribute to the following areas and assist policymakers in addressing the barriers to MBA enrolment:

1. This paper studies the barriers to MBA international enrolment. Understanding key barriers to MBA enrolment regarding the dynamics that the industrial revolution has placed on higher education will contribute to the successful implementation of MBAs.
2. Moreover, this paper is novel in that it prioritizes the barriers to international MBA enrolment by applying the GIA method. Although much has been suggested about the decline of MBA enrolment, no formal contributions towards prioritizing these barriers as reasons for such a decline have been made. This paper addresses this gap.
3. In addition, this paper investigates the nexus between Industry 4.0, higher education, and the application of the GIA.

A summary of the research process is presented in Figure 1 below. It is broken down into further details in the subsequent sections of this paper.

IV. METHODOLOGY

To quantify the decision-making and identify barriers, we selected GIA because it calculates the closeness of a relationship, which is judged based on the similarity level of the geometric patterns of sequence curves. The more similar the curves are, the higher the degree of incidence between sequences, and vice versa.

Methods such as regression analysis, variance analysis, and main component analysis are the most common analyses for systems analysis regarding identifying the various factors that influence a system's behaviour. However, one

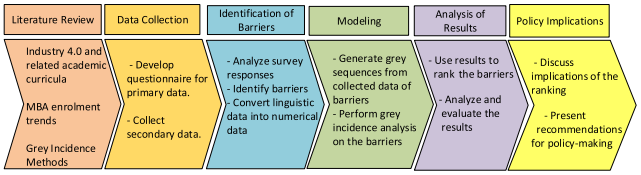

FIGURE 1. Research framework.

of the main limitations of such analyses is that they require large sample sizes to provide reliable conclusions, whereas GIA can process relatively smaller sample sizes while still yielding accurate results.

A. DATA COLLECTION

In this study, both primary and secondary data were collected and analysed. Based on the premise that global applications to MBA programmes have seen a downward trend, this study used secondary data from the 2019 Application Trends Survey of the Graduate Management Admission Council (GMACTM). The 2019 survey by Global Management Admission Council (GMAC) collected data on graduate business school applications for the 2019-2020 academic year. Responses to the survey were provided by 1,145 programmes at 336 business schools globally. Participating programmes were located in 40 countries as well as 39 US states and the District of Columbia. The total sample included 572 MBA programmes, 549 business master's programmes, seven postgraduate programmes (PGP), and 17 doctoral programs.

B. MODELLING

This study employs a set of GIA models to carry out the evaluation and prioritization of factors thought to be barriers affecting MBA enrolment rates. GIA models form a part of the grey system theory framework. Grey system theory was proposed by Professor Julong Deng in 1982 to solve uncertainty problems in systems usually characterized by lack of complete data. As a result, it even works very well with smaller data samples when compared with other conventional methods for uncertainty. Since its inception, GIA has been successfully applied in several fields, such as product development [45], education [46], sales [47], and logistics management [10]. For instance, in any of the above areas of application, any entity can be modelled as a system that is expected to yield the maximum output, preferably with minimal input. This involves identifying the different factors that make up the system.

GIA-based evaluation is possible because GIA models measure the extent to which associations exist among data sequences of a system. If geometric curves of the data sequences are plotted, the degree of similarity and closeness can be visualized. The more similar the curves are, the higher the degree of incidence between the sequences and vice versa [48]. This is what GIA models quantify and use to carry out prioritization problems. In this study, aspects of the MBA education landscape in selected regions (USA, Europe, and Asia-Pacific) are modelled as a system. Data from these regions are collected pertaining to aspects such as enrolment rates, expenses, salary upon graduation, and the duration it takes to recoup the costs incurred during the MBA education. Further, data regarding the employment and competencies of MBA graduates with respect to Industry 4.0 needs are sought. These include but are not limited to skills such as creativity, entrepreneurship, data analytics, and ease of adaptability. Because the focus of this research is to investigate the decline in MBA enrolment rates, this is taken as the sequence representing the system's characteristic behaviour, referred to as the characteristic (reference) sequence, X_0. The aforementioned factors suspected to influence the enrolment rates are then taken as sequences representing relevant factors, X_i, where $i = 1, 2, \ldots, m$, represents the number of factors. This is an important aspect of the system's analysis because these factors interact and determine how the system develops, and to a certain extent, they determine the overall behaviour of the system.

Let X_0 be a data sequence of a system's behavioral characteristic:

$$X_0 = (x_0(1), x_0(2), \ldots, x_0(n)) \tag{1}$$

Let the following $X_i \ldots X_m$ be relevant factor sequences:

$$\begin{aligned} X_i &= (x_i(1), x_i(2), \ldots, x_i(n)) \\ &\vdots \\ X_m &= (x_m(1), x_m(2), \ldots, x_m(n)) \end{aligned} \tag{2}$$

The steps involved in performing an evaluation based on a GIA are illustrated in Figure 2 and outlined as follows:

C. DENG'S GREY INCIDENCE ANALYSIS MODEL

The Deng GIA model measures the similarity between system factors by determining the grey relational grade. This parameter represents the level of correlation between a reference sequence and other sequences that are being compared to it [13].

Deng's degree of grey incidence [49] of a system of data sequences, X_0 and X_i, can be computed following the steps below:

Step 1: Calculate the initial image of X_0 and X_i, $i = 1, 2, \ldots, m$: Where

$$\begin{aligned} X_i' &= X_i / x_i(1) = \left(x_i'(1), x_i'(2), \ldots, x_i'(n)\right) \\ i &= 0, 1, 2, \ldots, m. \end{aligned} \tag{3}$$

Step 2: Compute the difference sequences of X_0' and X_i', $i = 1, 2, \ldots, m$, *and write* it as follows:

$$\Delta_i(k) = \left| x_0'(k) - x_i'(k) \right|, \tag{4}$$

where $\Delta = (\Delta_i(1), \Delta_i(2), \ldots, \Delta_i(n))$ *and* $i = 1, 2, \ldots, m$.

