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Information technology issues and challenges of the globe: the world IT project

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ABSTRACT

In this research, we report the information technologies rated as important by IT professionals in thirty-seven countries of the world, thus enhancing our understanding of the global technology landscape. Past research has focused primarily on the U.S. technology issues, which although useful in the U.S. context, may not generalize to all other countries. Globally, four core technologies have been ranked high for most of the countries: networks/telecommunications, business intelligence/analytics, enterprise application integration, and mobile and wireless applications. There were also differences among countries. Statistical analyses were performed to analyze the nature of these differences based on the economic level of the country and its IT infrastructure capability. Further insights were generated by performing cluster analysis; grouping the countries into three clusters (optimizers, pragmatists, and progressives), and examining their characteristics and technology priorities. These results are useful for multinational companies, governments, and international agencies as they forge their technology strategies and make investment decisions. We also lay the foundation for ongoing research to better understand the contextual factors that explain the differences in technology priorities among nations.

1. Introduction

Over the course of the last 50 years, Information Technology (IT) has revolutionized modern business. Virtually, no facet of business has been left untouched by some aspects of IT; be it computers, telecommunications, or the Internet, in some shape or form. Yet, the advances in IT continue unabated at a breathtaking pace. While only over a decade ago, technologies such as mobile communications, smart devices, ERP systems, and customer relationship management (CRM) systems were adopted by organizations, new technologies such as cloud computing, virtualization, data analytics, and big data systems have emerged in the last few years alone.

Organizations need to continuously evaluate and adopt various information technologies as they emerge and mature over time. Organizations do not wish to be left behind in the adoption of promising technologies so as not to lose competitive advantage; yet, they do not want to invest in technologies that have not matured or will not yield promised benefits. It is a delicate balance. Thus, it is vital to understand the importance of various information technologies to organizations; and there has been a concerted effort in the U.S. for over four decades to do just that. Over these years, authors have published their results in the journals *MIS Quarterly (MISQ)* and *MIS Quarterly Executive* (*MISQE*) after surveying members of the U.S-based Society for Information Management (SIM) to determine their technology priorities. The latest results for the U.S. were published for the year 2020 by Kappelman et al. [26]. Similarly, Kappelman et al. [29] provided the technology priorities in Europe from data collected in 2017. Both studies reported the ratings of various information technologies by their present investment and by those who require more investment.

While the U.S. rankings of technologies have been available for some time, any systematic rankings from other countries or regions of the world are generally lacking. Some rankings of information systems (IS)[1] management issues can be found for a few countries, but the only technology rankings from outside of the U.S. are reported by Luftman and his colleagues [40, 41], Kappelman et al. [29], and Luftman [37]. The first two of these studies report the topmost important technologies

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[1] As common in the literature, we use the two terms IS and IT interchangeably.

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in five regions: the U.S, Europe, Asia, Australia, and Latin America that are about 10 years old. However, the results from Europe, Asia, and Latin America do not distinguish among individual countries within their regions. The study by Kappelman et al., [29] reports results for Europe as a whole and the study by Luftman [37] presents a global view without providing a country breakdown.

The value of the above studies for the IT community is unarguable; however, the world is a large place, and a world view or any systematic effort to examine information technology issues across the globe is lacking. Theoretically, it is important to understand international perspectives to validate the applicability of any ethnocentric findings to global stakeholders and to make necessary refinements in existing research models. Several studies exist, albeit at a micro level, which examine several IS phenomena across countries (e.g., [6, 19, 33, 34, 42, 56]). While they make important contributions, they are limited in the consideration of contextual factors and their ability to explain macro level phenomena. Recognizing this important gap in research, the World IT Project was launched in 2013 by Palvia et al., [50] and has recently completed data collection in thirty-seven countries. The project examines various IS/IT topics in the context of each country's unique cultural, economic, political, religious, and societal environment. A prominent theme examined in the project is the importance of information technology issues in each country. This study focuses on this theme and specifically addresses the following research questions:

1 *What are the important global information technology issues?*
2 *What are the country differences and similarities with respect to information technology issues?*
3 *How do the global information technology issues compare with those reported in the U.S. and other studies?*
4 *What national level factors influence the information technology issues?*
5 *Can countries be grouped based on the similarity of information technology issues and yield further insights?*

This study makes several important contributions. Foremost, having only the U.S. studies and a few regional studies available in the literature limits our understanding of the global spectrum of technology issues. While these studies have been conducted for a reason and are valuable in their own right, their ethnocentric nature may limit their applicability to other parts of the world. Therefore, a real risk exists that stakeholders in other countries may erroneously adopt the American or European findings and their recommendations, resulting in actions that may be suboptimal or detrimental to several constituencies. Thus, a well-informed understanding of the critical technology issues confronting firms and their employees within their own countries is important at all levels: firm, national, and international. In a multinational firm, it helps management and staff to know and acquire suitable technologies in their countries of operation. At the national level, it allows stakeholders, such as policymakers, governments, and vendors, to address the critical technology needs of the country and provide resources for their acquisition and adoption. In international business, it helps firms, NGOs, and governments to be responsive to the needs of their partners and stakeholders in other countries. A comparative examination across countries and world regions helps to facilitate global understanding, cooperation, and knowledge transfer among partners and countries. At the academic level, it would provide researchers with a grounded understanding of the global information technology environment and offers a firm foundation for future international studies, and infuse a much-needed global perspective in IS research.

While a comparative examination of information technologies in various parts of the world is a valuable exercise in and of itself, we further attempt to grasp the nature of the technologies based on several national factors to improve our understanding of the underlying forces at work. With our statistical analyses using publicly available additional data, we explore two national factors that may influence the importance of various technologies: gross national income per capita and national information infrastructure. Furthermore, using cluster analysis, we group countries into three clusters that are similar in their technology priorities and examine the underlying characteristics of these clusters, again providing improved insights across the world. Finally, we provide a conceptual framework to better understand the contextual factors that explain the differences in technology priorities among nations. The framework with its five categories of factors lays the foundation for ongoing research in this area.

The study is organized as follows. The next section on literature review is necessarily short, given the paucity of international studies in this domain. It is followed by a brief background of the World IT Project and its methodology, which enabled the data collection effort. Then, the results are presented in several sections. A discussion section follows, which includes limitations, practical implications, and future research suggestions. Finally, concluding remarks are made.

2. Literature review

Various information technologies and related issues have been examined in the U.S., as part of the "IT Issues and Trends" studies conducted annually by the U.S-based SIM organization and are published in the *MIS Quarterly Executive* (e.g., those published by Kappelman et al., in 2020 and 2021 [26, 28]). The SIM membership, which provides responses to an annual survey, is largely comprised of senior IT executives from U.S. corporations. Before 2000, these surveys were conducted intermittently every few years; SIM started doing these formally on an annual basis, starting in 2004, with the study by Luftman and McLean [39]. For a comparative examination and to witness the evolution of technologies over time, we looked at the 2003 survey by Luftman and McLean [39], the 2010 survey by Luftman and Ben-Zvi [38], and the 2019 survey by Kappelman et al. [28].

In the 2003 survey [39], respondents were asked to rate the importance of 13 technology issues. The top five technology issues at that time were as follows: business intelligence, infrastructure developments, enterprise application integration, web services, and knowledge management. Seven years later, in 2010 and post-recession [38], when asked the same question, the top five technologies that were most important were the following: business intelligence, virtualization, enterprise resource planning (ERP) systems, continuity planning/disaster recovery, and cloud computing. Except for business intelligence, the rest of the important technologies were different from the 2003 survey and cloud computing was included as relatively new technology to the IT field. In the 2019 survey [28], the questions were reframed and respondents were asked to rate the technologies with the largest current investment, those which should get more investment, and those most personally worrisome. We feel that the question that asks "which should get more investment" comes closest to the "which is more important" question, and the top five technologies using this question were the following: analytics/business intelligence/data mining/forecasting/big data (all lumped together), security/cybersecurity, cloud computing, innovation/disruptive technologies, and disaster recovery/IT continuity planning. While business intelligence was also the top issue in 2003 and 2010, its present meaning has expanded to include data analytics and related technologies. Moreover, while these authors include security as a technology issue, many other authors and IT leaders treat it as more of an organizational issue (e.g., Kayworth and Whitten [32]).

We did not find similar studies conducted in other countries, but a few are worth noting. Two of these are by Luftman et al., [40] which was conducted in 2012, and by Luftman and Zadeh [41], which was conducted in 2011. Both studies are similar and use the same methodology. In both studies, the authors report the most important technologies in five countries/regions: the U.S., Europe, Asia, Australia, and Latin America. However, each of the three regions – Europe, Asia, and Latin America – constitutes many countries, both similar and dissimilar, and it is not apparent which countries were included. Considering the many disparities among the countries in each region, it is likely that they may not have the same technology priorities. In any case, in the 2012 study [41], for the five regions combined, the top five technologies in order were as follows: business intelligence, cloud computing, enterprise resource planning, apps developments, and customer relationship management. While Europe mirrored the overall rankings of the U.S., there were differences in the rankings of Australia, Asia, and Latin America. However, it is difficult to make any conclusions about specific countries, except for the U.S. and Australia.

