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Abstract:

In this paper, we present an analysis of 254 master's degree programs in Information Systems, offered by 229 universities in 32 countries. The entry requirements usually include a Bachelor's degree in IS or a related subject. In some countries such as USA any kind of Bachelor's degree is acceptable. In a few countries significant relevant work experience can replace or supplement the BSc. The duration of the degrees varies between one to two years, with the student workload between 1350-3200 hours. If we take into consideration the differences in entering the program (from none to four years of IS studies), the gap grows considerably. Most programs require course work in both computing and a domain of practice (such as business), but some have no requirements related to the domain of practice and still others have only modest computing requirements. Degrees with a professional orientation emphasize industry projects and internships, while in several countries a thesis is an essential part of the degree thereby preparing for further studies. A thesis also trains for reading and writing academic papers, thus enabling graduates to tap into current research in their daily work. The variation amongst programs presents a concern for the image of IS as a profession and a challenge for recruiters. The results are discussed in the context of an ongoing project to revise the graduate level model curriculum in Information Systems, with a particular emphasis on the IS profession.

Keywords: curriculum, entry requirements, student workload, capstone project, thesis, work experience

I.   INTRODUCTION

Institutions of higher education around the world have offered master's level programs in information systems at least since 1970s. These programs are currently serving an important role by satisfying the globally growing need for computing professionals who are in an innovative way able to address organizational needs with information technology. For the purposes of this study, we define Information Systems as a field of study that combines competences (1) in ICT, (2) in a domain of practice, such as business, government, or health care, (3) management and organizational practices and (4) individual foundational capabilities ("soft skills") such as leadership, negotiation, and ability to cooperate.

Since 1970s, associations based in the USA (primarily AIS, ACM, AITP, and IEEE-CS) have published model curricula in a number of computing fields. In IS, the latest curricula are IS 2010 at the bachelor's level (Topi et al., 2010) and 2006 (Gorgone et al., 2006) at the master's level. While these have provided a sounding board and benchmark for curriculum designs also outside USA, they fall short on recognizing the variety of local arrangements and industry needs in the global setting. This study seeks to provide this much needed information, based on an analysis of characteristics of existing Master of Science in Information Systems (MSIS) programs (including master's level graduate programs in IS under different titles). One of the motivations for this study was the ongoing review of the MSIS model curriculum that a joint ACM/AIS task force is currently leading.

Five different mechanisms were used to identify programs to include in our analysis: (1) programs ranked highly by widely recognized graduate program ranking organizations (such as US News and World Report, Eduniversal, and www.mastersportal.eu); (2) programs at schools listed in two directories of information systems programs on Wikipedia[1][2]; (3) programs at universities included in the list used by AIS in its recent Education Survey; (4) departments at universities that participate actively in major IS conferences (ICIS, AMCIS, ECIS, PACIS) and (5) the authors' personal knowledge of other potentially relevant programs. We focused mainly on programs that prepare for entry to the working life. So far, we have identified 254 programs in 220 universities in 32 countries (see table at the end of the paper). The highest number of programs is in the USA (78), followed by Australia (29) and Germany (24). The characteristics of programs were gathered from public sources, program web pages being the most used ones. When necessary, the collected data was sent to representatives of the target schools for verification.

For purposes of this analysis, MBA programs (including those with an emphasis in information systems) were not included as they represent a different program type (a generalist master's instead of a specialist program). To control the amount of effort, we have excluded all Universities of Applied Sciences and most IS programs at technical universities.

In the following, our results are presented first describing the typical features of the programs in each geographic region. Next we analyze what kind of entry requirements these programs have, especially in terms of IS background. We aimed to calculate student workloads in each program. The structure and contents of the programs reveal significant regional differences and tell also about the relationship between education and industry needs. We sum up the main shared and different features of the programs and present lessons learned for global curriculum development.

II.   TYPICAL FEATURES PER AREA

USA

The most common U.S. master's degree structure consists of a year of full-time study building on a four-year bachelor's degree. In many cases, a bachelor's degree in any field is acceptable as a foundation (and not only those with an emphasis on computing); it is, however, typical that programs require bridge courses to level the knowledge of the students at the beginning of the program. Typically, either GMAT or GRE is required but it is very atypical to require work experience.