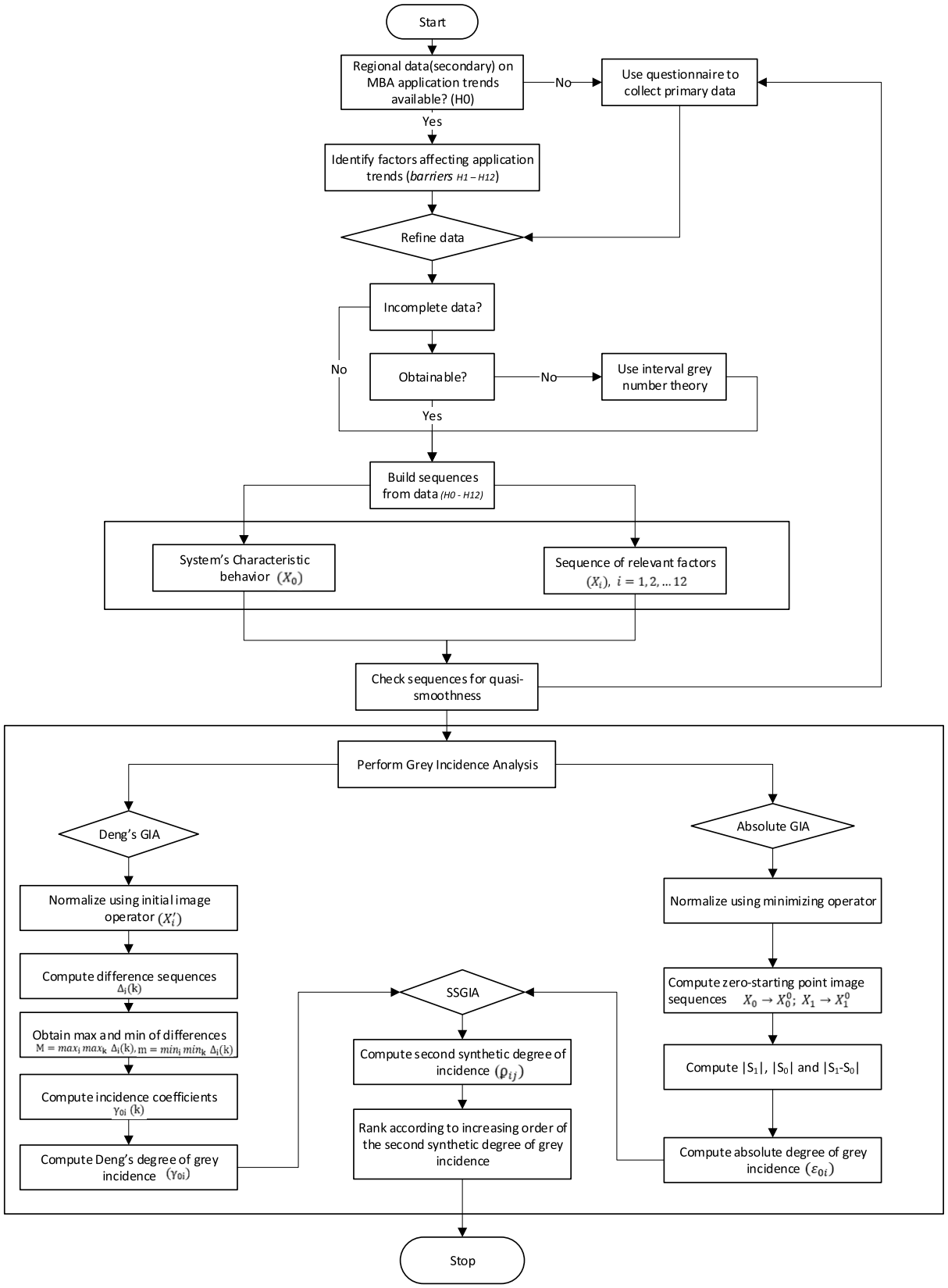

FIGURE 2. Flowchart of modelling process.

Step 3: Find the maximum (M) and minimum differences (m) and denote it as follows:

$$\mathrm{M} = max_{\mathrm{i}}\, max_{\mathrm{k}} \Delta_{\mathrm{i}}\,(\mathrm{k})\,, \tag{5}$$

$$\mathrm{m} = min_{\mathrm{i}}\, min_{\mathrm{k}} \Delta_{\mathrm{i}}\,(\mathrm{k}) \tag{6}$$

Step 4: Calculate the incidence coefficients as follows:

$$\gamma_{0\mathrm{i}}\,(\mathrm{k}) = \frac{\mathrm{m} + \xi \mathrm{M}}{\Delta_{\mathrm{i}}\,(\mathrm{k}) + \xi \mathrm{M}}, \quad \xi \in (0, 1) \quad k = 1, 2, \ldots, n; \quad i = 1, 2, \ldots, m. \tag{7}$$

where $\xi \epsilon$ [0,1] is usually 0.5.

Step 5: Calculate the degree of grey incidence as follows:

$$\gamma_{0\mathrm{i}} = \frac{1}{\mathrm{n}} \sum\nolimits_{\mathrm{k}=1}^{\mathrm{n}} \gamma_{0\mathrm{i}}\,(\mathrm{k})\,; \quad i = 1, 2, \ldots, m. \tag{8}$$

where $\gamma_{0\mathrm{i}} \epsilon$ [0,1] represents the level of correlation between the reference sequence and comparability sequence.

D. ABSOLUTE GIA MODEL

The absolute GIA model measures geometric proximity between system factors by using integrals to determine the area between curves plotted by the data sequences of the factors [50].

Step 1: Normalize the original data using the minimizing operator.

$$X_i\,(k)\,D = \frac{x_i(k)}{\max X_i(k)} \tag{9}$$

Step 2: Calculate the zero-starting point images (X_0^0 and X_1^0) of the sequence X_0 and X_1.

Step 3: Calculate $|s_0|$, $|s_1|$, and $|s_1 - s_0|$.

Step 4: Calculate the absolute degree of grey incidence (ε_{01}) between the sequence X_0 and X_1 using the formula below:

$$\varepsilon_{01} = \frac{1 + |s_0| + |s_1|}{1 + |s_0| + |s_1| + |s_1 - s_0|} \tag{10}$$

where $|s_0| + |s_1| + |s_1 - s_0|$ are computed as follows:

$$|s_0| = \left| \sum\nolimits_{k=2}^{n-1} x_0^0\,(k) + \frac{1}{2} x_0^0\,(k) \right| \tag{11}$$

$$|s_1| = \left| \sum\nolimits_{k=2}^{n-1} x_0^0\,(k) + \frac{1}{2} x_0^0\,(k) \right| \tag{12}$$

$$|s_0 - s_1| = \left| \sum\nolimits_{k=2}^{n-1} \left(x_1^0\,(k) - x_0^0\,(k) \right) + \frac{1}{2}(x_1^0\,(k) + x_0^0\,(k)) \right| \tag{13}$$

where ε_{0i} is the absolute degree of grey incidence [13].

E. SECOND SYNTHETIC GIA MODEL

The synthetic degree of incidence combines the properties of similarity and proximity from the DGIA and ADGIA, respectively, and thus gives a more complete representation of the relationship between system factors owing to the rates of change of their sequences for their initial values. The second synthetic degree of grey incidence is a further improvement, which reflects the overall closeness of two sequences based on particular points and an integral perspective. The model of the second synthetic GIA model is stated as follows:

$$\rho_{ij} = \theta \varepsilon_{ij} + (1 - \theta)\, \gamma_{ij}; \quad \theta \in [0, 1]\,, \tag{14}$$

where $\theta = 0.5$, which is suitable in ranking to favor both γ and ε [51].

V. METHOD IMPLEMENTATION AND RESULTS ANALYSIS

The focus of this study is on the trend of applications from international students to MBA programmes in the USA, Europe, and Asia-Pacific. The component of Table 1, indexed with H, represents the year-on-year percentage increase in international application volumes between 2018 and 2019. Whereas Europe and Asia-Pacific (mainly China) saw a 0.9% and 3.9% respective increase in application volumes, the USA saw a sharp decline of 13.7% (TABLE 2)

TABLE 1. Identified barriers to international MBA enrolments.