Two more recent international investigations are by Kappelman et al., [29] where the authors examine European IT issues, and the ongoing work on global IT issues by Luftman [37]. Both works follow the general methodology used in the U.S. studies, which predominantly survey senior IT executives and generate findings similar to the U.S. However, they do not break down results by countries within a region. The Kappelman et al. [29] study looks at all of Europe without providing a country-by-country breakdown, making it difficult to interpret heterogeneity among countries within Europe. Various reports by Luftman [37] provide insights from over 2500 organizations worldwide that cover all major geographies including North America, Europe, Asia, Latin America, Africa, Middle East, and Australia, but no regional or country breakdown is presented.

In conclusion, our analysis of the literature suggests that the research on technology issues is represented by two streams: the U.S-based, and the region-based. These lines of research have merit and offer valuable insights for both academics and practitioners; however, the U.S-based results may not generalize to other countries, and the regional studies only provide aggregated macroscopic views and do not develop a country-by-country analysis.

3. The world IT project and methodology

The World IT Project, the largest academic study of its kind in the IS field, was launched by Palvia et al. in 2013 [50], who noted that IS research is dominated by American and Western views, and that the perspectives of other nations are grossly under-represented. As an ambitious project, the World IT Project captures the organizational, technological, and individual issues of IT employees across the world and relates them to national, cultural, and organizational factors. Data was collected from thirty-seven countries, representing different economic, political, religious, and regional settings.

The World IT Project has a large scope, addressing multiple topics (see Palvia et al. [49, 50] for an understanding of the full scope of the project). In this article, we focus on technological issues[2] in thirty-seven countries. Technology issues deeply affect what IT personnel do for a living and in many ways, technology (i.e., computer hardware, software, and services) affect the entire occupation [15, 24, 25]. Therefore, these issues are evaluated from the perspective of IT employees, who are an integral part of the IT profession and are the most savvy and knowledgeable about technology concerns. Their perspectives are important and of significant consequence as they are grounded in daily realities and reflect what is pragmatic and realistic.

Presently, the World IT Project is headed by a core team of five IS researchers based in four countries: the U.S., Canada, Turkey, and India. They were aided by country teams who helped to collect data in their own countries. The core team developed a survey instrument to address the research goals of the entire project, based on existing instruments and scales. It was important to use previously validated items for various constructs for the instrument to have sound psychometric properties. The instrument contained 160 items in total. Pilot tests were conducted in several countries for refining the instrument. The final instrument was reviewed by the Institutional Review Board at the University of One of the core team members and received approval and exemption from further review.

While it was logistically impossible to collect data from every country in the world, our goal was to obtain data from countries representing every major region of the world. Therefore, we targeted countries that represent different cultures, levels of economic growth, religious beliefs, and political systems. As it was infeasible for the core team to collect the data all by itself, local country teams were recruited because they were the ones who understood the local culture and the best ways to approach local businesses and IT employees to participate. Each country team comprising several investigators was recruited and selected after a careful screening process. Teams were also charged with the translation/back-translation[3] process of the instrument (if translation to the local language was necessary) to ensure that the wording and meaning were appropriate for the local culture. Considering the wide disparity in population sizes and development levels among the countries of the world, it was not feasible to achieve true representation or random sampling, but the goal was to collect a large dataset that would be respected for its breadth of cultures and countries. Nevertheless, we tried to achieve a good representation of the IT employees by instructing the country teams to collect data from many small, medium, and large organizations in a variety of industries. As the unit of analysis is the IT employee, and not the organization, multiple responses were allowed from any single organization. In most cases, between 5 and 15 responses were collected from any single organization to make sure that no organization was over-represented in each sample. A high goal of 300 responses was set for each country, fully aware that we may not be able to reach this level in each country, but that a higher target would result in a larger sample size. This strategy worked; many countries achieved or exceeded the sample size of 300 valid responses. Considering the scope of the project and the range of countries, it took us three years to collect the data from all 37 countries, from 2015 to 2017. Because of logistical issues and having to work with 37 countries, it took us another 6–9 months to cleanse the data and validate it using various statistical means. The entire list of countries is shown in Table 1.

The actual collection of data required the use of several different methods. Considering the challenges in data collection, country teams were given considerable leeway in collecting the data. They relied on direct postal mail surveys, email distribution, web-based surveys, face-to-face meetings, and a mix of these approaches. Some countries came up with ingenious ways of collecting data; e.g., some used research as-

Table 1
Countries in the World IT Project.

Argentina	Iran	Portugal
Bangladesh	Italy	Romania
Brazil	Japan	Russia
Canada	Jordan	South Africa
China	Lithuania	South Korea
Egypt	Macedonia	Taiwan
Finland	Malaysia	Thailand
France	Mexico	Turkey
Germany	New Zealand	U.K.
Ghana	Nigeria	U.S.
Greece	Pakistan	Vietnam
Hungary	Peru	
India	Poland	

[2] A few articles that describe various aspects of the World IT Project have been published (e.g., [48]) and others are being prepared. We expect 6–8 articles to describe the full extent of the project results. There is likely to be some replication between these articles when describing the project's logistical aspects, but each article addresses different research questions. This is a common occurrence in large scale research projects with multiple outcomes.

[3] The instrument has been translated into the following twelve languages: Chinese, French, Italian, Japanese, Korean, Malay, Polish, Portuguese, Russian, Spanish, Thai, and Turkish.

sistants to identify and approach IT employees, few went to industry conferences for IT professionals, many used university advisory boards to gain access to IT employees, and some even hosted special events to collect the data.

We developed a list of important technology issues to be evaluated by the IT employees. Because using an all-inclusive list of specific technologies would not be feasible, we selected broad technologies based on their inclusion in the IS literature (e.g., the annual key issue studies cited above) and the industry experience of the core team members. Ultimately, we selected the following fourteen technology issues[4]: business intelligence/analytics, cloud computing, enterprise resource planning (ERP) systems, collaborative and workflow tools, customer relationship management (CRM) systems, mobile and wireless applications,[5] enterprise application integration, business process management systems, big data systems, networks/telecommunications, social networking/media, virtualization (desktop or server), software as a service (SaaS), and service-oriented architecture (SOA). Each technology was rated by each respondent on a 5-point Likert-type scale, where 1 represents "most important" and 5 represents "not important."

We made a distinction between big data systems and business intelligence/analytics, contrary to the most recent *MISQE* studies by Kappelman et al. [28, 30, 31]. This is because big data refer to immense volumes of raw and unstructured data from diverse sources, has high veracity, and requires enormous computing power to gather and analyze it; while data analytics is more focused and uses predictive and statistical modeling with widely available tools. We also kept cloud computing and software as a service (SaaS) separate. This is because, while cloud computing is a broad term and includes many services, SaaS is a specific service that is popular – receiving increased attention and adoption by many customers.

Table 2
Survey respondents (37 countries).

Characteristics	N	%	Characteristics	N	%
Age:			Sex:		
18 – 20	316	3.0	Male	7509	72.8
21 – 29	3371	32.5	Female	2801	27.2
30 – 39	3344	32.2	Education Level:		
40 – 49	2106	20.3	High School or	793	7.6
50 – 59	1013	9.8	Less	1342	12.9
60 +	227	2.2	Associate Degree	4998	48.2
			Bachelor's	2988	28.8
			Degree	250	2.4
			Master's Degree		
			Ph.D.		
Years of IT Work			Position:		
Experience:	2975	28.7	Not part of	5364	51.7
0 – 4	2717	26.2	management	1841	17.8
5 – 9	2789	26.9	In lower	1999	19.3
10 – 19	1398	13.5	management	1166	11.2
20 – 29	500	4.8	In middle		
30 +			management		
			In senior		
			management		
IT Role (top 10 shown)			Industry		
Programming	1857	17.9	Affiliation (top	3024	29.1
Analysis & design	1009	9.7	10 shown)	1067	10.3
Management and	795	7.7	Information	947	9.1
strategy	741	7.1	technology	848	8.2
Project management	703	6.8	Financial	842	8.1
System administrator	662	6.4	Manufacturing	582	5.6
Operations	503	4.8	Education	547	5.3
Maintenance	473	4.6	Government/	304	2.9
Consulting	408	3.9	Public	281	2.7
Financial	368	3.5	Professional	269	2.6
Telecommunications			Services		
			Retail		
			Healthcare		
			Transportation		
			Utilities		

4. Analysis and results

4.1. Respondent profile

Many U.S-based studies rely predominantly on the opinions of CIOs and high-level senior IS managers of large companies. As Burton-Jones and Galliavan [3] point out, IS research has suffered a level bias; in this case, researchers have examined the technology issues only at the executive level. However, multilevel analyses offer richer opportunities for theoretical and empirical insights [3]. Accordingly, the global sample in our study is more balanced: it includes small, medium, and large organizations in a variety of industries, and the respondents are IT employees at various levels in the organizational hierarchy, in various technology roles, and in various industries (see Table 2). The information technology industry has more IT employees and represented as such in our sample.

