Too Many Labels, Not Enough Agreement: Defining Sub-Disciplines in Computer Science-Related Fields

Terri L. Lenox
Mathematics and Computer Science
Westminster College
Market Street
New Wilmington, PA 16172

and

Charles R. Woratschek
Computer Information Systems
Robert Morris University
University Boulevard
Moon Township, PA 15108

Abstract

This paper examines the various definitions of computer science-related fields that have evolved since the 1960s. A survey was distributed to 150 people (with 67 responding) asking a variety of questions concerning the definitions of Computer Science (CS), Computer Information Systems (CIS), Management Information Systems (MIS), Information Systems (IS), and Information Technology (IT). One question asked whether Information Systems includes Information Technology or the reverse. Approximately 62% of respondents stated that IS is the umbrella under which IT lies. There appears to be much confusion about distinctions among the academic disciplines of Computer Science and Information Systems. The question arose – "Are these different disciplines or different names for the same discipline?" A redefinition of both IS and IT would fine-tune our definitions with actual practices and more accurately reflect the complete range of this discipline. An additional goal would be to help us to define these disciplines for our students and avoid excluding certain under-represented groups (e.g., women and minorities).

Keywords: CS, CIS, IT, IS, MIS, definitions

1. Introduction

Currently, the field of Information Systems suffers from an overabundance of different names, including: Information Systems (IS), Computer Information Systems (CIS), Management Information Systems (MIS), Business Information Systems (BIS), Decision Support Systems (DSS), Information Management (IM), Information Resource Management (IRM), Information Technology Resource Management (ITRM), Information Science, Information Technology (IT), Information Technology Systems (IST), Office Automation Systems (OAS), Accounting Information Systems (AIS), Information and Quantitative

Science, and Informatics (Gorgone, Davis, Valacich, Topi, Feinstein, & Longnecker, 2002). According to the authors of the IS '2002 model (Gorgone, Davis, Valacich, Topi, Feinstein, & Longnecker, 2002), these

different names reflect "historical development of the field, different ideas about how to characterize it, and different emphases when programs were begun" (p. 10).

However these labels originated, their proliferation and the resulting confusion concerning their meaning may have an adverse affect on the Information Systems discipline. As Cukier, Shortt and Devine (2001) reported, a narrow definition of the Information Systems discipline with an emphasis on technology "has the effect of excluding women and multi-disciplinary perspectives" (p. 2). A redefinition of both IS and IT would fine-tune our definitions with actual practices and more accurately reflect the complete range of this discipline. An additional goal would be to help us to define these disciplines for our students and avoid excluding certain under-represented groups (e.g., women and minorities).

Origins of IS Discipline

Information Systems as an academic field arose from several different disciplines including Accounting, Business, Computer Science, Management Science and Library Science due to the need to effectively use computer-based information systems in organizations. Following the evolution of Information Systems through one of the originating disciplines, Computer Science, it can be seen that CS has undergone many changes in a relatively short period of time. In March 1968, Curriculum '68 was published by the ACM and Computer Science became a distinct discipline from Mathematics (Mitchell, 2003; ACM, 1968). Curriculum '68 was one of the earliest attempts to define the discipline. It included a comprehensive core curriculum and also defined three major subfields of computer science: information structures and process, information processing systems, and methodologies (Tucker & Wegner, 1994; ACM, 1968).

By 1981 reports published by IEEE, DPMA (now AITP) and others helped to define three distinct areas of computing: Computer Science, Computer Engineering, and Computer Information Systems (DPMA, 1981; Nunamaker, Cougar & Davis, 1982). These three areas can be seen in the traditional range of computing courses offered by higher educational institutions in the 1980s: hardware (Engineering), software (Computer Science) and applications (Computer Information Systems). Mitchell (2003) states "it was customary to depict computing as a bar with hardware (engineering) at one end, software (computer science) in the middle and applications (CIS) at the other end" (pp. 97-98). In 1983, ACM published its recommendations for Information Systems (ACM, 1983). Several other curriculum models were developed including the DPMA's 1981, 1986 and IS '90 curricula (DPMA, 1981; DPMA, 1986; Longnecker and Feinstein, 1991) and the IS '95 and '97 model curricula (a joint effort by ACM, AIS, and AITP). The most recent effort is the "IS '2002 Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems" which is a collaborative effort among ACM, AIS, and AITP (Gorgone, Davis, Valacich, Topi, Feinstein, & Longnecker, 2002).