Index	Barriers	Reference
H1	Longer payback duration	(Chen, Grove and Hussey, 2012; Hussey, 2011; Saxena and Bendale, 2014)
H2	"Evolving job market"	(Elliott and Soo, 2013; Saxena and Bendale, 2014)
H3	"Employment difficulties"	(Jain and Stopford, 2011; Saxena and Bendale, 2014)
H4	"lack of leadership skills"	(Houldsworth, McBain and Brewster, 2019; Jain and Stopford, 2011; Guzmán et al., 2020; Saxena and Bendale, 2014)
H5	"Lack of adaptability skills"	(Jain and Stopford, 2011; Scott and Scott, 2016)
H6	"Lack of creativity skills"	(Jain and Stopford, 2011; Saxena and Bendale, 2014; Scott and Scott, 2016)
H7	"Lack of data analytic skills"	(Houldsworth, McBain and Brewster, 2019; Jain and Stopford, 2011)
H8	"Salary"	(Chen, Grove and Hussey, 2012; Hussey, 2012; Elliott and Soo, 2013)
H9	"10 yr. ROI"	(Chen, Grove and Hussey, 2012; Hussey, 2012; Elliott and Soo, 2013; Grove and Hussey, 2014)
H10	"High cost"	(Chen, Grove and Hussey, 2012; Elliott and Soo, 2013; Saxena and Bendale, 2014)
H11	"Lack of entrepreneurial skills"	(Jain and Stopford, 2011)
H12	"Employability"	(Jain and Stopford, 2011; Elliott and Soo, 2013; Saxena and Bendale, 2014; Scott and Scott, 2016)

Questionnaires were developed as a tool to solicit primary data, to identify the barriers suspected to have an impact on the recent MBA enrolment trends. The barriers H1–H7 extracted from the questionnaire results were based on a Likert scale whose linguistic terms are as follows: no

TABLE 2. 2019 MBA international student enrolment (GMAC Survey).

INDEX	DESCRIPTION	USA	Europe	Asia - Pacific
H0	2019 Percent Increase in MBA Enrolment	-13.70	0.90	3.90

effect, low, medium, high, and extremely high. This corresponds to values of 0 to 5 on a numerical scale. For each region, all the responses for each barrier, after being converted into their corresponding numerical values, were grouped and represented by a grey number ($\otimes$). For instance, if 20 interviewees responded to the questionnaire item represented by H1, the numerical values of these 20 responses are represented by $\otimes_{H1}$. The whitenization ($\tilde{\otimes}$) of the grey numbers for each region was then carried out using the averaging operator, i.e.,

$$\begin{aligned}\tilde{\otimes}_{H1} &= D\otimes_{H1}\\ &= \frac{1}{k}[\otimes_{H1(1)} + \otimes_{H1(2)} + \ldots + \otimes_{H1(k)}]\end{aligned}$$

The results from this step are shown in Table 3.

TABLE 3. Original grey data sequences of identified barriers.

INDEX	BARRIERS	USA	Europe	Asia - Pacific
H1	Longer payback duration	2.34	2.00	1.80
H2	Evolving job market	2.00	2.20	1.30
H3	Employment difficulties	3.00	2.40	1.50
H4	Lack of leadership skills	2.67	3.20	1.90
H5	Lack of adaptability skills	2.33	3.00	1.60
H6	Lack of creativity skills	2.67	2.80	1.90
H7	Lack of data analytic skills	2.33	2.40	1.50
H8	Annual Salary (10,000 usd)	14.54	12.85	14.67
H9	10 yr. ROI (10,000 usd)	41.92	43.05	26.89
H10	High cost (10,000 usd)	4.90	4.82	2.80
H11	Lack of entrepreneurial skills	73.98	59.28	59.71
H12	Employability	62.40	60.70	67.39

The data for barrier H8 were obtained from the Financial Times' global MBA ranking for 2019. The data for barrier H9 were obtained from the QS TopMBA.com Return on Investment Report 2018.

As an example, the step-by-step calculation of the grey incidence for barrier H1 is shown. The data from Table 3 is input into the model to produce results for the evaluation.

From Eq. (1), the characteristic behaviour under investigation, which is enrolment in this case, is represented by the sequence $X_{H0} = (x_0(1), x_0(2), \ldots, x_0(n))$

$$\text{i.e., } X_{H0} = (-13.70, 0.90, 3.90),$$

where the 1st, 2nd, and 3rd terms of the sequence represent the data values for USA, Europe, and Asia-Pacific, respectively.

The identified barrier H1 is represented by the sequence

$$X_{H1} = (2.34, 2.00, 1.80)$$

i.e., from Eq. (2), $X_i = (x_i(1), x_i(2), \ldots, x_i(n))$.

Deng's Degree of Grey Incidence:

We start by computing the Deng degree of grey incidence. The first step is to calculate the initial image (X'_0) of X_{H0}. After which the initial images (X'_i) of $X_{H1}, X_{H2} \ldots, X_{H12}$ are also calculated. For the sake of this example, the calculation of X'_{H0} and X'_{H1} for Europe is shown.

$$X'_i = X_i / x_i(1)$$
$$X'_{H0} = \frac{0.90}{-13.7} = -0.0657; \quad X'_{H1} = \frac{2}{2.34} = 0.8558$$

Subsequently, the differencing operator is applied to the image sequences to obtain the difference sequence. This is the absolute value of the difference between the initial image of each factor (X'_i) and the initial image of the characteristic behavior (X'_0). For the case of barrier H1, it is as follows:

From Eq. (4), $\Delta_{10}(\mathrm{k}) = \left|x'_0(\mathrm{k}) - x'_i(\mathrm{k})\right|$,

$$\Delta_{10}(\mathrm{k}) = |-0.0657 - 0.8558| = 0.9215$$

where k = 2, i.e., the 2nd term in the sequence, representing data entries for Europe.

After the differences are computed for all the terms, i.e., $\Delta_{10}(\mathrm{k})$, the maximum (M) and minimum (m) among them have to be obtained. For this study,

$$\mathrm{M} = max_{\mathrm{i}}\, max_{\mathrm{k}}\, \Delta_{\mathrm{i}}(\mathrm{k}) = 1.36464$$
$$\mathrm{m} = min_{\mathrm{i}}\, min_{\mathrm{k}}\, \Delta_{\mathrm{i}}(\mathrm{k}) = 0$$

The next step is to calculate the incidence coefficients using the formula in Eq. (7), where the distinguishing coefficient ξ is taken to be 0.5.

$$\gamma_{01}(2) = \frac{0 + (0.5 * 1.36464)}{0.9215 + (0.5 * 1.36464)} = 0.42544$$

For barrier H1, the incidence coefficients of the other terms, $\gamma_{01}(1)$ and $\gamma_{01}(3)$, is also obtained such that for the full sequence, we would have $\gamma_{01}(1)$, $\gamma_{01}(2)$ and $\gamma_{01}(3)$.