The unit of analysis in this study is the IT employee; so, we could collect responses from multiple employees from any single organization. However, to achieve a wide representation of IT employees within each country, as a guideline, we instructed the country teams not to collect more than 5 – 15 responses from any single organization and that the organizations had to be small, medium, and large and in a variety of industries. Most country teams could abide by these guidelines. Table 3 shows the number of valid responses, median range of the number of employees[6] in respondents' organizations, percent of female respondents, and the approximate number of unique organizations[7] in the sample, for each country.

4.2. Global analysis

We first present the overall results for the global dataset which includes more than 10,000 data points from all 37 countries. Considering the massive nature of our database, summary information is provided first; detailed and selective analyses of individual countries will be shown later.

While computing the ranks of the technologies, we soon realized that different respondents were using different parts of the 5-point scale more than others, possibly because of individual and cultural

[4] We purposely excluded "security" as one of the technology issues. It falls more in the realm of organizational IS issues. Managers have to implement many security measures using a variety of approaches, such as policy, controls, training, education, and have to address both internal and external threats [5, 36]. As an organizational issue, security did rank high, both in the U.S. studies and the Word IT Project [48].

[5] We had initially included mobile apps development as a separate category, but later realized that it is subsumed under mobile and wireless applications. Data mining was also removed because of its close relationship with data analytics.

[6] Two proxy measures for the size of an organization are annual revenue and the number of employees. We did not ask for revenue because of different currencies and purchasing power in different countries and because the IT respondent may not be aware of it. Furthermore, as the respondent may not know the exact number of employees in the organization, we asked only to indicate a range for the number of employees.

[7] IT employees were not required to report the name of their organization as the focus was on the employee and we wanted their honest opinions. The Institutional Research Boards in some countries also do not allow to collect names of organizations to ensure respondent anonymity. Many did report the name of the organization, but some did not. So, our count of unique organizations is approximate and is not available for some countries.

Table 3
Selected country demographics.

No	Country	Number of responses	Full-time employees (median range)	Percent female	Number of unique companies
1	Argentina	309	1001 – 2000	28.5	46
2	Bangladesh	284	101 – 200	19.4	19
3	Brazil	348	501 – 1000	13.8	257
4	Canada	311	1001 – 2000	23.2	Not Available
5	China	297	51 – 100	36.0	28
6	Egypt	175	501 – 1000	16.0	43
7	Finland	144	501 – 1000	28.5	22
8	France	293	1001 – 2000	39.9	Not Available
9	Germany	308	201 – 500	6.2	Not Available
10	Ghana	304	26 – 50	27.6	23
11	Greece	106	501 – 1000	29.2	17
12	Hungary	273	26 – 50	13.6	Not Available
13	India	350	2001 – 5000	18.6	28
14	Iran	357	201 – 500	39.8	Not Available
15	Italy	310	2001 – 5000	11.6	Not Available
16	Japan	310	101 – 200	8.7	Not Available
17	Jordan	253	201 – 500	28.1	44
18	Lithuania	146	51 – 100	19.2	13
19	Macedonia	294	51 – 100	39.8	45
20	Malaysia	283	101 – 200	42.4	Not Available
21	Mexico	333	201 – 500	18.3	122
22	New Zealand	516	2001 – 5000	28.3	31
23	Nigeria	93	501 – 1000	17.2	19
24	Pakistan	301	101 – 200	17.6	Not Available
25	Peru	159	1001 – 2000	19.5	17
26	Poland	300	51 – 100	19.3	Not Available
27	Portugal	224	501 – 1000	17.0	34
28	Romania	328	51 – 100	57.9	53
29	Russia	147	201 – 500	45.9	38
30	South Africa	304	1001 – 2000	27.6	36
31	South Korea	301	51 – 100	31.2	Not Available
32	Taiwan	303	201 – 500	28.4	48
33	Thailand	634	501 – 1000	46.8	Not Available
34	Turkey	287	201 – 500	19.9	26
35	UK	96	1001 – 2000	40.6	24
36	US	309	2001 – 5000	28.5	49
37	Vietnam	298	101 – 200	21.1	Not Available

differences. Therefore, to get a more accurate picture, we standardized all 14 technology responses within each respondent[8] and used them for all further analyses. The averages of the standardized scores of each technology for all respondents (globally or within each country) formed the basis for determining the technology ranks.

Table 4 shows the ranks of the fourteen issues for the global dataset – listed by rank order. A lower number denotes a higher rank and thus higher importance.

Networks/Telecommunications is ranked as the top technology issue in the combined dataset of all 37 countries. These are the backbones to most IT solutions and innovations, such as the Internet, mobile communications, and cloud computing, and the IT professionals are fully aware of its continued importance and forthcoming innovations. Some of the newer developments in telecommunications include 5 G networks and the Internet of Things. There are enormous possibilities with 5 G networks, and we are likely to see novel kinds of applications – the likes of which have not been imagined yet.

The second topmost global issue is business intelligence/analytics. Worldwide, business intelligence/data analytics has been increasingly embraced by many organizations in the last few years. The underlying technologies are important because they enable a company to make

[8] We had used a different method earlier. This refinement was made based on the advice of one of the anonymous reviewers and we are thankful to this reviewer. It led to a more accurate and cleaner analysis.

Table 4
Global ranks of information technology issues.

Information technology issues	Global rank
Networks/Telecommunications	1
Business Intelligence/Analytics	2
Enterprise Application Integration	3
Mobile and Wireless Applications	4
Collaborative and Workflow Tools	5
Customer Relationship Management Systems	6
Business Process Management Systems	7
Software as a Service	8
Enterprise Resource Planning Systems	9
Virtualization (Desktop or Server)	10
Big Data Systems	11
Service-Oriented Architecture	12
Cloud Computing	13
Social Networking/Media	14

better business decisions, help analyze customer trends, and even optimize internal performance – leading to expanded markets, newer products, and reduced costs. Ransbotham et al. [54], pointed out that the hype behind data analytics has reached a feverish pitch in the last few years with many stories of corporate success with data analytics, vendors touting their products, and pundits and media exalting its virtues.

The third topmost global technology is enterprise application integration (EAI). Many countries and organizations within these countries have a long history of IT applications and legacy systems, with the resultant effect of proliferation of disparate systems, which cannot communicate with one another. EAI provides a collection of technologies and services which form a middleware to enable the integration of systems and applications across an enterprise (e.g., refer Freire et al. [13]).

Ranked fourth, mobile and wireless applications are proliferating across the world. They fulfill the promise of conducting business from anywhere and at any time. Many developing countries in our sample were latecomers to the IT revolution. Out of necessity, many of them have bypassed the mainframe and even personal computer technologies, and could leapfrog directly to the newly emerged mobile technology (refer Fong [12]) and thus catch up or even surpass the more economically developed countries.

Ranked fifth and sixth globally are collaborative and workflow tools, and customer relationship management systems (CRM). Collaborative and workflow tools enable the conduct of business without regard to physical proximity or geographic location, with features such as audio and video communication, desktop sharing, whiteboards, polls, and webinars. Incidentally, during the present COVID health crisis permeating the entire world, organizations have relied heavily on such tools to successfully run their business (refer DeFilippis et al. [9]). CRM systems are technologies to manage an organization's relationships and interactions with its present and potential customers. They provide a deeper understanding of the customers' needs and wants, and the ability for the firm to meet them – thus retaining present customers and attracting potential customers.

Rounding out the top ten global technology issues are the following: business process management systems, software as a service, enterprise resource planning (ERP) systems, and virtualization. Popularized earlier by Hammer [16] as business process re-engineering, business process management has emerged as a more mature next-generation version and refers to software and processes used to analyze, improve, and automate existing business processes. Software as a service is becoming increasingly popular as a way to deliver applications over the Internet by a third party, thus freeing up the client firm from installing and maintaining the software. ERP refers to the software that organizations use to manage daily operational activities, such as accounting, procurement, human resources, and supply chain operations. While large corporations first started adopting ERP systems, more and more middle-sized and small

Table 5
Top five ranks of all thirty-seven countries for the information technology issues.