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[1] http://en.wikipedia.org/wiki/List_of_universities_offering_degrees_in_business_informatics

[2] http://en.wikipedia.org/wiki/Master_of_Science_in_Information_Systems

An analysis of the characteristics of information systems graduate programs in the Unites States reveals a high degree of heterogeneity concerning degree name, college in which the program resides, entry requirements, and degree program content. Variation also exists, but to a lesser extent, regarding work required to complete the program, delivery method, and STEM (Science, Technology, Engineering, and Math) orientation. Overall, MS in information systems programs in the US are characterized by a high degree of diversity reflecting the broad domain of required knowledge in the discipline and the variety of program stakeholders involved.

The titles of Master's degree programs in the United States vary: 47% were named a Master of Science in Information Systems, 15% were named a Master of Science in Management Information Systems and the remaining 38% of programs fell in the specialized topic domain such as Analytics or Security. Despite the name differences, the various master's degrees encompass the core elements of technology, domain expertise (typically in business), and management and organizational topics. Some of the programs have a management emphasis, while others have a technical emphasis and there are many variations along the continuum. The University College or School housing the information systems degree program also varies widely, with programs belonging to the College of Business, College of Science, College of Information Technology, College of Engineering, and College of Information Science. The majority of programs, approximately 77%, reside within the business college/school; however, a significant portion reside in non-business colleges reflecting the diversity of the discipline.

One of the driving factors in program naming conventions in the US is the amount of time authorized for optional practical training (OPT) for non-domestic students, allowing for a longer period of time to gain work experience after graduation without a separate work visa. Programs that qualify as STEM designation entitle graduates to 27 months of OPT as opposed to 12 for non-STEM programs. Although the actual content of the program is one of the deciding factors, programs that are management information systems (vs. information systems or information technology) may be perceived to have more of a management focus and less of a technology focus, designating them as non-STEM.

Europe

Global competition, rapidly increasing knowledge and increased mobility instigated the Bologna process that led to the establishment of a platform of mutual agreement that provides transparency of educational offers and facilitates the recognition of studies done abroad by students in mobility (Bologna Working Group 2005). After high school graduation, the bachelor's degree takes three years and the master's degree additional two years.

Amount of student workload is measured in ECTS[3] credits. The workload indicates the time students typically need to complete all learning activities (such as lectures, seminars, projects, practical work, self-study and examinations) required to achieve the expected learning outcomes. One ECTS credit equals 25-28 hours of student work, with slight country variations. One year of study is 60 credits that correspond to approximately 1600 hours. While in the UK and Ireland master programs typically have a one year duration, in the remainder of Europe their common duration is 2 years (120 ECTS credits).

MSIS is an established degree in the UK, in the Nordic countries and, as Wirtschaftsinformatik, in Germany and as MIAGE[4] in France. Informatique is a term popularized in France in the 1960s that combines the words information and automatic. In Germany, Informatik has the same meaning. Both terms are ambiguous, conveying anything related to computers, either in the IS sense or in several others, thus bringing additional difficulty to the identification of IS programs.

MSIS degrees very often are a direct continuation of the three-year bachelor's degree in the same field. With the Bologna, it became possible to have separate master's degree programs, often in English and in a specific area such as e-commerce, digital services, or security. Also bachelor's degrees obtained at Universities of Applied Sciences give eligibility to apply to a master's program. These programs attract also non-European students.

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[3] ECTS – European Credit Transfer System

[4] Méthodes Informatiques Appliqueés à la Gestion des Entreprises

Two-year master's degrees in many parts of Europe specifically prepare also for research activities as typically one fourth of MSIS studies is devoted to writing a Master's thesis. For this, the student is expected to carry out an independent study in a self-chosen topic and relate the findings to literature. A relevant exception is France where MIAGE master's degrees favor industry relevant projects and the existence of internships.