The average of the coefficients of all terms in each barrier's sequence is calculated, i.e., by Eq. (8). For barrier H1, this would be the average of $\gamma_{01}(1)$, $\gamma_{01}(2)$, and $\gamma_{01}(3)$, i.e., 0.60607. This value represents Deng's degree of grey incidence for barrier H1. The Deng degree of grey incidence is computed for all other barriers, as shown in the 2nd column of Table 4.

Absolute Degree of Grey Incidence:

The next step in the computation is to calculate the absolute degree of incidence. This step requires input from Table 3. The first step is to normalize the data in Table 3 using the minimizing operator. Using barrier H1 and its corresponding data entry for Europe as an example, Eq. (9) becomes

$$x_{H1}(2)\, d = \frac{2}{2.34} = 0.8558$$

TABLE 4. Results of grey incidence modeling.

INDEX	γ_{ij}	ε_{ij}	ρ_{ij}	RANK
H1	0.606068	0.558392	0.58223	4
H2	0.597062	0.543706	0.570384	8
H3	0.635295	0.573077	0.604186	1
H4	0.585672	0.541947	0.563809	11
H5	0.582601	0.546282	0.564442	10
H6	0.595414	0.545467	0.570441	7
H7	0.602448	0.549519	0.575984	6
H8	0.587818	0.54698	0.567399	9
H9	0.602864	0.549868	0.576366	5
H10	0.612562	0.556243	0.584403	3
H11	0.608334	0.561165	0.58475	2
H12	0.576618	0.539369	0.557993	12

This operation is carried out on the other terms of the sequence, $X_{H1} = (2.34, 2.00, 1.80)$, as well as for all barriers up to H12.

The normalized data is then used to calculate the zero-starting point image (X_i^0) for each sequence. The zero-starting point images of the characteristic behavior (H0) and barrier H1 are shown below.

Original data: $X_{H0} = (-13.7, 0.90, 3.90)$
Normalized data: $X_{H0}D = (-3.5128, 0.2308, 1)$
Zero-starting pt. image: $X_{H0}^0 = (0, -3.7436, -4.5128)$
Original data: $X_{H1} = (2.34, 2.00, 1.80)$
Normalized data: $X_{H1}D = (1, 0.8558, 0.7692)$
Zero-starting pt. image: $X_{H1}^0 = (0, 0.1442, 0.2308)$

The next step is to solve $|s_{H0}|$, $|s_{H1}|$, and $|s_{H1} - s_{H0}|$. Note that s_i is the area under the curve plotted by zero-starting point image sequence, i.e.,

$$s_i = \int_1^n (X_i - x_i(1))dt$$

$$s_i - s_j = \int_1^n (X_i^0 - X_j^0)dt$$

From Eq. (11)

$$|s_{H0}| = \left| \sum_{k=2}^{2} (-3.7436) + \frac{1}{2}(-4.5128) \right| = 6$$

$$|s_{H1}| = \left| \sum_{k=2}^{2} (0.1442) + \frac{1}{2}(0.2308) \right| = 0.2596$$

$$|s_{H1} - s_{H0}| = |0.2596 - 6| = 5.7404$$

Subsequently, the values obtained from solving $|s_{H0}|$, $|s_{H1}|$, and $|s_{H1} - s_{H0}|$ are fixed into Eq. (10). This results in the absolute degree of grey incidence between barrier H1 and the characteristic behaviour as follows:

$$\varepsilon_{01} = \frac{1 + |6| + |0.2596|}{1 + |6| + |0.2596| + |5.7404|} = 0.5584$$

The absolute degree of grey incidence between the characteristic behaviour and all the other barriers are also calculated in like manner and presented on the 3rd column of Table 4.

Second Synthetic Degree of Grey Incidence:

The second synthetic degree of incidence combines the Deng degree and the absolute degree of grey incidence for each barrier, using the expression in Eq. (14). The second synthetic degree of grey incidence is calculated for barrier H1 as an example. From Table 4, we pick the already calculated values for ε_{ij} and γ_{ij}, which correspond to H1.

$$\rho_{ij} = \theta\varepsilon_{01} + (1 - \theta)\gamma_{01}; \quad \theta = 0.5$$

$$\rho_{ij} = (0.5 * 0.5584) + (0.5 * 0.60607) = 0.58224$$

The second synthetic degree of grey incidence (ρ_{ij}) is calculated in a similar manner for all the barriers. This is the final output of this model. Thus, the values of ρ_{ij} are ranked such that the barrier that has the largest ρ_{ij} value (closest to 1) is said to have the highest degree of incidence to the characteristic behaviour (the 4th and 5th columns of Table 4). In other words, it has the strongest impact on the characteristic behaviour (international student enrolment in this case). An illustration of barriers ranked according to their ρ_{ij} values is shown in Figure 3.

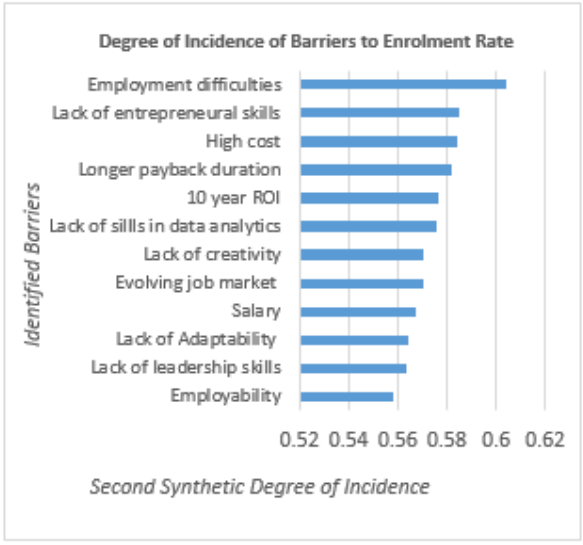

FIGURE 3. A graph showing prioritized barriers using GIA.

From the above results, "employment difficulties" (H3) was ranked as the most important barrier to MBA international enrolment with a weight (second synthetic degree of grey incidence (ρ_{ij})) of 0.604186. As already explained in the stepwise method application, this barrier then has the highest degree of incidence to the decline in MBA international enrolment. Hence, the need for policymakers to pay attention to this barrier. For the sake of simplicity, the ranked barriers are divided into two groups, the upper six (those ranked from 1-6) and the lower six (those ranked from 7-12). Even though all barriers must be given considerable attention during policy discussions, those of the upper six group must be

dealt with as having much importance. This is because they are barriers influencing the drop in recent MBA international enrolment the most. In this case, scarce resources must be committed to the barriers ''lack of entrepreneurship skills'' (H11; 0.5846), ''high cost'' (H10; 0.5844), ''longer payback duration'' (H1; 0.5822), ''10 yrs. ROI'' (H9; 0.5764), and ''lack of data analytic skills'' (H7; 0.5759). The rank of the 12 barriers is given in descending order, respectively: ''employment difficulties'' (H3; 0.604186) > ''lack of entrepreneurship skills'' (H11; 0.5846) > ''high cost'' (H10; 0.5844) > ''longer payback duration'' (H1; 0.5822) > ''10 yrs. ROI'' (H9; 0.5764) > ''lack of data analytic skills'' (H7; 0.5759) > ''lack of creativity'' (H6; 0.570441) > ''evolving job market'' > (H2; 0.570384) > ''salary'' (H8; 0.567399) > ''lack of adaptability'' (H5; 0.564442) > ''lack of leadership skills'' (H4; 0.563809) > ''employability'' (H12; 0.557993). Furthermore, a detailed explanation on each barrier is presented below.

