Skill Requirements of ERP Graduates

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ABSTRACT

This research develops a list of the key skills that organizations expect from recent graduates of university programs in Enterprise Resource Planning (ERP). Quantitative and qualitative analysis of 105 surveys from IT professionals involved in the implementation or support of ERP systems (e.g., IT project managers, systems analysts, IT consultants) indicate a wide variety of skills needed by ERP graduates. These skills are classified as ERP Technical Knowledge, Technology Management Knowledge, Business Functional Knowledge, Interpersonal Skills, and Team Knowledge and Skills. The specific skills that comprise each group are identified and discussed. The main benefit of this study is that it presents a list of key skills that business schools must consider teaching when implementing their own ERP program. For business schools with existing ERP programs, this research provides a list of skills that can be used to help determine how well their program is meeting the needs of industry.

Keywords: ERP, Business School Curricula, SAP Education

1. INTRODUCTION

Enterprise Resource Planning (ERP) is taking the business community by storm. As organizations undertake the enormous challenge of implementing and supporting such complex and wide spanning systems, business schools are becoming increasingly interested in how to integrate ERP into their curriculum. Not considering the advantages of increasing the marketability of graduates, the pedagogical advantage of integrating ERP into business school curricula is the process view of business activities that ERP emphasizes. "Just as organizations are seeking to reengineer their business processes in part to move away from functional disintegration, management education has also begun to question its functional orientation" (Becerra-Fernandez, Murphy, and Simon, 2000, pp. 39). By focusing on business processes, rather than on specific business functions, students can gain an understanding of the complex relationships between the various business functions and how these relationships impact business decision making in general.

Researchers have highlighted that business schools must consider what direction to take when integrating ERP into their curriculum (e.g., Hawking, Ramp, and Shackleton, 2001). Hawking (1999) identifies a number of such possible options including instruction or training on a specific ERP software package (e.g., SAP R/3), examining business processes as executed in a specific ERP package (e.g., MRP using SAP R/3), teaching IS concepts (e.g., database administration using SAP R/3), and teaching ERP issues and

concepts (e.g., single database, single development environment). At the extreme of such integration, a number of business schools have implemented complete majors or programs in ERP, thus addressing all of these options. Graduates of such programs will be primarily involved in the implementation and support of ERP systems. For business schools implementing major programs in ERP, one question that must be addressed is how well such a program will meet the needs of those organizations using or about to implement an ERP system. This research examines this issue by identifying the key skills that organizations expect from graduates of ERP programs.

2. ERP IN BUSINESS SCHOOL CURRICULA

There has been a significant amount of research conducted over the past several years focused on the integration of ERP into business school curricula. Considerable attention has been given to developing complete programs focused on presenting ERP concepts and software across multiple courses (e.g., Cannon, Klein, Koste, and Magal, 2004; Hawking et al., 2001; Hayen, Holmes, and Cappel, 2000; Johnson, Lorents, Morgan, and Ozmun, 2004; Joseph and George, 2002; Peslak, 2005). Other research has focused on using ERP software to help teach a specific business area or concept, such as logistics or operations management (e.g., Boykin and Martz, Jr., 2004). There has also been recent efforts to develop projects, simulations, or capstone courses focused on either existing or hypothetical companies (e.g., Davis and Comeau, 2004; Draijer and Schenk, 2004; Stewart and Rosemann, 2001). A number of researchers have also

reported on the current status and evolution of ERP in business schools (e.g., Antonucci, Corbitt, Stewart, and Harris, 2004; Hawking et al., 2004). To help ease the process of integrating ERP into business school curricula, various researchers report lessons learned or recommendations for a smooth integration (e.g., Becerra-Fernamdez et al., 2000; Fedorowicz, Gelinas, Jr., Usoff, and Hachey, 2004).

While attempting to develop ERP curricula, a number of researchers have proposed specific skills and knowledge that should be taught in such a program. Watson and Schneider (1999) in their KnowDule curriculum outline some potential key skills needed by ERP graduates including knowledge of enterprise systems, process-centered systems, ERP planning and implementation, change management, ERP systems administration, network resource planning, and exposure to an ERP programming language (e.g., ABAP). Becerra-Fernandez et al. (2000) reporting on an enterprise resource management track for undergraduate and master level programs highlight a number of potential skills and knowledge needed by ERP graduates including exposure to business processes and how they are executed in SAP R/3, business process design and implementation, database applications and administration, enterprise systems analysis, administration, and configuration, network design and administration, systems analysis and design, and project management.