	Networks/ telecommunications	Business intelligence/ analytics	Enterprise application integration	Mobile and wireless applications	Collaborative and workflow tools	Customer relationship management	Business process management systems	Software as a service	Enterprise resource planning	Virtualization (desktop or server)	Big data systems	Service-oriented architecture	Cloud computing	Social networking/ media
Global (all countries)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Argentina	3	2	1		5						4			
Bangladesh		2	4	3			5	1						
Brazil	3	1	2	5			4							
Canada	1	4	3	5						2				
China	1	5				4		3			2			
Egypt	1	2	3			4			5					
Finland	3	1	2	4	5									
France	3	1		4	5	2								
Germany	1		3	5	4					2				
Ghana		2	3	4		1	5	7						
Greece	2	1	3	4				5						
Hungary	1		3	5				4		2				
India	2	1	5			3			4					
Iran	2	4	1						3			5		
Italy	3	2	1	5	4									
Japan	2	1	4				5			3				
Jordan	1	2			4		5				3			
Lithuania	2				1			3		4		5		
Macedonia		1		2	5	3		4						
Malaysia	2	3		1		4		5						
Mexico	3	2	4		5	1								
New Zealand	1	5	2	3	4									
Nigeria	2	4		1	3								5	
Pakistan		1		2		3		5				4		
Peru	5	1	2	3			4							
Poland	1		3	5				4					2	
Portugal		1	2		4		5		3					
Romania	5	4			2	1			3					
Russia		1	3				2		5		4			
South Africa	2	1	4	3			5							
South Korea	3					2	4		5		1			
Taiwan	1	4			5	2		3						
Thailand	1			4	3		5				2			
Turkey	3	1	2	4										5
U.K.	4	2		1				5					3	
U.S.	1	3	2		4					5				
Vietnam	1	2				3					4			5

Table 6
Global ranks vs. previous U.S. ranks.

Information technology issues	Global rank (our study)	U.S. rank 2019 (*MISQE*) current/ future investment	U.S. rank2016 (*MISQE*) current/ future investment
Networks/ Telecommunications	1	Not listed	8/33
Business Intelligence/ Analytics	2	1/1	1/1
Enterprise Application Integration	3	10/16	9/14
Mobile and Wireless Applications	4	Not listed	Not listed
Collaborative and Workflow Tools	5	Not listed	Not listed
Customer Relationship Management Systems	6	5/8	5/8
Business Process Management Systems	7	Not listed	16/7
Software as a Service	8	2/4	4/3
Enterprise Resource Planning Systems	9	6/18	6/18
Virtualization (Desktop or Server)	10	Not listed	Not listed
Big Data Systems	11	1/1	1/1
Service-Oriented Architecture	12	Not listed	Not listed
Cloud Computing	13	2/4	4/3
Social Networking/ Media	14	Not listed	Not listed

Table 7
Economic classification of countries.

High income countries		Upper-middle income countries		Lower-middle income countries	
Country	GNI per capita PPP	Country	GNI per capita PPP	Country	GNI per capita PPP
Argentina	$ 20,250	Brazil	$ 15,200	Bangladesh	$ 4040
Canada	$ 46,070	China	$ 16,760	Egypt	$ 11,360
Finland	$ 45,400	Iran	$ 20,880	Ghana	$ 4280
France	$ 43,790	Jordan	$ 9110	India	$ 6980
Germany	$ 51,680	Macedonia	$ 14,680	Nigeria	$ 5700
Greece	$ 27,620	Malaysia	$ 28,660	Pakistan	$ 5830
Hungary	$ 26,960	Mexico	$ 17,840	Vietnam	$ 6450
Italy	$ 39,640	Peru	$ 12,880		
Japan	$ 44,850	Romania	$ 25,940		
Lithuania	$ 31,910	Russia	$ 24,890		
New Zealand	$ 39,740	South Africa	$ 13,090		
Poland	$ 27,970	Thailand	$ 17,040		
Portugal	$ 30,980	Turkey	$ 26,170		
South Korea	$ 38,340				
Taiwan	$ 49,800				
United Kingdom	$ 42,560				
United States	$ 60,200				

firms are beginning to use these systems. Finally, virtualization technology offers optimization of computing resources as it allows the hardware elements of a single computer (processors, memory, storage, and more) to be divided into multiple virtual computers, referred to as virtual machines. Each virtual machine acts as an independent computer, even though it is running on the same underlying computer hardware.

4.3. Individual country findings

The ranks of all fourteen technology issues for all 37 countries are shown in Table 5. Considering the large volume of data contained in one single table, only the top five technologies for each country are shown. While we provide a detailed analysis later, some general observations are made below.

Networks/Telecommunications and business intelligence/analytics rank as the top two technologies in a majority of the countries across the globe. Networks/Telecommunications is ranked the top technology in 12 countries and is among the top three in 28 countries, while business intelligence/analytics is ranked the top technology in 13 countries and is among the top three in 24 countries. Advanced countries – which have a strong and fully developed IT infrastructure – may not regard networking and telecommunications as a pressing concern. Many countries in our sample represent the developing and under-developed regions of the world and have lower levels of network readiness (refer Baller et al. [1]); thus, it is a matter of pressing and vital concern for these countries to assimilate in the growing world economy. Furthermore, the advent of newer telecommunication technologies, such as 5 G networks and the Internet of Things, has put additional pressure on IT employees to adopt and deploy them in their organizations.

While the need for networks/telecommunications technology is fundamental to most IT applications and innovation, business intelligence/analytics experienced a meteoric rise in the last decade. Many companies worldwide have bought into the promise of data analytics, but some are still struggling to derive benefits from the technology. While the opportunities may be many and significant, there are still challenges associated with data analytics, as follows: finding qualified data analytics professionals, threats from repurposing the data, consolidating data from varied sources, finding the right tools for analysis, and implementing the recommendations (refer Clarke [7]). It is for these reasons that in a few countries such as Hungary, Poland, Thailand, and South Korea, the IT employees did not ascribe as much value to the role of data analytics. There may be other reasons for the low ranking, which require further probing and verification.

Another important technological concern for IT professionals, usually not observed in the Western media, is enterprise application integration (EAI). It ranked as the top issue in three countries and among the top three in eighteen countries. While this issue may appear rather mundane to those at senior executive levels, it is where reality sinks in for the line-level IT employees. Considering that many organizations in our global sample have a wide range of disparate IT applications and systems – which are both bordering on obsolescence and cannot easily communicate with one another – it has become a pressing issue in many countries. It is even more challenging as senior management may wish to invest any scarce resources only in new technologies and applications which may not be necessarily compatible with existing ones.

Mobile and wireless applications are also gaining importance worldwide. It was among the top three issues in nine countries. While many developing countries were latecomers to the IT arena, the use of mobile devices appeared to have leveled the playing field and have allowed countries to leapfrog directly to advanced technology [12]. Mobile technology has become an essential part of the daily lives of billions of people across the world, and it has become an essential tool for communication and e-commerce. Examples abound of the many novel applications of mobile technology for successful businesses, such as in healthcare, e-learning, gaming, and banking.

It is also interesting to look at some of the issues that are ranked very low by most countries. Ranked lower in importance across all countries were the following: social networking/media, cloud computing, service-oriented architecture, big data systems, and virtualization. Of these, there has been much hype in recent times about social networking/ media, cloud computing, and big data systems, yet they are not regarded as highly important by the global IT community.

Table 8
Technology ranks by economic classification.

Information technology issues	Global rank	High-income rank	Upper-middle income rank	Lower-middle income rank
Networks/ Telecommunications	1	1	2	2
Business Intelligence/ Analytics	2	2	1	1
Enterprise Application Integration	3	3	3	4
Mobile and Wireless Applications	4	5	4	7
Collaborative and Workflow Tools	5	4	7	8
Customer Relationship Management Systems (CRM)	6	8	6	3
Business Process Management Systems	7	9	5	6
Software as a Service	8	6	9	5
Enterprise Resource Planning Systems (ERP)	9	10	8	9
Virtualization (Desktop or Server)	10	7	12	12
Big Data Systems	11	11	10	11
Service-Oriented Architecture (SOA)	12	12	11	14
Cloud Computing	13	13	13	13
Social Networking/Media	14	14	14	10

4.4. Comparison with the U.S. and other studies

We compared our global findings with the 2019 and 2016[9] U.S. results from the *MISQE* surveys [27, 28] and a couple of regional studies in the literature. The U.S. studies do not directly report the importance of technologies, but they provide two sets of ranks based on current investment and future investment in technology.[10] The global ranks and the corresponding U.S. ranks are shown in Table 6. As current investment is a culmination of past decisions and investments, we believe that future investments are a better indication of the technologies' perceived importance. In any case, the importance can be extrapolated by looking at both sets of ranks.[11]

A wide divergence exists between the global ranks and the U.S. ranks. There is agreement on business intelligence/analytics as it is ranked first in the U.S. studies and second in our global study. Some of this may be real and some fueled by the hype surrounding this technology [54]. The "Big Data" was lumped with data analytics in the U.S. reports, but by itself ranked at #11 in our study. The biggest difference in the global ranks is the high importance attributed to networks/telecommunications, enterprise application integration, and mobile and wireless applications, ranked at #1, #3, and #4, respectively – while all three technologies are rated much lower in the U.S. studies. Technologies ranked higher in the U.S. studies are artificial intelligence, cloud computing, disruptive technologies, and cybersecurity.