A. RETURN ON INVESTMENT

In simple terms, the ROI is a measure of the monetary amount recouped from an investment after the costs have been accounted for. According to the Global Management Admission Council (GMAC) survey, investment in this context is the sum of the following two categories: total out-of-pocket costs and opportunity costs. The out-of-pocket costs are made up of all the tuition costs and other fees paid out of pocket. This category, however, does not include other expenses paid from sources that do not require payback, such as scholarships, grants, parental support, or employer reimbursements. The second constituent of the MBA investment is the opportunity cost associated with lost wages for students who are unemployed while pursuing their MBA degree. The opportunity cost of unemployment is calculated by taking the salary of the previous job prior to enrolment as a constant multiplied by the number of years required to complete the degree.

From the survey, and in respect to the return, data on MBA alumni's salaries were categorized under three different time periods. The categories are the base salary prior to MBA enrolment, the base salary after graduation, and the base salary at the time of this survey. The difference in salary (salary boost) between the period prior to and after the MBA degree was also taken into consideration. The initial salary boost was calculated and carried forward annually. To determine the annual salary, we also calculated the increase in salary for alumni during their period of work after graduation, the compound annual growth rate of the post-degree salary, and the current salary. The average length of time for a full-time two-year MBA alumnus to recoup his or her investment is three and a half years (Table 5). This implies that in a short amount of time, alumni can recover the investment made in their education. This justifies the position of ROI as being fifth in the order of importance in influencing MBA enrolment decision-making, according to our grey relational analysis-based evaluation. In the questionnaire used to gather primary data for the evaluation, respondents were asked what they thought about the rate at which MBA graduates recouped the cost incurred in obtaining the degree. The questionnaire focused on participants from China, the USA, and Europe. Most people who answered the questionnaire were students and were self-employed, out of which 46% were male and 54% were female. With reference to the scale of 0 to 5, a majority (76%) of the respondents answered ''medium,'' which implies that the length of time needed to recover investments in their MBA degree is in between what they would describe as a very short period (very high rate) and a very long period (very low rate).

TABLE 5. Median investment, initial boost in salary, CAGR, ROI and cumulative salary at various time periods after graduation.

Program type	Median (USD) Total Investment	Initial boost in base salary	Years to recoup investment	Compound annual growth rate
FT 2-year MBA	105000	30000	3.5	7.1%
FT 1-year MBA	50000	20000	2.5	8.0%
PT or flexible MBA	25000	10000	2.5	6.1%
Executive MBA	25000	10000	2.5	5.1%
Online MBA	25000	10000	2.5	6.3%
Master of accounting	35000	45000	0.8	10.9%
Master of finance	35000	22500	1.6	9.4%
Master of management	30000	30000	1.0	7.6%

REF: 2016 GMAC ALUMNI PERSPECTIVES REPORT

B. JOB MARKET

At the time of the GMAC survey (2016), the employment sectors with the highest demand for MBA degree holders were finance and accounting firms, products and services companies, and the technology industry. The majority (63%) of MBA graduates take up roles in finance and accounting (24% of respondents), marketing and sales (21%), and general management (19%). Findings from the survey reveal that the roles filled by MBA graduates in the various sectors depend on the current trends in the era. For instance, according to the GMAC survey report, alumni who graduated around 2016 were more likely to be employed in products and services and technology-related industries, whereas those who graduated earlier were more likely to hold jobs in government and non-profit organizations. Recently, there has been increased interest in big data, fintech, blockchain, AI, etc. This relates to our current era, and almost every firm is associated with the aforementioned concepts.

As such, the employment market also finds itself being skewed in a direction akin to what the era dictates. This means that alumni who have graduated without skill sets related

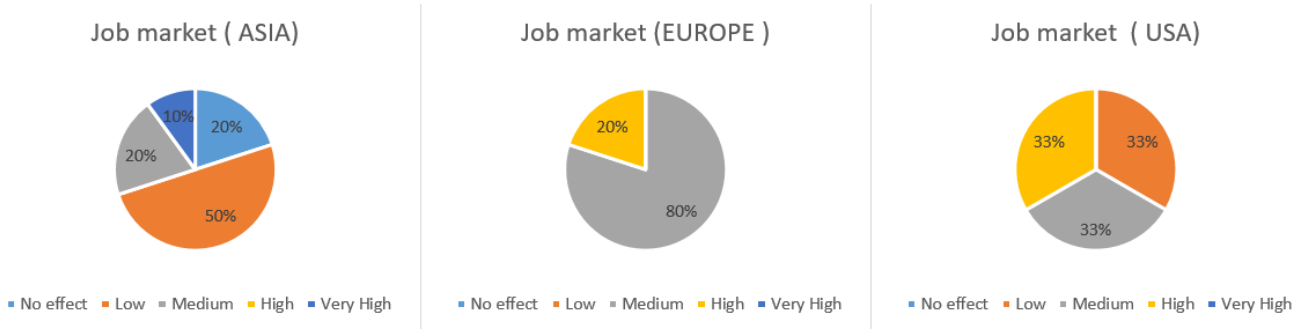

FIGURE 4. Job market in Asia, Europe, and the USA.

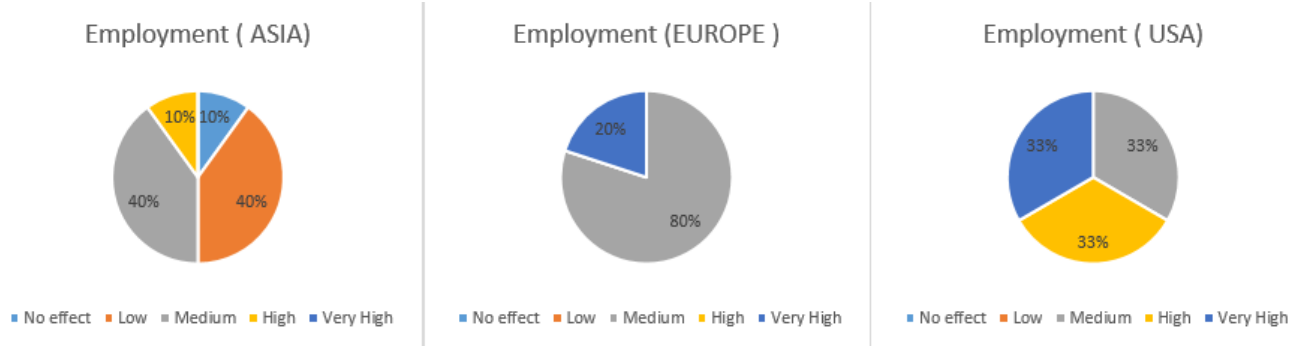

FIGURE 5. Job market from Asia, Europe, and the United States.

to these areas may need to become up-to-date by taking professional courses or risk being replaced by professionals with expertise in those areas. As a result, the demand in the job market at a particular period is an important factor that is taken into consideration by prospective MBA applicants.