Hawking et al. (2001) in their proposed ERP curriculum identify a number of key technical skills needed by ERP graduates, including exposure to ERP concepts, an ERP programming language, telecommunications and networks, database design and management, and systems analysis and design. Davis and Comeau (2004) develop an ERP capstone project that provides students with a knowledge of enterprise integration concepts, business process management, technical infrastructure for enterprise integration, project planning, change management, decision making in an ERP environment, and hands-on SAP R/3 exposure. Draijer and Schenk (2004) discuss an ERP business simulation used to teach a process view of business activities. Peslak (2005) in his 12-step curriculum suggests a number of key skills including knowledge of the various business functions, business processes, hardware and software required by the ERP system, reporting using the ERP system, an ERP programming language, and hands-on exposure to ERP navigation and company setup.

On a somewhat broader scope, Lee, Trauth, and Farwell (1995) surveying 98 IS professionals (e.g., IT managers, IT consultants, user managers) identify the key skills required by IS professionals, grouped into technical specialties knowledge/skills (e.g., programming languages, networks, and databases), technology management knowledge/skills (e.g., ability to learn new technologies and understand technological trends), business functional knowledge (e.g., ability to understand the business environment, learn about business functions, and interpret business problems), and interpersonal and management knowledge/skills (e.g., ability to be proactive, deal with ambiguity, accomplish assignments, and teach others). These skill requirements

were compared to IS academic programs. Their results revealed an "expectation gap" between industry needs and academic preparation. In a later study, Stewart and Rosemann (2001) highlight similar skills as key skills for industry ready IS graduates.

3. KEY SKILLS REQUIRED BY ERP GRADUATES

To ensure that ERP programs adequately address the needs of industry, it is important to empirically identify the key skills industry expects from ERP educated students. The skills suggested by Lee et al. (1995) are used as a starting point for developing such a list. As these skills are for IT positions in general, the key ERP technical skills and knowledge highlighted in the literature (e.g., Hawking et al., 2001; Peslak, 2005; Watson and Schneider, 1999) are also included to make the study focused on ERP. The proposed skills required by ERP graduates are placed into five categories, specifically ERP Technical Knowledge, Technology Management Knowledge, Business Functional Knowledge, Interpersonal Skills, and Team Skills and Knowledge. These categories are based on the IT skills categories developed by Lee et al. (1995) with some minor changes and updates to address the ERP focus of this study.

The first category of skills for this study is ERP Technical Knowledge and is a variation of the more general Technical Specialties Knowledge/Skills category developed by Lee et al. (1995). ERP Technical Knowledge involves exposing students to the basic information technology components critical for the operation of an ERP system and include both general IS skills (e.g., systems analysis, systems design) and ERP focused skills (e.g., ERP programming, ERP administration, databases). Lee et al. (1995) present a wide variety of key technical skills that IT professionals should possess, including 3rd generation languages, 4th generation languages, telecommunications and networks, operating systems (i.e., micro, mini, and mainframe), systems integration, systems analysis, systems life cycle management, relational databases, distributed processing, a specific programming language, data management (e.g., data modeling), structured programming/CASE methods and tools, decision support systems (e.g., what-if scenarios, business simulations), an assembly language, and expert systems/artificial intelligence. However, a number of these technical specialties skills have little relevance to ERP systems and are subsequently omitted from further investigation. These skills include knowledge of an assembly language, artificial intelligence, 3rd generation languages, 4th generation languages, and mini and mainframe operating systems. Based on a review of the literature, two ERP specific skills are added to this category specifically knowledge of a programming language such as ABAP, SAPscript, or JAVA and knowledge of ERP administration. As ERP administration consists of several responsibilities, this research will capture ERP administration as knowledge of how to support the existing portfolio of applications (e.g., running batch jobs, support for add-ons and applications that interface with the ERP system), knowledge of how to support the end user (e.g., create user accounts, reset passwords), and knowledge of how to support the hardware

(e.g., back-ups, performance tuning).

In addition to the technical aspects of ERP systems, it is also expected that graduates possess knowledge of general ERP concepts and the strategic implications of ERP systems and information systems. The Technology Management Knowledge class provides students with an understanding of how ERP systems, and technology in general, can be used to meet the strategic goals of the organization. This class is a slight variation of the Technology Management Knowledge class of skills developed by Lee et al. (1995). The skills in this class include knowledge of ERP concepts (e.g., no data duplication, real time update of data, process view of business activities, reengineering of business process) and the general technology management knowledge and skills suggested by Lee et al. (1995), specifically the ability to learn new technologies, focus on technology as a means, not an end, and understand technological trends.

Peslak (2005, pp. 149) highlights "ERP is based not on business functions, but on business processes, but business processes rely on an understanding of business functions". As a result, it is critical for an ERP graduate to have knowledge of the traditional business functional areas such as operations, accounting, and finance. In addition, given the scope of ERP systems, ERP professionals are typically responsible for implementing or supporting a specific module of the ERP system, such as the human resources application module of SAP R/3. To effectively implement or support an ERP module, ERP professionals require detailed knowledge of the impacted functional area (i.e., human resources), as well as its related business processes. Business Functional Knowledge focuses on understanding the basic business functions and their relationship to one another, and is based on Lee et al.'s (1995) classification. The specific skills in this class include knowledge of the traditional business functions, willingness to learn in detail a specific functional area (including the related processes) of the organization, ability to quickly understand the needs of customers, ability to understand the business environment, and the ability to interpret business problems and develop appropriate technical solutions.