Asia

Asian economies vary significantly, ranging from strongly developed to early stage developing economies. The programs found in Asian institutions typically reflect the needs of the economy in which the programs reside. In strongly advanced economies, the governments produce and make available long-term ICT or technology master plan (e.g., Infocomm Media in 2025 for Singapore and Vision 2025 for South Korea) that can guide programs. These master plans identify emerging skillsets that are likely to be needed in the future, thereby providing an avenue for programs to incorporate contents that are likely to be valued by the industry. In some instances (e.g., Hong Kong and China), specialized programs such as e-commerce may be offered to meet the specific needs of various segments of the industry. In India, the focus is mainly on software production. In less developed economies, where there is usually a lack of critical mass of higher-end ICT jobs, programs tend to be less ambitious in terms of covering cutting edge topics. Nevertheless, these programs do serve the intended purpose of producing ICT personnel at a level that is appropriate for the state of development of the economy.

The placement of graduates is carefully tracked because such information can affect the future applicant pool. Part-time teachers from industry are commonly employed to teach some of the courses to add an industry perspective. Soft skills are typically embedded in courses (e.g., through team work and project presentations) rather than explicitly stated as learning outcomes. There is a wide variety of degree titles (some emphasizing business while others emphasizing technology) but it would be more important to examine specific program contents (i.e., the set of courses covered) to assess what graduates of each program may be capable of doing. New programs (e.g., those focusing on analytics or security) are launched from time to time to respond to emerging industry needs.

Australia and New Zealand

Australia and New Zealand (ANZ) have long-term strategic migration policies that attract IS/IT workforce from other countries, in particular from China and India as well as European countries. The majority of master's degree intakes in IS are international students, who may have quite different background with various entry levels. Many ANZ universities offer a group of master's degrees in IS/IT with changing focus of content and entry requirements. The degrees with lower entry requirements quite often act as a pathway to more advanced or professional level degrees.

The titles of MSIS-like degrees in the ANZ region vary to a great extent, but 'Master of Information Technology' and 'Master of Information Systems' are the most common ones. When deciding the titles, each university takes into consideration of marketing goals and targets, their own teaching or research strength, staffing limitations. The faculty or school who offers such degrees may also be an important factor, for example, business school would highlight 'business' or 'management' flavors while science or engineering schools would highlight 'technology'.

Australian Computer Society (ACS) plays a significant role in guiding master's degrees in IS/IT in Australia. ACS accredits Australian IS/IT degrees and also assesses migration skills. ACS allows universities to design their curricula with flexibility while it also has an accreditation framework to which the curriculum should be mapped. There are detailed matrices for universities' curriculum designers to map degree and unit content. For different levels of accredited degrees, the expected outcome should also be mapped to the appropriate capability levels. Skills Framework for Information Age (www.sfia-online.org) by British Computer Society and Bloom's taxonomy of learning objectives (Bloom et al, 1956) have been adopted by ACS as benchmarks. After 2014, ACS accredits master's degrees on two levels, professional and advanced. However, the guidelines for 'advanced level' are still under development.

III.   COMPARISON OF THE PROGRAMS

Students Entering the Programs

In general, entering a master's program requires a bachelor's degree. Some programs are designed to enable a university's own undergraduates to continue on to complete a master's degree. These integrated programs are very prevalent in Europe and in some countries in Asia, and are becoming more common in the U.S. The main difference is whether a bachelor's degree is required or can relevant work experience replace it.

In Europe, the typical requirement is to have at least 90 ECTS credits in IS or a closely related field in the three-year bachelor's degree. The degree can also be obtained at a University of Applied Sciences. Significant work experience in IS (over seven years) is also considered qualifying in some countries such as UK and Ireland. These two options may necessitate bridge studies.

In Asia, while most programs have specified a bachelor's degree in IS or a related discipline as entry requirement. These programs are also flexible in considering candidates who lack such qualifications but have relevant experience. This facilitates the buildup of the ICT profession, which is much needed because most Asian economies face ICT personnel constraints.

In Australia and New Zealand, entering a master's degree in IS requires an equivalent three-year bachelor degree, which may not necessarily be in IS/IT area, or a shorter sub-degree plus substantial work experience in IS/IT areas. There are also some two-year degrees, which might be a pathway degree or part of transitional degrees for entering a master's program. However, these are gradually phased out.