2. Challenges to IS

The discipline of Information Systems is faced with several challenges. First, it must keep pace with the rapid changes in technology and its use within organizations (Davis, 1992). Secondly, the curriculum itself must be modified to reflect these changes without focusing entirely on the technology aspect of the discipline (Mitchell, 2003; Clarke, 1999; Davis, 1992). The IS 2002 Curriculum Model and a recent survey by Woratschek and Lenox (2002) reiterate the need for IS professionals to have a business perspective, strong analytical skills, good, non-technical skills (such as communication skills, ethics and team skills) and the ability to "design and implement information technology solutions that enhance organizational performance" (Gorgone, Davis, Valacich, Topi, Feinstein, & Longnecker, 2002, p. v).

The third challenge is the need to develop a common understanding of the Information Systems discipline that is agreed to by both practitioners and educators. In an online survey in July, 2001, Lankford, questioned 74 IT professors and discovered a "surprising variety of program names" (p. 1) and differing definitions for IT, IS, MIS, and CS. She found that some respondents defined IT as a separate entity from Information Systems (IS), Management Information Systems (MIS), and Computer Science (CS); while others believed IT was

the umbrella under which these other groups or divisions fall (Lankford, 2001).

The final challenge for Information Systems is to decide whether or not to distinguish itself from Information Technology as a discipline. The authors are not proposing a solution to the challenge, but wish to contribute to the discussion. One problem that arises in this discussion is the need to decide whether IS includes IT or IT includes IS. Several proposed curricula for IT appear to be only revising the IS discipline and not creating a new IT discipline. For example, Finklestein and Hafner (2002) summarize a report presented to a group of 30 deans of colleges and schools of IT who are wrestling with the issues of defining the Information Technology discipline. They proposed a continuum for the IT curriculum stretching "from fundamental computing principles (far left), to the impact of technology on society (far right)" (pp. 2-3). The center of this continuum is how to apply cognitive/social constraints to the technology. This definition strongly overlaps with the traditional definition of Information Systems. So again, the question arises – is there a difference between Information Systems and Information Technology and can we agree upon a common definition?

From a brief examination of IT curricula in various institutions, (Chu, 2002; Finklestein & Hafner, 2002; Mitchell, 2003), it appears that IT programs, like IS programs, are very diverse and typically multi-disciplinary.

Some researchers believe that the IS discipline will continue to specialize along problem areas including telecommunications, animation, e-commerce, wireless-telephony, data mining, and bioinformatics where the required skills are disjoint (Mitchell, 2003). Another way of dividing the Information Systems/Information Technology field is reported by Denning (2001) who suggested that students be prepared for professions. He divided the IT profession into three types of individuals: 1) those whose focus is a specific IT discipline; 2) those whose focus is a discipline that is IT intensive; and 3) those whose job is IT supportive. Some of these researchers are proposing that the set of skills required for the various areas are so disjoint as to make them separate disciplines with little or no commonality.

However, the IS 2002 Model Curriculum suggested that there is still a large amount of overlapping knowledge between IS and IT and proposed three levels of coursework for IS students (Gorgone, Davis, Valacich, Topi, Feinstein, & Longnecker, 2002, pp. v - vi):

1. General courses in information systems for IS majors and minors.
2. Specialized information technology and application design courses for IS majors and minors.
3. Specialized application development, deployment, and project management courses for IS majors.

To investigate the currently held beliefs about the disciplines related to Computer Science we asked 150 people about some common definitions. Specifically, the survey provided some definitions for Information Science, Computer Science, Management Information Systems, Computer Information Systems, and Information Technology. These definitions were developed from a variety of sources including current textbooks, dictionaries, web pages from higher educational institutions who offer these programs and from a review of the literature (these sources are cited in the References section, wherever possible). The survey asked respondents whether they agreed with these definitions and to comment where appropriate. A subset of the possible labels for Information Systems was selected due to time constraints. The survey also asked whether IS was the encompassing discipline or IT.

3. Methodology

The survey employed in this study was designed in three parts. Part I consisted of questions regarding the responder's company characteristics and the responder. Part II consisted of questions related to definitions for Information Science, Computer Science, Management Information Systems, Computer Information Systems, and Information Technology. Part III asked the respondents to rank the skills appropriate to the various majors (information science, CS, CIS, MIS, and IT). Due to confusion regarding how to complete Part III and feedback from respondents on the pilot survey, this section was dropped and was not analyzed in the final results.