Aside from the obvious differences because of the scope of the two studies (i.e., global vs. U.S.), the differences in the two sets of ranks could be attributed to the underlying population of the two studies, and to a lesser extent, methodological differences. The U.S. studies are conducted under the auspices of the U.S-based Society for Information Management (SIM). The SIM membership, which provides responses to an annual survey, largely comprises several senior IT executives in large companies. The samples in our study are more balanced; they include small, medium, and large organizations in a variety of industries, and the respondents are IT employees at various levels and in various roles. Both studies are important in their own right and provide unique perspectives. The *MISQE* U.S. studies are focused and provide an executive top-down view; our global study offers a more grounded, pragmatic, and bottom-up perspective. With regard to methodological differences, our study asked the respondents to rate each issue directly on a 5-point Likert scale, while the 2019 U.S. study asked the respondents to select the top five technologies from a list of 37 options. This could have led to minor differences in the rankings.

Two other international studies discussed in our literature review are by Kappelman et al. [29] and by Luftman [37]. They both use a methodology similar to the U.S. studies and survey senior IT executives. The Kappelman et al. [29] study conducted in 2017 surveyed senior IT executives in Europe. While they did not provide a breakdown by country, the top five largest IT investments in Europe were analytics, software development, cloud, cybersecurity, and ERP. In his "Global IT Trends" research, Luftman [37] provides insights from a 2018 survey of senior IT executives in major geographies such as North America, Europe, Asia, Latin America, Africa, the Middle East, and Australia. Once again, no country-by-country breakdown is provided, but the top five IT investments are remarkably similar to the Kappelman et al. studies, i.e., analytics, cybersecurity, cloud computing, software development, and ERP.

[9] At the time of the writing of this article, only 2019 results were available. Since then, the 2020 results have been published [26], but they are not very different from 2019. The 2016 results were included to be closer to the time frame of our study. In any case, all results are similar.

[10] The U.S. study reports a third set of ranks based on most personally worrisome technologies.

[11] The 2016 and 2019 studies report only the ranks of those technologies which are among the top 10; either with current investment or future investment.

Table 9
Internet users by country.

Country	Internet users percent	Country	Internet users percent	Country	Internet users percent
Argentina	75.81	Iran	60.42	Portugal	73.79
Bangladesh	18.02	Italy	61.30	Romania	63.75
Brazil	67.47	Japan	90.87	Russia	76.01
Canada	92.70	Jordan	66.79	South Africa	56.17
China	54.30	Lithuania	77.62	South Korea	95.10
Egypt	44.95	Macedonia	75.90	Taiwan	92.78
Finland	87.47	Malaysia	80.14	Thailand	52.89
France	80.50	Mexico	63.85	Turkey	64.68
Germany	84.40	New Zealand	90.81	U.K.	94.62
Ghana	37.88	Nigeria	27.68	U.S.	75.23
Greece	69.89	Pakistan	15.51	Vietnam	49.57
Hungary	76.75	Peru	48.73		
India	34.45	Poland	75.99		

5. A deeper exploration

To gain a deeper understanding of the nature of technology issues across countries, we conducted additional analyses. Various scholars have suggested that the importance of IT issues varies from country-to-country based on national characteristics, such as the level of economic development and the prevailing IT infrastructure (refer Ives & Jarvenpaa [23] and Palvia et al. [39]). More specifically, Palvia et al., [51] investigated the nature of organizational IT management issues based on the country's level of economic development. In this study, we use each country's level of economic development and IT infrastructure to gain further insights into the nature of technology issues. We also conduct a ground-up cluster analysis to group countries based on the similarity of technology issues.

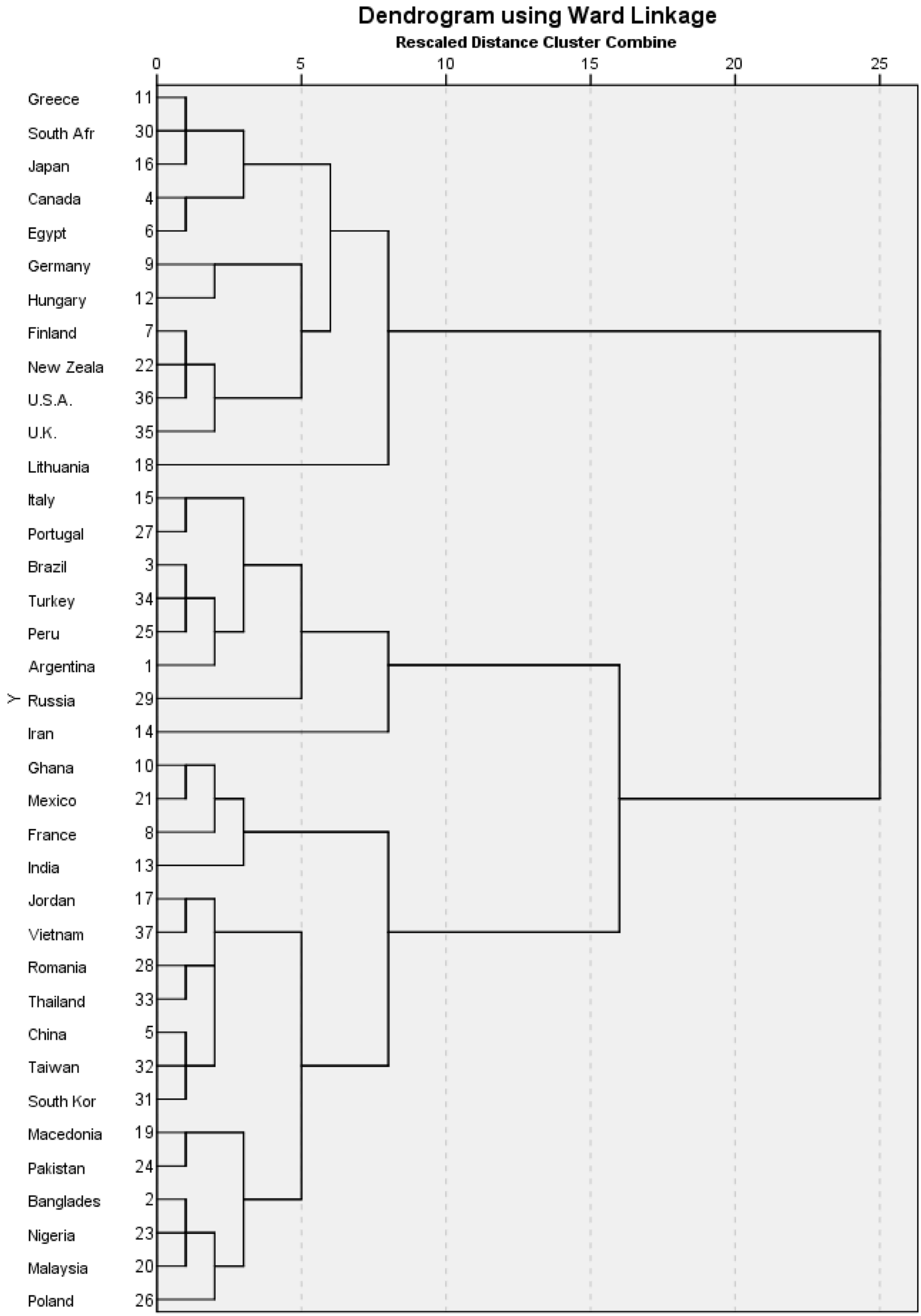

Fig. 1. Cluster analysis dendrogram.

5.1. Analysis by economic level

For the economic analysis, 37 countries were categorized by their economic level. The World Bank classifies countries based on the gross national income (GNI) per capita into four income groups: high, upper-middle, lower-middle, and low, using the Atlas method. The Atlas method smooths exchange rate fluctuations by applying a 3-year moving average, price-adjusted conversion factor. Using the 2018–19 classification scheme [60], each of the 37 countries was placed in a single category. In our dataset, we did not have any country in the low-income

Table 10
The three country clusters.

Cluster 1 Optimizers	Cluster 2 Pragmatists	Cluster 3 Progressives
Canada	Argentina	Bangladesh
Egypt	Brazil	China
Finland	Iran	France
Germany	Italy	Ghana
Greece	Peru	India
Hungary	Portugal	Jordan
Japan	Russia	Macedonia
Lithuania	Turkey	Malaysia
New Zealand		Mexico
South Africa		Nigeria
U.K.		Pakistan
U.S.		Poland
		Romania
		South Korea
		Taiwan
		Thailand
		Vietnam

Table 11
Technology ranks of country clusters.