Students who enter master's degree programs in North America are all required to have a four-year bachelor's degree but they come from a variety of disciplinary backgrounds. That is, the entering students are not required to have any kind of background in IS or related subjects, although in many cases some bridge courses extending the undergraduate experience are needed.

Structure of the Studies

Typically a master's program is one or two years of full-time study, suggesting significant differences between the requirements. Some schools offer also part-time options for those working in the field. In addition to the on-site study, distance education appears often as an option.

Doing comparisons based on the amount of student work appeared challenging. However, in Europe, the introduction of ECTS credits gives considerable comparability. A typical European two-year master's degree is 120 ECTS credits corresponding to 3200 hours student work, with one-year degree half of that. Also three-semester degrees exist. In France, the MIAGE degrees emphasize three possible modes of attendance: (1) full time followed by internship after the academic year; (2) apprenticeship, where periods at university are combined with periods in industry; and (3) continuous, where students work for a company and attend courses during their free time.

In Asia, programs are typically between one to two years in duration for full-time students and twice as long for part-time students. There are plenty of programs teaching in the evenings and during weekends thereby supporting studying while working.

The length of Master's degrees in ANZ is either 1.5 or two years, where two years is more popular as it aligns better with migration requirements. Regarding student working hours, New Zealand universities follow a standard model in which a typical student workload per year is 1200 hours. However, among Australian universities, the credit system varies significantly. The workload for Australian master's degree students may range from 900 hours to 1600 hours, where 1200 hours of workload is most common.

In Asia, the workload required for one credit varies, for example in Singapore one credit is 32.5 hours. In reality, students spend about 50% more time studying. Whilst the calculated work load is 1400 hours, it can be even 2800 hours.

In USA, one credit is often equivalent to 15 classroom contact hours, with the assumption that students will work externally for two hours for each hour in the classroom. The credit hour requirements for

programs range from 30 to 53, which equates to 1350 to 2385 hours of total student work; most programs are between 30 and 36 credit hours. This range of credit and associated work hours is represented in programs lasting 12 to 24 months for full-time students.

Degree structures

The degree consists usually of a number of core courses in IS and some electives in the domain of practice. In United States, the degrees are usually course-based, with no capstone project. If a thesis is part of the program, it is often supported by a seminar and courses in research methods. In some cases, the thesis can be replaced by a capstone project.

In Australia, ACS mandates that the master's degrees in IS/IT should include a cornerstone project unit, which is often a practical component rather than a research thesis. The project often requires supervision and liaison with industry or real problems. In France, the MIAGE degree emphasizes professional training, including always internships and possibly projects with industry. In Germany, several programs include a 6 or 12 ECTS project in addition to the thesis.

In Europe, the thesis is an essential part of the degree, usually worth 30 ECTS credits. In a German university, the student is expected to participate in a research project. In United States and in Asia, a thesis is an option for students interested in a research career.

In Asia, the core and elective courses make up about 50 % of the program. Some examples of core courses are Integration of IT and Business, Software Project Management, IT Entrepreneurship and IT Policies. Other parts of the degree include, for example, business projects and international internships.

Student Competencies at Graduation

An overall characterization of qualifications that signify completion of master's degrees was formed by the Bologna Working Group (2005) for European universities. According to it, master's degrees are awarded to students who:

- have demonstrated knowledge and understanding that is founded upon and extends and/or enhances that typically associated with the bachelor's level, and that provides a basis or opportunity for originality in developing and/or applying ideas, often within a research context;

- can apply their knowledge and understanding and problem solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study;

- have the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete or limited information, but that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgements;

- can communicate their conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences clearly and unambiguously;

- have the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.

We are not aware of any other similar general statements regarding master's level competencies at the time of graduation, although the elements of the European specification are not unfamiliar in other parts of the world, either. Also, we have not collected data regarding student outcome expectations at the time of graduation. This is primarily because relatively few schools have these degree level outcome expectations articulated in public, at least not in a way that allow them to be compared.