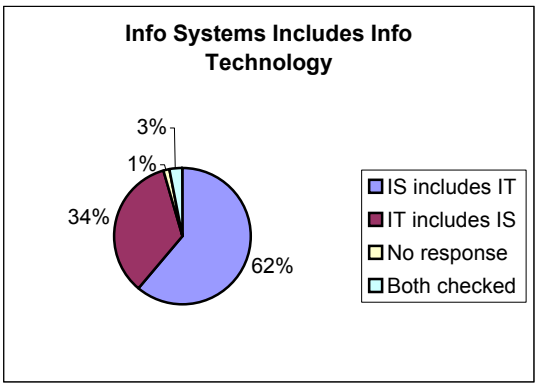

Figure 1: IS Includes IT

The survey was distributed to members of a doctorate of Information Systems and Communications program, employers who hired entry-level IS individuals and randomly selected members of ISECON. Approximately 150 surveys were distributed and 67 were returned for a 44% return rate.

4. Results

Respondents from Higher Education comprised 44.78 percent of the respondents with 6 percent from K-12 education. The next largest group of respondents was in the computer/services/ IT consulting business (19.40%); followed by financial services or insurance (12%) and manufacturing (7.46%).

As seen in Figure 1, the statement Information Systems includes Information Technology was selected by 61.9 percent of the survey respondents. The opposing statement, Information Technology includes Information Systems, was selected by 34.44 percent of the respondents. Two respondents selected both statements, while one respondent did not respond. Several respondents commented on this question (all comments can been seen in Appendix A) – "All Information Systems have information technology as a core ingredient. The system is the entire project and the technology used to power or run that system is the information technology."

Another comment – "I changed my mind several times on this one. But I think that Information Systems has a broader range – a system could include manual procedures whereas Information Technology relies on hardware and software for solutions (primarily)." Several questions were asked regarding definitions of various fields in the Information Systems field. Table 1 below summarizes the results found in this survey.

The first definition was for Information Technology (IT); 77.61 percent of the 67 survey respondents agreed with this definition while 20.90% did not agree. Appendix B shows all of the comments from twenty-one out of the 67 survey respondents. Several of the comments indicated a desire to limit the definition of Information Technology to just hardware and software – "I could agree if it only included hardware and software."

The second definition provided was for the field of Information Science and 89.55 percent of the respondents agreed with this definition while 7.46 percent did not. One respondent selected "don't know" and one respondent did not answer. Comments from eleven of the survey respondents are shown in Appendix C.

The third definition in the survey was for Management Information Systems (MIS) and 79.10 percent of the respondents agreed with this definition and 20.90 did not. One respondent commented – "I think this is a pretty good definition. I think of MIS as IS from the management perspective. There is more emphasis on what the results are for the business, and less emphasis on how it actually happens. MIS is not a worker-bee activity. IS is a worker-bee activity." Another commented – "I dislike it when textbooks present the term MIS as a type of IS that provides management reports. I do think MIS is a bit more broad than just the study of IS business applications. Also includes IT strategy, resource allocation, project management, and other activities." All comments on the definition of MIS can be seen in Appendix D.

The definition of Computer Science (CS) was accepted by 86.57 percent and not accepted by 11.94%. Several respondents suggested alternative definitions or additions to the definition provided for computer science. One respondent commented – "Like anything else, it is hard to fully agree with your definitions. Add to it the science of programming and the engineering of software systems, and I think you have a pretty good definition. " Another tried to

differentiate the fields – "I think this is a helpful definition. In my mind, the CS people develop new things. The IS people apply those developments and target them to actual needs in the real world. For instance, CS would develop a general-purpose inventory control system, or a new form of database system. IS would buy it off the shelf and customize it for their current clients. IT would keep it running day to day, but if it broke, they would need to call IS to fix it." Other comments are found in Appendix E.

Eighty-two percent of the respondents agreed with the last definition provided in the survey for Computer Information Systems (CIS) and 13.43 percent disagreed. Appendix F lists the comments from survey respondents regarding this definition. One respondent stated – "From what I've seen CIS is so 'gray' that it could either be MIS or IS." Several respondents did not like the choice of the word "exploit" in the definition.