Information technology issues	Global rank	Optimizers	Pragmatists	Progressives
Networks/ Telecommunications	1	1	3	2
Business Intelligence/ Analytics	2	2	1	1
Enterprise Application Integration	3	3	2	7
Mobile and Wireless Applications	4	6	5	4
Collaborative and Workflow Tools	5	5	7	5
Customer Relationship Management Systems	6	9	8	3
Business Process Management Systems	7	8	4	8
Software as a Service	8	7	10	6
Enterprise Resource Planning Systems	9	11	6	9
Virtualization (Desktop or Server)	10	4	12	14
Big Data Systems	11	12	11	10
Service-Oriented Architecture	12	13	9	11
Cloud Computing	13	10	13	13
Social Networking/Media	14	14	14	12

category, leading to a three-way classification of high, upper-middle, and lower-middle-income countries. There were 17 countries in the high-income group, 13 in the upper-middle group, and 7 in the lower-middle-income group. We also captured the GNI per capita based on purchasing power parity (PPP) for each country from the World Bank database [59]. Taiwan's figures were not available in the World Bank database; they were retrieved from another source [20]. The economic data are shown in Table 7.[12]

The technology ranks for the high, upper-middle, and lower-middle-income countries along with the global ranks are shown in Table 8. There is more similarity than dissimilarity between the three sets of ranks, and all Spearman rank correlations between them are significant at $p < 0.005$. However, there are a few differences, and we highlight the issues where the rank difference is three or more. Some of these can be explained, but others would require further exploration. Customer relationship management systems (CRM) are rated higher in lower-middle-income countries than in high and upper-middle-income countries. A plausible explanation is that the advanced countries have had CRM systems for many years while the lower-middle-income countries may be yearning to get CRM systems but are relatively inexperienced. Similarly, social networking/media experience may be limited in lower-middle-income countries, yet the desire to use this technology may be high. The importance of collaborative technology and virtualization are rated higher in the high-income countries than in the lower-middle-income countries; we argue it is because they have a greater need for such technologies to optimize both human and computer resources. Business process management systems and mobile and wireless applications were rated higher in upper-middle countries than in both high-income and lower-middle-income countries, and software as a service was rated lower in upper-middle countries than in high-income and lower-middle-income countries. These three findings suggest that the relationship of country income and a specific technology may not be so straightforward and linear, but more nuanced and curvilinear.

To examine each specific technology issue and its relationship with the economic status of each country, a more granular analysis was conducted by correlating each issue rank with GNI per capita PPP. Considering that the non-normal nature of the data and the dependent variable is ordinal, nonparametric tests were the most appropriate to use. Significant Spearman's rank correlations were observed for collaborative and workflow tools ($\rho = -0.46, p < 0.01$); business process management systems ($\rho = 0.36$, $p < 0.05$); virtualization ($\rho = -0.41$, $p < 0.05$); and social networking/media ($\rho = 0.53, p < 0.01$). Note that as a lower number represents a higher rank and higher importance, a negative correlation indicates higher importance with higher GNI per capita PPP. Thus, higher-income countries rate the importance of collaborative and workflow tools and virtualization more than lower-income countries; whereas, lower-income countries rate the importance of business process management systems and social networking/media more than higher-income countries. These results are consistent with the findings and explanations provided above.

5.2. Analysis by IT infrastructure capability

A country's income may not necessarily be a direct measure of information technology priorities; one can argue that these priorities may be more directly related to the IT infrastructure of the country. Therefore, we sought out to explore the relationships of technologies with the country's IT infrastructure. It is noteworthy that over the last two decades, many countries have made significant strides in the development of their ICT (Information and Communication Technology) infrastructure (e.g., refer Bollou [2], and Ngwenyama and Morawczynski [46]). The International Telecommunication Union (ITU), a United Nations agency, collects telecommunications/ICT statistics for over 200 countries. Many of their statistics [22] are pertinent to the ICT infrastructure capability of a country, e.g., those related to the use of and access to computers, fixed phones, mobile phones, and the Internet. The most appropriate statistic for our use appears to be Internet use, as it captures several dimensions of computing and communication. The ITU Statistics web page [22] provides the "percentage of individuals using the Internet" for each country. The latest data from 2017 were downloaded. Macedonia's statistics were not available from ITU; it was obtained from an Internet World Stats web site [21]. Table 9 shows the data on Internet usage.

The Internet usage numbers were correlated with the ranks of each technology issue using Spearman's rank correlations. Two significant correlations were found: one for business process management systems ($\rho = 0.37$, $p < 0.05$) and the other for social networking/media ($\rho = 0.41$, $p < 0.05$). The positive correlations indicate that the lower infrastructure countries value the importance of business process management systems and social networking/media more than the higher infrastructure countries. On the surface, these results are not

[12] The Atlas method classification [60] is not based strictly on GNI per capita. For this reason, Argentina is included among high-income countries and Jordan among upper middle-income countries. There are also few other variations.

particularly revealing and would require deeper exploration.

Based on the above analyses, it appears that the country's economic conditions are a better predictor of technology priorities than the IT infrastructure. To gain a superior understanding of the global technology issues, we conducted a cluster analysis as reported below.

5.3. Cluster analysis

While there may be more ways to classify the countries to understand their technology issues, the technique of cluster analysis has an advantage – it is performed organically based on the data rather than any pre conceived assumptions. Our goal is to cluster countries based on the commonality of technology issues among them and then examine the characteristics of these clusters to identify their inherent properties. This analysis provides us further insights into the global dataset.

We employed hierarchical clustering using IBM SPSS Version 25 (with Ward's method and squared Euclidian distance) to segment the countries. Much judgment and iteration have to be exercised in selecting from among the 14 technology issues as the criteria variables for clustering. One option was to use all 14 issues, but it led to the problem of too many variables (refer Everitt [10]) and did not provide meaningful and interpretable clusters. Therefore, we focused on the more important issues in all of the countries and after some iteration, settled on the top ten issues as the criteria variables. Those are as follows: networks/telecommunications, business intelligence/analytics, enterprise application integration, mobile and wireless applications, collaborative and workflow tools, CRM systems, business process management systems, software as a service, ERP systems, and virtualization. An analysis of the agglomeration schedule (similar to a scree plot) was conducted to decide on the number of clusters. The most reduction in the dissimilarity coefficient occurred with two and three clusters (17.3% and 10.9%), and the four-cluster solution had an 8.9% reduction. The three-cluster solution was more balanced in terms of the number of countries included in each cluster. Therefore, the three-cluster solution was chosen; it has 12, 8, and 17 countries in each cluster, respectively. The dendrogram from the cluster analysis is shown in Fig. 1, which also supports the three-cluster solution shown in Table 10. While it is customary to label the clusters with meaningful names, it was difficult to do so because of the lack of a clear differentiation among them; however, we tentatively labeled them as optimizers, pragmatists, and progressives.

Table 11 shows the technology ranks for the three clusters. We considered the distinguishing features of each cluster. All the three clusters have similar rankings on several technologies including the following: networks/telecommunications, business intelligence/analytics, mobile and wireless applications, collaborative and workflow tools, big data systems, and social networking/media. What distinguishes the first cluster from the other clusters is the relatively high ranking of virtualization (6 points ahead of the global rank and 8–12 points ahead of the other two clusters) and cloud computing (3 points ahead of the global rank); this cluster is labeled as optimizers. Both technologies optimize the organization's IT resources. In particular, the primary benefits of virtualization are resource optimization, higher efficiency, agility, and responsiveness (see Pogarcic et al. [53]). The second cluster places a higher value on state-of-the-art and established technologies such as business process management systems (4 points ahead of the other two clusters), ERP systems (3–5 points ahead of the other clusters), and service-oriented architecture (2–4 points ahead of the other clusters). As these countries are exploiting these proven technologies more than others, we labeled them as pragmatists. Finally, the third cluster places a low value on enterprise application integration, but a higher value on technologies such as CRM systems (5–6 points ahead of the other clusters), software as a service (4 points ahead of the second cluster), and big data systems (2 points ahead of the first cluster); therefore, we label the cluster as progressives. These are newer technologies that offer new opportunities, albeit combined with new challenges (refer Michael and Miller [43]). As a note of caution, these generalizations and remarks apply to the clusters as wholes. Each individual cluster is comprised of countries in diverse geographic regions and various economic, demographic, and cultural strata; thereby highlighting and generalizing the difficulties in specific countries.

We conducted an exploratory examination of the three clusters to identify any distinguishing characteristics between them based on national income, IT infrastructure, and national culture. On national income, the average GNI per capita PPP are $36,787, $23,861, and $19,102 for the optimizers, pragmatists, and progressives, respectively. An ANOVA test showed significant differences at $p < 0.01$. The Internet penetration rates are 78.5%, 66.0%, and 57.9% for the optimizers, pragmatists, and progressives, respectively; these differences are significant at $p < 0.05$. The optimizers group is more advanced economically and in its IT infrastructure compared to the rest of the countries – corroborating our earlier analysis.