Our survey asked the respondents to describe the recent (within the last three years) demand for MBA graduates, relative to graduates from other fields and in their respective regions, on a scale of 0 to 5. As seen in Figure 4, respondents from the USA and Europe found that the rate at which recruiters demand MBA graduates is medium. In the Asia-Pacific region, the demand is not as high compared to other regions.

These results are confirmed by the 2019 GMAC corporate recruiters survey, which studied hiring trends. The USA and the Asia-Pacific region both reported drops in projections for hiring MBA graduates. For the USA, the figures dropped for the second consecutive year. Only in Europe was it reported that there was a projected increase in the hiring of MBA graduates between 2018 and 2019.

C. EMPOLYMENT

Respondents to our survey were asked about the chances of MBA graduates receiving employment within zero to three months after graduation in their region.

From the survey, the average response for respondents from the USA was 33%, followed by Europe at 88% and Asia-Pacific at around 40%. This implies that, on average, MBA graduates in the United States are employed faster than in Europe and China, respectively, as shown in Figure 5.

D. COST

The GMAC survey report ranks cost as a vital inhibiting factor for people enrolling in an MBA programme. The change in the cost valuation of MBA enrolment over time is characterized by the economic conditions of the country and the strength of its currency.

According to the respondents, the average cost value accrued in pursuing an MBA programme varied by country, with the USA recording an average of more than $20,000 USD. Other currencies converted to USD showed an average MBA enrolment cost of $20,000–$30,000, as shown in Table 3.

The cost attached to completing an MBA programme was valued against the significance related to studying an MBA in each country.

Some countries, such as China, showed a low preference for this degree compared to other regions in this study. Therefore, the attributed cost of enrolling in an MBA programme was valued low compared to other economies.

Generally, estimating the cost depended on the industrialization level, and it also affected enrolment in an MBA programme. A high preference for an MBA as an essential degree in the current era was followed by a higher cost valuation.

In other terms, the measure of cost, as determined from the GMAC survey results, was dependent on the attached value of enrolling in an MBA programme in the current economy, subject to a particular condition.

This result highlights that cost has a direct impact on MBA enrolment. We speculate that this enrolment decrease is due to the overall decreasing value of the MBA. The results show that individuals who enroll in different MBA programmes expect higher outcomes in terms of acquiring skills that are in high demand in the job market or are required to either become employed or boost entrepreneurship.

However, the cost is one of the most noticeable barriers to enrolment. The results show that this does not have a direct impact on MBA enrolment because there are many individuals who would not mind the cost if the MBA were profitable in terms of payback and ROI and if its value increased in terms of the skills acquired.

E. PAYBACK

Payback refers to the return value of enrolling in the MBA program; for example, this includes the ROI and the duration within which the investment in an MBA education can be recouped. The payback value in this scenario involved the likelihood of becoming employed and the expected outcome (salary). The expected salary of an MBA was averaged at $100,000 and higher in countries that highly regard MBA programmes. The acceptability of MBA graduates measures the market value of an MBA, and in return, determines their salary and the likelihood of becoming employed [52]. Additionally, there is a payback in the status that a person gains after completing an MBA program, and this status is also perceived by other professionals, as shown in Figure 6.

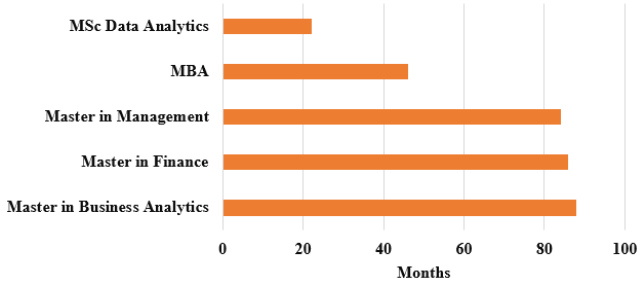

FIGURE 6. Global average payback period for selected graduate degrees.

Therefore, individuals were evaluated on the payback value of enrolling in an MBA programme. The more considerable value of the payback was what individuals gained after pursuing an MBA, which generally involved valuable factors, such as the acquired skills or entrepreneurship capacity. However, more specifically, this was measured against salary. To determine the payback value, individuals evaluated the average cost of enrolling in and completing an MBA programme (above $20,000) against the average salary expected for an MBA graduate (above $100,000), as shown in Figure 7. The payback estimate was high in the region that valued the MBA (the USA) as being critical in the current industrial era. However, some economies, such as China, which had little regard for an MBA, demonstrated little payback value in an MBA study programme.

In China, payback is a significant barrier to MBA enrolment, whereas in other regions, enrolment is still declining, despite a relatively higher payback. This demonstrates that the value of an MBA is no longer limited to the salary earned but also to other factors that are considered more valuable to the Industry 4.0 era, such as analytical skills, digital adaptability, and innovation capacity.

From our results, payback was ranked as the fourth barrier to enrolment after the cost, employment potential, and entrepreneurship capacity, respectively. It is important to highlight that skills and curriculum are the main variables to assure successful employment and entrepreneurship strength.

Employers will be willing to pay higher salaries if their personnel are skilled and have the appropriate skills that are relevant to the current era. The payback issue could then be addressed by offering skillful human capital with great innovation capacity to keep up with the constantly adapting Industry 4.0. Analytical skills and technical knowledge about technology should be kept in the MBA programme.

Business schools and universities that offer various MBA programs should renovate their curricula and match them with the needs of the job market. If the MBA programs increase their value by offering more updated and valuable curriculums, the cost might be more acceptable by individuals, and the payback would have been more likely to increase.

F. ADAPTABILITY TO INDUSTRY

Adaptability to the current Industry 4.0 era is one of the key aspects that influences the perception of and current attention drawn to the study of an MBA programme. The measure of adaptability involves the significance of an MBA. Most respondents stated that an MBA had become less significant compared to the significance it held in the past. Nonetheless, other respondents highlighted the need to renovate the current MBA study programme and adopt the current industrial needs to adapt to the Industry 4.0 trends. These results show that analytical skills are extremely important in the current era.

Notably, some respondents viewed the current industrial evolutions is not relevant to the MBA. However, they found that the MBA standards can be adapted to contemporary industrial changes, which can lead to an expected increase in the demand for MBA graduates.

Generally, despite a decrease in the significance of an MBA, the responses from the survey results believed that an MBA meets most of the current industry demands, although MBA programmes should be updated by adding vital new skills to the curriculum. Currently, the focus is on MBA analytical skills in the current Industrial Era 4.0. In addition, MBA graduates without engineering backgrounds lack the skills that are essential in every modern business.