5. Discussion

Just as Lankford (2001) discovered, this survey found no consensus concerning Information Systems and Information Technology. The statement Information Systems includes Information Technology was selected by more respondents (61.9%) than the opposing (Information Technology includes Information Systems). However, many of the comments reflect confusion about the actual differences. As reflected in the survey results, many believe that IS subsumes IT; while others see IT as the encompassing discipline. This later tendency is appearing more frequently in both popular and research journals with an emphasis on the technology.

It appears that many of our respondents believe that Information Technology is a subset of Information Systems which focuses on the technology, including systems architectures, operating systems, and networking (Gorgone, Davis, Valacich, Topi, Feinstein, & Longnecker, 2002). Does this imply that IT is not a discipline unto itself? It is evident that further discussion and debate is crucial.

Although our respondents would argue about specific word choices, the overall agreement for the definitions of Computer Science, Computer Information Systems, Management Information Systems, and Information Science was 77% and above. One may be concerned that we are not 100% in agreement. It appears, therefore that more discussion and debate regarding our fundamental definitions is necessary.

Obviously, it is important for both the academic and business communities to develop commonly agreed upon definitions for the various sub-disciplines that allows us to:

- Reflect the current state of these disciplines and reduce the confusion currently existing about these disciplines.
- Create appropriate curriculums.
- Develop effective IS/IT professionals with a strong foundation in both technical and non-technical skills.
- Match employers' expectations.
- Avoid disenfranchising women and minorities.
- Work collaboratively within our disciplines.
- "Design and implement information technology solutions that enhance organizational performance" (Gorgone, Davis, Valacich, Topi, Feinstein, & Longnecker, 2002, p. v).

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Table 1: Definitions of Various Sub-Disciplines Within CS and IS

Definition	Agreed With	Disagree With	Don't Know	No Response
Information Technology (IT) - the development, management installation, & implementation of computer systems & applications, including the hardware & software.	77.61%	20.9%	1.49%	0%
Information Science - the systematic study & analysis of the sources, development, collection, organization, dissemination, evaluation, use, & management of information in all its forms, including the channels (formal and informal) & technology used in its communication.	89.55%	7.46%	1.49%	1.49%
Management Information Systems (MIS) - the study of information systems used in business. Business applications typically include payroll, accounts payable, sales, inventory control, and enterprise management.	79.1%	20.9%	0%	0%
Computer science (CS) - the study of computers and their applications, in all aspects, as well as the mathematical structures that relate to computers and computation.	86.57%	11.94%	1.49%	0%
Computer Information Systems (CIS) - the study of how to combine general business knowledge with the latest software engineering tools and techniques to create and exploit information systems for organization success.	82.09%	13.43%	1.49%	2.99%

Appendix A : Information Systems includes Information Technology was selected by 61.9 percent of the survey respondents.

1) All Information Systems have information technology as a core ingredient. The system is the entire project and the technology used to power or run that system is the information technology.

2) Students studying IT are probably studying a more narrow area than those in IS. I think of IT as being the non-theoretical parts of IS, including laying cable, troubleshooting hardware, doing helpdesk things, but NOT programming or doing database.

3) I believe that IT is a subset of IS.

4) IT implies hardware & software but most systems rely on people & process issues, in addition to technical tools.

5) Either is appropriate, I have no preference. It's a matter of opinion of which becomes the umbrella for other disciplines.

6) I changed my mind several times on this one. But I think that Information Systems has a broader range – a system could include manual procedures whereas Information Technology relies on hardware and software for solutions (primarily).

7) I chose the first but truly I believe they are different at the core. IS focus on business' use and software. IT is primarily hardware systems.

8) Information Systems includes people, business processes, culture, management styles, decision styles in addition to IT.

9) I feel both statements are true. It would depend on the context in which the statement is being used.

Appendix B : Information Technology (IT) has been defined as the development, management installation, and implementation of computer systems and applications, including the hardware and software. (American Heritage Dictionary of the English Language, 2000).

1) IT INCLUDES THE COMMUNICATION SYSTEMS USED TO LINK COMPUTERS i.e. TELECOMMUNICATION SYSTEMS

2) See above. I think the definition could be valid, but I don't think it matches what most people think. I think that most people think of IT as being a notch lower than IS. (See above refers to # 2 of question 9).

3) IT includes more technologies than just computer systems and applications.

4) That is what Information Systems is. IT is the technology behind it.