IV.   CONCLUSIONS

Even at this early stage, this study demonstrates, however, that there are globally significant differences in how the master's in information systems is interpreted and implemented in various contexts. Our analysis revealed that MSIS programs vary in many significant dimensions, including the following:

- The nature of the undergraduate degree that is required for entry into an MSIS program. In some parts of the world, it is the norm to require a prior degree information systems or a related field, whereas in other areas it is not uncommon to accept any undergraduate degree as the foundation (potentially with additional courses to bridge the difference).

- The length of the program measured in full-time completion time, number of (standardized) credit hours, or amount of student work required. There are plenty of MSIS programs that require approximately 1350 hours of student work (10 courses at 135 hours each) at one end, and at the other end others that require more than 3200 hours of student work.

- Most programs require course work in both computing and a domain of practice (such as business), but some have no requirements related to the domain of practice and still others have only modest computing requirements. There appears to be no commonly accepted standard regarding the balance, and the required amount of work in each of the areas varies significantly.

- Many of the programs are general in nature at least in the core studies, potentially allowing or encouraging specialization with electives. There is, however, a growing number of MSIS programs with a specialization even in the program name (Analytics and Security appear to be the most typical ones).

- Most programs are targeted or at least open to students with little or no (IS) work experience. Other programs are specifically targeted to experienced IS professional. Still others attempt to serve all audiences.

- Given the differences articulated above, the programs' expectations regarding the competences of the graduates appear to vary widely. It is clear that a program with no formal requirements for undergraduate degree, 1350 hours of required student work over a year, and light emphasis on technology will lead to different outcomes from a program that requires an undergraduate degree in IS/computing, includes 2700 hours of student work over two years, and has a clear emphasis on the development of computing competencies.

Why do these differences matter? One key issue is the extent to which each individual program corresponds to the expectations of various stakeholders, including students, employers that recruit program graduates, and governmental and other quality assurance organizations. At least in terms of common core competencies, it seems reasonable that degree programs with the same name should lead to approximately the same average outcomes. If the outcomes vary significantly, it is likely that the strength of a degree type's identity among key stakeholders is going to suffer: students don't know which programs to consider and recruiters don't feel confident to recruit from programs that they don't know personally. Particularly in the context of the current labor market with increasing global mobility, having a shared sense of core expectations would appear to be very important.

A stronger shared understanding of what the common competences of master's level graduates are would also appear to be important from the perspective of the IS profession. Given the relatively small total number of graduates from global Information Systems master's programs and the significant variance between the program characteristics, these programs are not able to have a similar impact on the identity of the IS profession as many more established professional degree programs do (e.g., in engineering, law, and medicine). Having a strong shared identity of master's level degree programs would strengthen the shared identity of the IS profession, which, in turn, would support the programs. The need for professionals who are able to bring together computing and understanding of business in a transformative way will continue to grow; the question is who will address this need.

One of the key purposes underlying this research is to support the work of the task force that is currently revising the MSIS model curriculum. In light of these results, the task force will have to, in consultation with the IS community, decide how strong of a stand it can take in support of a more unified set of expectations for MSIS graduates and what the scope of its work can be. For the first time, the task force has representatives from all three AIS regions and aims for a globally applicable model curriculum.

This study is still very much work in progress, as we have several countries and regions missing from our data set. Also, it would be interesting to know the typical intake in each program so that we could analyze how this relates to the program structure. We can already assume that supervising groups doing a

capstone project is feasible in large programs whereas single authored theses would require much more supervising.

Table: Analyzed master's degree programs.

Country	Universities teaching IS on graduate level in our sample	Number of Master's Degree Programs in our sample
Australia	29	29
Austria	3	3
Belgium	3	3
China	2	2
Czech Republic	2	2
Denmark	5	5
Finland	5	12
France	7	7
Germany	23	24
Greece	3	3
Hong Kong	4	7
India	1	1
Ireland	4	4
Italy	1	1
Japan	2	2
Latvia	1	1
Liechtenstein	1	1
Lithuania	2	2
New Zealand	7	7
Norway	2	2
Portugal	2	2
Singapore	2	4
Slovenia	2	2
South Korea	5	5
Spain	2	2
Sri Lanka	1	1
Sweden	10	15
Switzerland	3	3
Taiwan	2	2
The Netherlands	4	4
United Kingdom	15	18
USA	74	78
Total	*229*	*254*

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