Despite the ranking of MBA graduates' contribution being above average, according to the GMAC survey, the results

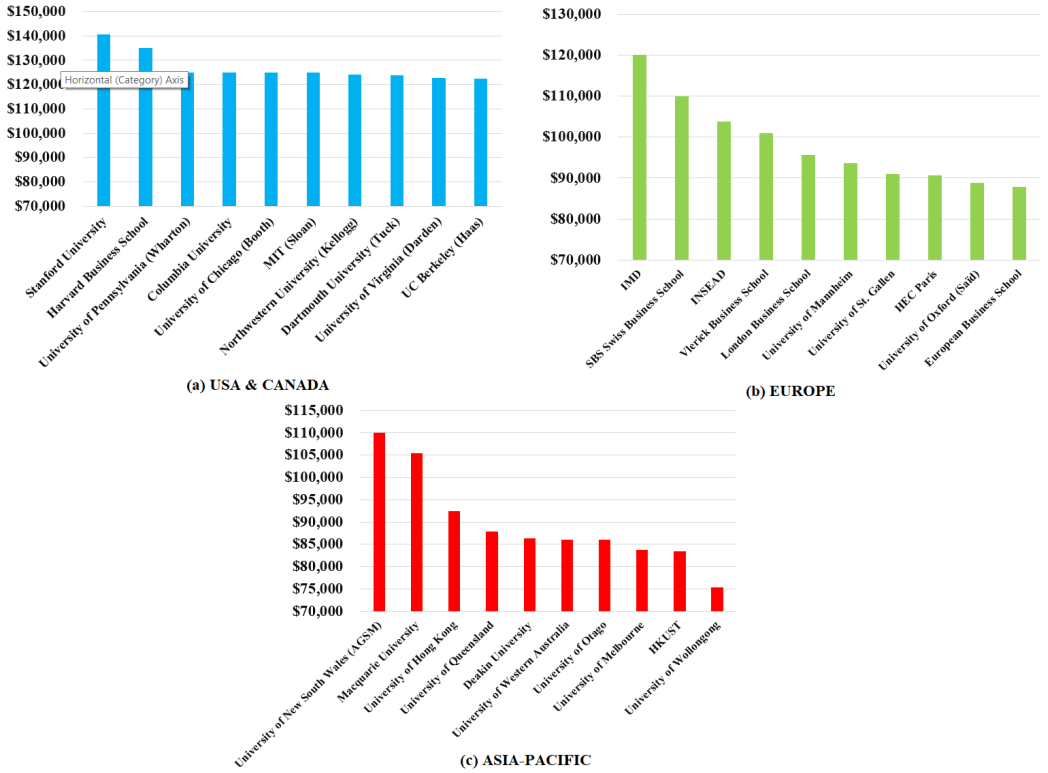

FIGURE 7. Average annual salary of professionals graduating from the top 10 MBA programs.

FIGURE 8. Average annual salary of professionals graduating from the top 10 MBA programs.

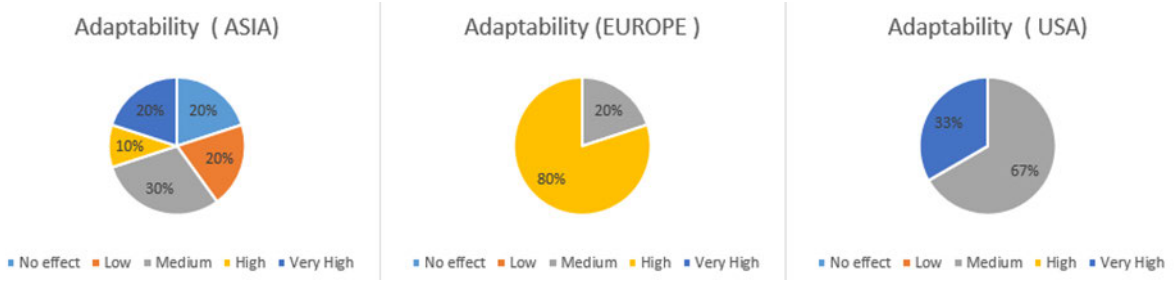

FIGURE 9. Adaptability of an MBA program in different region.

of this study prove that changing the current MBA study programmes to cohere with the current industrial revolution must be considered, as shown in Figure 9. We argue that updates to both current MBA programmes and the design of adapting to new curricula must be considered top priorities for business schools and other higher education institutions that

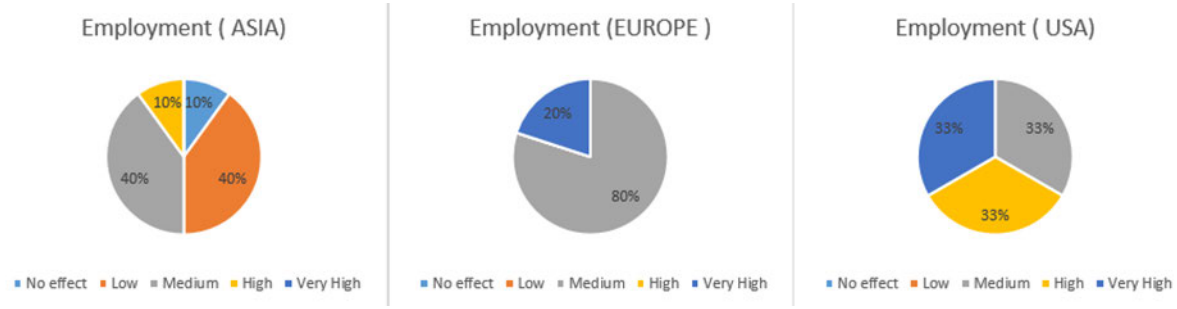

FIGURE 10. Impact of employability.

offer MBA degrees. Revamping MBA programmes should be the first step in increasing their value and tackling the issue of declining enrolment.

G. EMPLOYABILITY

Employability is another key issue identified in the GMAC survey report. In this study, we define employability as possessing the skills and competencies that allow MBA graduates to be employed. This aspect is characterized to include the preference of an MBA in current economies and to indicate the number of MBA enrolments against the number of job vacancies in the Industry 4.0 era. In the past, holding an MBA degree could easily facilitate access to or movement into higher management positions. At the time, the immense relevance of an MBA led to a significant increase in the number of enrolments. Despite the high value of an MBA, employability was also an issue in the economies that had adopted a different view of an MBA. Today, even with the high-ranking importance that an MBA holds and the high esteem attributed to the analytical skills of MBA graduates in the present industrial age, issues of employment continue to strongly affect the enrolment rate.

Seventy-two percent of respondents saw that the difficulty to gain employment was a significant barrier to MBA enrolment. The GIA assessment results show that employability is ranked last among the barriers influencing MBA enrolment. This can be explained by the fact that the measure of employability includes the capacity of the economy to absorb MBA graduates as well as the measurement of the number of employed graduates. The lack of the appropriate skills has reduced MBA graduates' capacity for employment. Employability was measured as an average, and it could have had a significant impact on the MBA enrolment rate in the Industry 4.0 era.

However, the extent that the issue of employability affects the enrolment rate remains unclear. At this stage of understanding, we believe that the issue could be addressed from two perspectives. The first is to facilitate the MBA graduates' employability by enriching their skills via appropriate and updated curricula. The second is to strengthen the entrepreneurship capacities because economies are not always capable of absorbing the number of graduates, even when they have suitable skills for the present industrial age. Moreover, MBA programs could spark economic development by designing strong entrepreneurship programs that provide students with the necessary skills to help them to develop their vision to start new businesses and create jobs. This would also improve various key socio-economic growth goals, such as the employment rate, quality of life, community development, exports, and GDP.