5) I am assuming "management" includes maintenance & refinement/upgrade.

6) Too focused, It can mean many things to many people. I see it used as umbrella term for multiple disciplines or a generic term for CIS and IS related disciplines.

7) Perhaps my definition is more expansive than this.

8) Not include software

9) Our department has even changed its name from Information Services to Information technology.

10) I consider Information Technology to be the hardware, architecture and support delivery mechanism for software.

11) I would say that this is a definition of Information Systems, where the computer systems and hardware are the Information Technology.

12) I view IT as a term that is a very broad umbrella encompassing all technologies used for management of information and decision making

13) Have seen it defined many (often diverse) ways. Information technology is a very broad term. I think you have captured the essence of it (at least my understanding of it).

14) I could agree if it only included hardware and software.

15) We would also include the networking HW & SW in here as well.

16) The definition omits the Change Management, "workflow" consulting, and other soft organizational skills that ought to be part of I.T. in an institutional/corporate setting.

17) If "development" means design and deployment of the hardware and software, then the inclusion of development to the definition is too broad. IT individuals are specialists in developed, available solutions – not crafted ones. Any crafting of pieces goes to an IS specialist.

18) As far as I know.

19) Don't feel qualified to judge. Computer Science is my area, and I teach from a CS perspective.

20) The definition of IT and IS are confusing the more the layers are peeled away.

21) and the IT people (management, recruitment, etc.)

Appendix C: Information Science (IS) has been defined as the systematic study and analysis of the sources, development, collection, organization, dissemination, evaluation, use, and management of information in all its forms, including the channels (formal and informal) and technology used in its communication. (Reitz, J. M., 2002).

1) I have no opinion on the definition of Information Science at this time.

2) Information and knowledge are critical resources that have come to be recognized as complements to labor and capital resources in the modern business organization. Information systems are artifacts (the combinations of technology, data and people) that produce the information resource for the use of individuals, organizations and society.

3) " . . . including the roles, processes, and technology used in its communication." Also, doesn't "IS" typically refer to "Information Systems"?

4) Pretty good definition!

5) However, I come from a school that defines it that way. Most folks refer to the same thing as Information Management.

6) Agree with the definition. But in some places, Info Science is info systems with an emphasis on an application area outside of business, such as in health sciences, psychology, etc.

7) DON'T KNOW

8) I could agree if it also specifically included people and processes.

9) "IS" is not a term we use here.

10) I won't quibble with it, but you're using I.T. and I.S. in the reverse relationship from what I'd answered (to question #9).

11) Information Science is the "scientific" study – may be what was meant by systematic, but systematic is too general. IS is also concerned with the representation of the named components (sources, organization) and the creation of rules of change that govern information processing across all forms of knowledge development. IS is not studied for the sake of understanding information, but for the sake of understanding its relationship with respect to data, knowledge, and noise – across any and all domains.

12) and people, and knowledge tacit/concrete

Appendix D : Management Information Systems (MIS) has been defined as the study of information systems used in business. Business applications typically include payroll, accounts payable, sales, inventory control, and enterprise management. (Laudon and Laudon, 2003).

1) Combining the business and information system knowledge with management skills to successfully lead and manage an organization

2) Not just "the study of" but "the analysis, design, and development of"

3) At the Federal Government agency where I work, MIS is used to define the data extract/summaries that are prepared from daily/monthly transaction data. MIS data is presented in reports for use by upper management and to support administrative functions.

4) I think this is a pretty good definition. I think of MIS as IS from the management perspective. There is more emphasis on what the results are for the business, and less emphasis on how it actually happens. MIS is not a worker-bee activity. IS is a worker-bee activity.

5) More or less. MIS also includes the strategic use of IT and a host of related issues.

6) Traditionally, I agree but today it's much broader. Many programs include some programming curriculum too.

7) This definition didn't seem to convey or cover some of the applications I have worked on while in the MIS department. We have developed the actual products and services provided to our customers – if the term "sales" above is supposed to cover these, then a little more clarification should be added. We also build knowledge management applications that include analysis for marketing, cross-selling and developing new products and services for our customers. If this is covered by "enterprise management," then again I think a little more elaboration is needed.

8) Believe this is the broader accepted definition. The operational definition must be expanded to include moving all types of data, information, and knowledge through an organization.

9) Yes… the non-technical side of IT within the business world. In my experience, individuals in this area can become excellent, business analysts.