Of the six cultural dimensions prevalent in the literature (refer Hofstede and Hofstede [18]), the two most relevant to this study are uncertainty avoidance and long-term orientation. Briefly, uncertainty avoidance refers to the degree of people's preference for clear and structured situations and behaviors over unclear and unstructured ones, and long-term orientation refers to the ability to adapt easily to changing conditions and show perseverance as opposed to the preference for immediate gains and short-term performance. While Hofstede's national culture scores are publicly available for many countries (https://www.hofstede-insights.com), we independently measured these scores for all thirty-seven countries using the same survey items and procedures as Hofstede himself. On uncertainty avoidance, the differences in means were significant ($p < 0.10$) between the three clusters. Pragmatists had the highest average uncertainty avoidance score (i.e., least risk-taking), and optimizers and progressive had about the same, but low average uncertainty avoidance scores (i.e., more risk-taking). These results are generally in accordance with the ranks of the issues in the three groups as discussed earlier. There was no statistically significant difference between the three groups in the long-term orientation dimension. Of course, these results are preliminary and require further scrutiny and interpretation.

6. Discussion

The most notable contribution of this study is to provide a global view of information technology issues in the world. The IS literature only offers the U.S. view, with a couple of studies that look broadly at a few regions of the world. IT pervades the entire world and all societies, and an ethnocentric U.S. view, while useful in its own right, does not do justice to the rest of the world. At times, practitioners and researchers around the world take the U.S. perspective as the absolute truth and apply it to their context indiscriminately. The results can be suboptimal and even detrimental at times. The World IT Project took a large cross-section of the world that included 37 countries, providing world representation in terms of economic development, cultural background, political ideology, and societal environment. We also used a common instrument, scale, and methodology to capture the technology issues, thus providing greater comparability and reliability of the results. Furthermore, all were collected during a recent time frame ensuring the comparison of contemporary issues. This is particularly important as information technology is advancing at a breathtaking speed, and the specific technologies change over time, sometimes rapidly.

The top five global information technology issues are the following: networks/telecommunications, business intelligence/analytics, enterprise application integration, mobile and wireless applications, and collaborative and workflow tools. While networks/telecommunications are not even listed among the top technologies in the U.S., on a worldwide-basis, important developments such as 5 G networks, the Internet of Things, and many more disruptive innovations are fueling their growth. Business intelligence/analytics came in second globally, and it was identified by recent U.S. studies as its top issue (refer

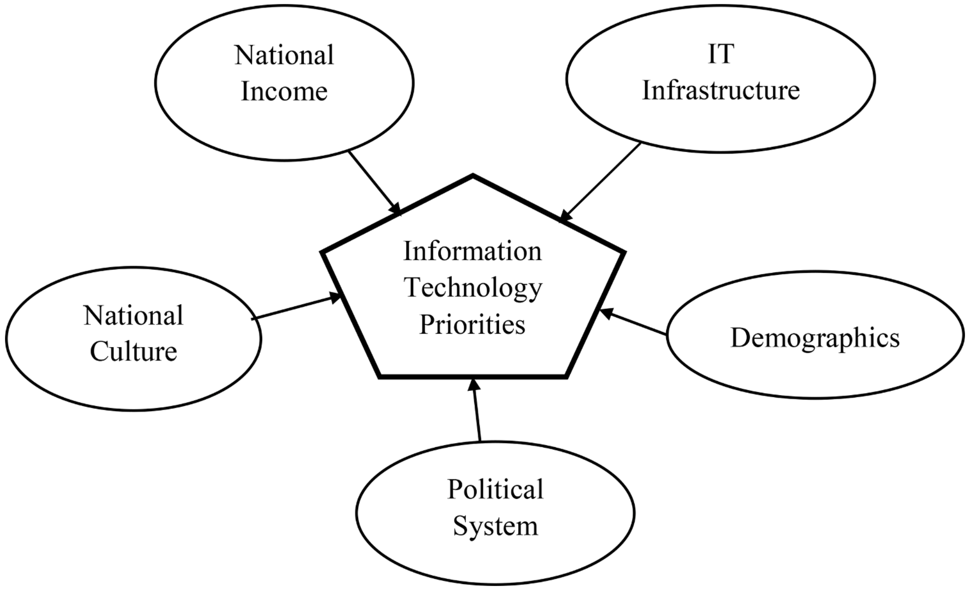

Fig. 2. A conceptual framework for national information technology priorities.

Kappelman et al. [26, 28, 30, 31]). The use of data analytics has witnessed a steep rise by companies worldwide as confirmed by a recent report by Frost and Sullivan [14]. According to this report, the demand for big data analytics will multiply by 4.5 times its size, generating a revenue of $68.09 billion by 2025 from $14.85 billion in 2019, showing an annual growth rate of 28.9%. In third place is enterprise application integration, driven by the steady accumulation of disparate systems and applications in many companies. It is to be noted that four of the top five global issues (i.e., networks/telecommunications, enterprise application integration, mobile and wireless applications, and collaborative and workflow tools) are ranked much lower in the U.S. study [28]. There are at least two reasons for such divergence of views. First, the more obvious and compelling reason is that countries of the world are dissimilar in terms of their economic development and technology evolution. While the U.S. was among the first countries to embrace and even develop various information technologies, many countries came late to the stage in adopting IT solutions. However, several countries have bypassed older technologies and legacy systems, and directly leapfrogged to newer technologies, e.g., India (refer Miller [44]), Arab countries, South Korea, Taiwan, and Singapore (refer Mody and Sherman [45]). A second reason is that the U.S. issues reported in the *MIS Quarterly Executive* studies [26 – 28, 30, 31] are based on the opinions of senior IT executives who may be more concerned about strategic and organizational issues and current investments, and may not be fully conversant with all specific technologies that are used by frontline employees. They may also be more influenced by media reports, prevailing IT fads, and vendor pressures. Our results are based on the views of IT employees who are less strategically focused, but being in the trenches, know more of the pressing realities. Their views are grounded in daily experiences and offer what is pragmatic and realistic. Besides, as Burton-Jones and Galliavan [3] point out, IS research has suffered a level bias; past research on key issues has focused on the executive level. Focusing on the employee level provides new perspectives.

A comparison of technology issues across 37 countries reveals some interesting insights. First, there is a core set of issues that rank high for most of the countries. These include the following: networks/telecommunications, business intelligence/analytics, enterprise application integration, and mobile and wireless applications. Of these, enterprise application integration is rarely observed in the U.S. studies and deserves special mention. From the point of view of IT professionals worldwide, it is a major concern as the persistence of legacy systems and the proliferation of disparate systems impede integration, agility, and flexibility. Some issues are of not much importance across most countries. These include the following: social networking/media, cloud computing, service-oriented architecture, and big data systems. Thus, despite the hype and constant chatter among media and vendors, it does not appear that social networking/media, cloud computing, and big data systems are among the top global concerns.

To gain a deeper understanding on the nature of the technology issues, we conducted an economic analysis and an infrastructure analysis. For economic analysis, all the 37 countries were categorized into three groups: high-income, upper-middle-income, and lower-middle-income. There were many similarities between the three groups, indicating that, to a large extent, technology preferences do not change drastically from country to country. However, there were a few exceptions that may require further probing. For example, customer relationship management systems and social networking/media are rated higher in lower-middle-income countries than in the other groups. A plausible explanation is that these technologies may be relatively new for lower-middle-income countries, yet they see value in them. Collaborative technology and virtualization are rated higher in the high-income countries; these countries may perceive a greater need for these technologies to enhance the value of their human and computer resources. A finer granular analysis was conducted by correlating each technology issue with the economic level of each country. This analysis confirmed that the higher-income countries rate the importance of collaborative and workflow tools and virtualization, more than the lower-income countries; while lower-income countries rate the importance of business process management systems and social networking/media more than the higher-income countries.

As for infrastructure analysis, it showed only two significant relationships: the lower infrastructure countries value the importance of business process management systems and social networking/media more than the higher infrastructure countries. It appears that the country's economic conditions are a better predictor of technology priorities than the IT infrastructure.

As we had limited success using economic analysis and infrastructure analysis to explain our findings, we embarked on an exploratory analysis to tease out the differences in the country rankings. The technique of cluster analysis is a good way to do so as it has the advantage of doing so organically based on the data rather than any pre conceived assumptions. The cluster analysis was conducted to place countries in different groups based on their similarity with respect to the technology issues. While subjective judgment and interpretation are required to develop the clusters, three clusters were identified and labeled as: optimizers, pragmatists, and progressives. While the three clusters had similar rankings for several technologies, the optimizers were focused on optimizing their computing resources (by way of virtualization and application integration), the pragmatists were focused on exploiting state-of-the-art technologies (such as mobile and wireless applications, and customer relationship management systems), and the progressives appear to place more value on newer and emerging technologies (such as big data systems, and collaborative and workflow tools).

Further analysis of the characteristics of the three clusters can provide deeper insights into the underlying factors driving technology priorities.[13] Given the exploratory nature of this study, we briefly examined only three factors: national income, IT infrastructure, and national culture. On national income and infrastructure, statistical tests demonstrate that the optimizers have the highest GNP per capita PPP and a superior infrastructure followed by progressives and pragmatists. This explains our earlier finding: the optimizers have plenty of resources and perhaps even excess computing capacity because of decades of technology build-up; so they are now focused on optimizing their computing resources using virtualization technology and enterprise application integration. The pragmatists are the lowest on the economic and infrastructure scale and so are focused on using tried and tested solutions rather than venturing into new arenas.