VI. DISCUSSION

This study highlights the key barriers in MBA enrolment and states the importance of those factors in tackling the issues of an MBA programme in higher education. From its creation until the 2000s, MBA programmes have grown in both academia and the business world. The objective of MBA programmes is to prepare graduates for managerial functions and encourage collaboration and collective learning among professionals who need assistance to acquire a better understanding of the industrial and business worlds' needs and requirements. The purpose is to enrich graduates' skills and provide them with competencies that are applicable to their careers [53], [54].

Different studies highlight the role of education in Industry 4.0, which is required to improve economic conditions and the rapid development of a country. Table 7 shows some studies that highlight the similar significance of our study.

Moreover, serious criticisms about MBAs began over a decade ago [55]. Some studies pointed out that business schools behave more like businesses than academic entities and that their curriculum was profit-oriented [56]. Some scholars stated that MBA programmes should be designed for practicing managers with substantial work experience rather than inexperienced graduates [57]. Other researchers accused the MBA curricula of being irrelevant to the managerial needs and practices of employers [58] and found a significant disparity [59] between the managerial skills that students have acquired and what was expected from them when they integrated into industries [60]. Assessing MBA graduates' outcomes is a necessity, and very few MBA programmes consistently evaluate and measure outcomes related to student professional development [52]. It was predicted that the MBA might face extinction by 2025 if no actions were taken to address the existing gap in competencies [61].

TABLE 6. MBA tuition fees from the top 25 business schools (FT Global Ranking).

FT rank	Business School	Country	Tuition
1.	HARVARD BUSINESS SCHOOL	USA	111,102
2.	UNIVERSITY OF PENNSYLVANIA	USA	114,896
3.	STANFORD GRADUATE SCHOOL OF BUSINESS	USA	115,917
4.	INSEAD	France / Singapore	94,540
5.	CEIBS	CHINA	62,219
6.	MIT: SLOAN	USA	118,818
7.	LONDON BUSINESS SCHOOL	UK	114,103
8.	COLUMBIA BUSINESS SCHOOL	USA	114,309
9.	HEC PARIS	France	29,340
10.	UNIVERSITY OF CHICAGO	USA	72,000
11.	NORTHWESTERN UNIVERSITY (KELLOGG)	USA	105,610
12.	UNIVERSITY OF CALIFORNIA AT BERKELEY	USA	101,534
13.	IESE BUSINESS SCHOOL	SPAIN	106,217
14.	YALE SCHOOL OF MANAGEMENT	USA	104,660
15.	NATIONAL UNIVERSITY OF SINGAPORE BUSINESS SCHOOL	SINGAPORE	46,490
16.	DARTMOUTH COLLEGE	USA	115,040
17.	DUKE UNIVERSITY	USA	96,850
18.	UNIVERSITY OF VIRGINIA	USA	101,290
19.	HKUST BUSINESS SCHOOL	CHINA	116,484
20.	UNIVERSITY OF CAMBRIDGE	UK	73,992
21.	UNIVERSITY OF OXFORD	UK	77,224
22.	NEWYARD UNIVERSITY	USA	116,511
23.	CORNELL UNIVERSITY	USA	96,948
24.	ESADE BUSINESS SCHOOL	SPAIN	78,241
25.	UCLA	USA	110,938
26.	IMD BUSINESS SCHOOL	SWITZERLAND	92,421

I. Industry 4.0 is an era that changes the way higher education institutions are offering MBAs. The vision of Industry 4.0 is characterized by cross-linked production processes and a noticeable shift towards more synergistic and collaborative components within higher education learning and e-learning. As a result, higher education is exposed to a large potential field of research [62]. In consideration of future employment areas, higher education students from different programmes, including MBAs, should be prepared to meet the demands of Society 4.0 and Industry 4.0 [63].

II. Over the last decade, significant changes were noticed worldwide regarding the MBA's enrolment rate. Those fluctuations are due to a multitude of factors, such as the availability of various substitute master's programmes and the fact that MBAs are no longer exclusively available at prestigious business schools in North America and Europe. Master's and MBA programmes are now globally accessible and at a lower cost. Furthermore, as many universities have revamped and automated their curricula [28], the evolution of e-learning has made MBAs accessible anytime and anywhere. The literature highlights the growing gap between the supply and demand

TABLE 7. Higher education and Industry 4.0.

Key focus	Study
Impact of higher education and Industry 4.0	[23][43]
Business curriculum and Industry 4.0	[56][58]
Technology and Industry 4.0	[31][45]
Skills and Industry 4.0	[12][61]

of skills in Industry 4.0 [24]. Industry 4.0 has introduced new technologies and opportunities for individuals, governments, and businesses worldwide [55]. It has also changed the fundamental factors that affect competitiveness in different sectors, such as the financial system, innovation skills, health, education, and other macroeconomic variables [64]. Hence, the creation and maintenance of highly competitive advantages require global skill alignments in all industries. For business schools to provide the changing world with elite managers, they must continue adapting their curricula to the economic, environmental, industrial, and social changes imposed by Industry 4.0 [65].

As emerging technologies have a large effect on industry and education, the need to bridge the gap between the curricula and the managerial requirements of the market in the Industry 4.0 era is increasing. Producing better managers requires a collaboration between the industry and business schools of higher education institutions [66] because only qualified employees with updated skills will be able to control and manage these technologies [67]. Many institutions of higher education are collaborating with businesses to develop programmes that equip MBA students with the necessary skills to work in the Industry 4.0 labour environment. Additionally, competency analyses have been used as a tool to develop a curriculum for training MBA students to acquire the necessary skills and competencies to work in an automated environment. Preparing individuals to work in a highly automated work environment is critical [68]. For instance, many universities and business schools aim to ensure that MBA programmes incorporate Industry 4.0's skills and requirements to make them competitive and responsive to the societal needs of the digital era [69]. Although the MBA curriculum is one of the most influential barriers to enrolment into MBA programmes, it is not the only one. This study aimed to investigate and prioritize the barriers that affect MBA enrolment in the USA, Europe, and China.

VII. CONCLUSION

This study highlights the key barriers in the enrolment to programmes of MBAs worldwide. Additionally, it provides an overview of how MBA programmes are important in the current Industry 4.0. MBA education is relevant to every industry because of its professional courses, which involve corporate strategy, the market economy, operations, supply chain, finance, and public relations. Although MBA courses are not designed for learning, they can help people to understand the rules of corporate development and the interests of various departments to enable anyone to increase the success rate or maximize their cooperation. Moreover, an MBA education teaches a framework of thinking. In this framework, everyone is aware of what fatal mistakes to avoid, thereby generating guidance for future work in the business. This study analyses the key factors as to why the enrolment of MBA education is decreasing.

This study focused on the input factors of the education sector. In future studies, we will develop a model to assess the output quality factors, which may help to monitor the current changes brought by Industry 4.0 and Education 4.0.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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