10) Strategic uses are emphasized even more than operational uses

11) I dislike it when textbooks present the term MIS as a type of IS that provides management reports. I do think MIS is a bit more broad than just the study of IS business applications. Also includes IT strategy, resource allocation, project mgmt, and other activities.

12) Your definition suggests that MIS is about the study of a specific categories of information systems themselves and underplays the role of information systems and the profound and strategic impacts of IS in organizations.

    An alternative definition: the study of the development, deployment, use, and impacts of information technology in an organizational and managerial context

    A typical question is "how can IT add value to the organization?"

13) I think of MIS as all the reporting stuff, including LDAP and decision support, which aren't included in the sample definition.

14) MIS definition (as with all of the others) lack a defining purpose for its study. One studies IS in relationship to business in order to facilitate and enable effective decision-making processes – whether by a executive, manager, employee, or customer. Hence e-commerce, web development, decision-support, and database all are applicable areas of study within the field.

15) Enterprise Management is umbrella MIS and others fall under

Appendix E : Computer science (CS) has been defined as the study of computers and their applications, in all aspects, as well as the mathematical structures that relate to computers and computation. (http://kosmoi.com/Computer/).

1) Needs to include computer architecture and development of systems software.

2) At the Federal Government agency where I work, Computer Science is used to refer to mathematical programming in non-business applications.

3) I don't think this is a helpful definition. In my mind, the CS people develop new things. The IS people apply those developments and target them to actual needs in the real world. For instance, CS would develop a general-purpose inventory control system, or a new form of database system. IS would buy it off the shelf and customize it for their current clients. IT would keep it running day to day, but if it broke, they would need to call IS to fix it.

   Maybe your definitions would be more useful if they related to what people do, rather than what they study.

4) Like anything else, it is hard to fully agree with your definitions. Add to it the science of programming and the engineering of software systems, and I think you have a pretty good definition.

5) Its also embedded systems and artificial intelligence, etc.

6) Better definition: "The field of computer hardware and software. It includes systems analysis & design, application and system software design and programming and data center operations. For young students, the emphasis is typically on learning a programming language or running a personal computer with little attention to information science, the study of information and its uses." (Source: http://www.techweb.com/encyclopedia/defineterm?term=computer+science)

7) Based on my first 2 years in CS, it was basically just programming.

8) I don't agree with the "all aspects" portion - too broad. See the following site for a description of how we differentiate CS vs IS (note: credit should go to http://www.xu.edu/information_systems/is_vs_cs.cfm (credit for definition should go to Vicki L. Sauter,U. of Missouri-St.Louis).

9) The efficient use of computer resources has been a traditional goal of CS research.

10) should concentrate more on hardware than software.

Appendix F: Computer Information Systems (CIS) - the study of how to combine general business knowledge with the latest software engineering tools and techniques to create and exploit information systems for organization success. (http://www2.cis.gsu.edu).

1)	I WOULD USE THIS FOR QUESTION # 12 (MIS definition).
2)	I have no opinion about this definition at this time. Except see my comment about that fact that all your definitions relate to what people "study" and not to what people "do". Refers to #3 under question 13.
3)	Should include more definitive technology capabilities.
4)	ADD TO IT PROGRAMMING TOOLS.
5)	I would include the study of best practices and standards for software development and managing IT infrastructure.
6)	Yes… the more, technical side of IT within the business world. In my experience, individuals in this area can become excellent, "heads-down" coders or business analysts.
7)	From what I've seen CIS is so "gray" that it could either be MIS or IS.
8)	I DON'T CARE FOR THIS DEFINITION. I DON'T THINK SOFTWARE ENGINEERING HAS ANY PLACE IN THIS DEFINITION . I THINK SOFTWARE ENGINEERING IS QUITE DIFFERENT.
9)	I am unfamiliar with the term and do not feel comfortable commenting on it.
10)	DON'T KNOW.
11)	I would not include general business knowledge.
12)	This definition is close to what I was suggesting for MIS. I wouldn't use the term "exploit" because of its negative overtones, though. I wouldn't be certain how to differentiate CIS from MIS. My Ph.D. degree is from a business school program, and the acronym I most identify with is your "MIS."
13)	"CIS" is not a term we use here.
14)	I DON'T HAVE A DEFINITION FOR THAT TERM.
15)	not sure this is a good word (exploit), has a negative connotation.
16)	not just for business.