On culture dimensions, we found a statistically significant difference in the uncertainty avoidance dimension with progressives having the highest score (i.e., least risk-taking) and optimizers having the lowest score (i.e., most risk-taking). This may be somewhat counterintuitive requiring further scrutiny, given that in our sample, the progressives appear to be more focused on exploring some of the newer technologies.

There is no silver bullet to explain some of our results and we suggest that there is a confluence of factors that are at play. We believe that there are at least two other macro factors: political system and demographic factors that influence the technological landscape of a country, as shown in our conceptual framework in Fig. 2. The political system or the type of government in a country can influence the technology choices made by its people and organizations. As Patanakul and Pinto [52] observe, government policies and regulations that are well-targeted can stimulate specific technologies while certain policies and regulations can also create obstacles and hinder innovation. Case in point: certain Arab countries and developing countries have leapfrogged technology by major government initiatives, e.g., Saudi Arabia and Azerbaijan [57]. Another example is where the Chinese government has made heavy investments over the years in its telecommunications infrastructure (refer Kshetri et al. [35]).

Demographic factors come into play as they define the needs and wants of the country. They include at least the following factors: the division between urban and rural population, the age distribution, and the level of education (refer Skaletsky et al. [55]). As an example, a recent article by Hauk et al., [17] reported that age was negatively related to the acceptance of various technologies and the negative effect was driven by the lack of perceived ease of use.

The ultimate point of the above analyses – which brings us back to the starting point of the study, is that despite many similarities – countries are nevertheless different in terms of how they value various technologies. Therefore, they must be treated differentially and not by a single stroke of the brush. A careful examination is required to discern these differences and the factors underlying these differences.

Another important implication of the framework presented in Fig. 2 is that it underscores the necessity of a systematic and methodical examination of contextual factors that affect various IS/IT phenomena. While we examined the global technology issues at a macro level, there are literal scores of studies that have compared various IS phenomena across countries at the macro- or meso-levels. Such studies compare either a very few countries (typically two or three) or do a more comprehensive global examination with multiple countries. We provide a few examples of such studies here, in no particular order. The study by McCoy et al. [42] compares the applicability of the Technology Acceptance Model (TAM) (by Davis [8]) across many countries and uses national culture to explain the differences. Im et al., [19] do a two-country comparison of the UTAUT technology acceptance model (by Venkatesh et al. [58]), but do not explicitly consider any particular factors. More recently, Khan et al., [33] have examined IT diffusion across multiple countries and consider legal and national culture factors in their analysis, and Krishnan and AlSudiary [34] have examined social network diffusion through the lens of national culture. The 2020 study by Srivastava et al., [56] investigates cybercrime across multiple countries and considers technological and economic factors to explain their findings. The study by Chen and Zahedi [6] does a two-country comparison of security perceptions and behaviors through the lens of national culture. There are numerous other studies, but there are commonalities among these studies. Either they do not use any factor for their comparisons, use only national culture as a factor, or at most use two or three factors. While such studies have made contributions in their own right, future studies would benefit from a more comprehensive set of factors as elucidated in our conceptual framework. However, it should be noted that while we suggest a broad range of contextual factors, their operationalization[14] would require specific measures unique to each study.

6.1. Limitations

Being an extensive study, the World IT project has certain limitations. Some limitations are associated with surveys in general, e.g., sample size and representativeness. Our desired threshold for sample size in each country was 300, which is generally considered adequate and comparable to past IS studies. Fortunately, in many countries, we met or exceeded this threshold. As often in the case of IS research, no direct attempts were made to randomize the sample; however, we tried to achieve representativeness by specifying to the country investigators that they should find responding IT employees from various levels of staff and management, in organizations of various sizes, and in different industries. The instrument was developed based on English-based literature and past English instruments; thus, its implementation in some countries posed challenges. The instrument had to be translated into twelve languages. To maintain semantic equivalence between the English version and the local language version, several steps were taken. First, the instrument was translated into the local language and back-translated to English by two different bi-lingual investigators. Second, the core team maintained regular communication with the local investigators to resolve any discrepancies. Third, a limited number of changes were allowed in the language to accommodate local meaning and expressions.

Other limitations include the number of countries participating in our study. While 37 countries is a good representation, future studies can include more countries (notwithstanding the amount of effort and labor involved). The data collection process was complex and laborious. Although we had planned a two-year window to collect the data, it took us three years to collect the data from all 37 countries. This may have resulted in some evolution of the issues over time. Further, we could not

[13] Our attempts to find the underlying factors that determine global technology priorities may be less than fruitful if the convergence hypothesis is to be accepted. Although controversial with mixed empirical results, the convergence hypothesis maintains that over time; economic conditions and technologies converge across nations [47, 61].

[14] We used or discussed several measures for each factor in this study. A comprehensive development of measures for each factor would require careful scrutiny and examination, which is a major effort by itself and is outside the scope of this article.

keep track of the non responses, early responses, and late responses to observe possible biases. Our results are based on weighing each country rank equally in the global rank; we tried other weighting schemes, but they did not make any appreciable difference. There were several other challenges in the World IT Project, as described in [50].

6.2. Practical implications

The U.S. technology issues reported in the annual *MISQE* studies are certainly useful in the American context. While the U.S. perspectives are important to know as the U.S. is a large part of the global economy; its GDP is about one-fourth of the global GDP [11] and has 4.4% of the world's population. Thus, the U.S. perspective provides only an ethnocentric and incomplete view of the world. Therefore, a global understanding of the critical technology issues faced by firms and their employees is important from organizational, national, and international points of view. For a multinational firm having IT operations in many countries, a global view would enable it to customize its technology portfolio in accordance with the needs of the country. For example, while virtualization and big data may be priorities in one country, software as a service and social networking/media may be important in another. At the national level, it would allow stakeholders, such as policymakers, government agencies, and technology vendors, to address contemporary technology issues faced by organizations and the IT industry. Specifically, government agencies and vendors may provide investment and incentives to stimulate the growth of certain technologies. In international business, it would help firms and governments to respond to the needs of partners and stakeholders in other countries and promote appropriate technology transfer.

6.3. Future research directions

As possibly the first comprehensive study to examine information technology issues on a global scale, it opens up many new opportunities for IS researchers. We list several of these, in no particular order. First, it would be useful to examine more countries of the world and investigate whether our global analysis extends to a larger number of countries and perhaps points to areas of similarities and differences. Second, it would be worthwhile to examine the evolution of technologies over time and whether there is a pattern that many countries go through. Typically, five generations of computers are recognized in the literature: the first generation of vacuum tubes (1940–1956), the second generation of transistors (1957–1963), the third generation of integrated circuits (1964–1971), the fourth generation of microprocessors (1972–2010), and the fifth generation of artificial intelligence (2010 and beyond) [3-4]. Does this taxonomy apply to specific technologies or is there a different taxonomy? Third, related to this question, do countries have to go through an evolutionary path or can countries leapfrog, as evidenced in some familiar examples [44, 45]?

Fourth, using statistical cluster analysis, we were able to classify the 37 countries based on technology preferences into three clusters: optimizers, pragmatists, and progressives. Does this classification hold up in future investigations or should it be refined? Fifth, while our exploratory investigation revealed some factors explaining the nature of technology issues, we need to further sharpen our understanding. We offered a conceptual framework with five broad factors (refer Fig. 2) but the relationships within the framework may be complex and at times recursive. Therefore, we propose to examine these and other factors carefully and rigorously to arrive at more definitive conclusions. Similarly, more research is required to understand why some rankings are either too high or too low in some countries; there just might be local and nuanced factors at play.

Sixth and finally, we would like to recommend a program of research, which would evaluate global information technology issues periodically, just as the U.S. issues are investigated annually. We realize that it would be a formidable task, which requires a significant commitment of effort and resources. We expect that such an undertaking would require the sponsorship of and collaboration among several organizations across the world.

7. Conclusion

This study reports the information technologies considered as important by IT professionals in 37 countries, thus contributing to an enhanced understanding of the global technology landscape. Our study supplements prior IS literature that has focused primarily on the U.S. and regional IT issues, thus providing an enhanced and broader view. Our findings indicate major differences between the global rankings and the U.S. rankings of information technologies. In our analysis, there is a core set of technologies that rank high for most of the countries. These include the following: networks/telecommunications, business intelligence/analytics, enterprise application integration, and mobile and wireless applications. We also observed some important differences between countries based on their economic level and IT infrastructure capability. Finally, based on statistical cluster analysis, we could group the 37 countries into three clusters: optimizers, pragmatists, and progressives, and offer explanations for differences between the clusters.

A global examination of information technology issues in various parts of the world was long overdue. We finally propose other scientists to continue this effort so that both practitioners and researchers can observe technology trends in various parts of the world and be prepared to meet imminent challenges.

Author statement

All authors contributed equally to the article. One author was removed with mutual agreement because of nonparticipation.

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