The graduate of an ERP program is likely to become a member of a team responsible for the implementation or support of an ERP system. As a result, the ERP graduate will be expected to possess excellent team skills and, following the ERP literature, possess some project management knowledge. Team Skills and Knowledge is focused on the skills needed by graduates to ensure that they can become effective members of an IT project team. The specific skills in this category are based on the skills presented by Lee et al. (1995) and include the ability to work cooperatively in a project team environment, ability to work in a collaborative environment, ability to plan projects, and the ability to lead projects.

Finally, Interpersonal Skills are needed as ERP graduates must effectively work with clients and members outside of their team. Interpersonal Skills are adopted from Lee et al. (1995) and include the ability to deal with uncertainty, accomplish assignments, write effective reports / memos / documents, deliver effective presentations, be proactive, be sensitive to the organizational culture, and teach others. The proposed list of skills required by ERP graduates is presented in Table 1.

4. METHODOLOGY AND DATA ANALYSIS

To identify the key skills required by ERP educated students, a web-based survey was developed. To develop this survey the general skills expected of IS graduates were first determined (e.g., Lee et al., 1995; Stewart and Rosemann, 2001). Next, based on examining the ERP literature, a proposed list of technical and business skills required by ERP graduates was developed (e.g., Hawking et al., 2001; Peslak, 2005; Watson and Schneider, 1999). These two skill lists were combined to form the proposed skills required by ERP graduates as presented in Table 1. Next, a list of open ended questions was created to allow respondents to discuss the skills presented or add additional ones. Once an initial list of skills and open-ended questions were developed, a pre-test was conducted to confirm the wording and ordering of the questions.

The resulting web-based questionnaire is divided into four sections. Section One introduces the study and collects general information on the respondent and their organization. Respondents are first presented with the following filter question.

* Have you ever used, implemented or maintained an enterprise system such as SAP R/3, JD Edwards, or Peoplesoft?

As the survey is web-based, and thus interactive, if respondents select "No", they are informed that the survey is intended for people knowledgeable of ERP systems, thanked for their time, and the survey is concluded. For respondents that answer "Yes", they are asked the following questions to collect information on their organization:

* What enterprise system does your organization use?
* Your organization is located in what country?
* What industry is your organization in?
* Approximately how many people work in the organization?
* What is the size of your IT department?

The following questions are used to collect background information on the respondent:

* What is your current job function?
* How are you involved with an enterprise system and what modules do you use?
* How many years experience do you have working with an enterprise system?

Section Two asks respondents to rate on a 9-point Likert-type scale how important is it for an ERP graduate to possess the technical knowledge and business skills presented in Table 1 (e.g., ERP Technical Knowledge, ERP Technology Management Knowledge, Business Functional Knowledge). Following the recommendation of Jackson (2003), a 9-point Likert-type scale is selected over a 5 or 7-point scale as "the greater the number of categories in a Likert-type variable, the less reduction there will be in the correlation

Skill Description	Support from the Literature
ERP Technical Skills	
ERP Administration: support end-user computing, existing portfolio of applications, support, hardware	*Watson and Schneider (1999), Becerra-Fernandez et al. (2000), Peslak (2005)*
Networks	*Watson and Schneider (1999), Becerra-Fernandez et al. (2000), Hawking et al. (2001), Lee et al. (1995)*
Operating systems	*Becerra-Fernandez et al. (2000), Lee et al. (1995)*
Systems analysis	*Hawking et al. (2001), Lee et al. (1995)*
Systems design/integration	*Becerra-Fernandez et al. (2000), Hawking et al. (2001), Lee et al. (1995)*
Systems life cycle management	*Lee et al. (1995)*
Relational databases	*Becerra-Fernandez et al. (2000), Hawking et al. (2001), Lee et al. (1995)*
ERP related programming language (e.g., ABAP)	*Watson and Schneider (1999), Hawking et al. (2001), Peslak (2005)*
Data management (e.g., data modeling)	*Becerra-Fernandez et al. (2000), Hawking et al. (2001), Lee et al. (1995)*
Decision support systems (e.g., what-if scenarios, business simulations)	*Lee et al. (1995)*
Technology Management Knowledge	
Knowledge of ERP concepts	*Watson and Schneider (1999), Hawking et al. (2001), Davis and Comeau (2004)*
Ability to learn new technologies	*Lee et al. (1995)*
Ability to focus on technology as a means, not an end	*Lee et al. (1995)*
Ability to understand technological trends	*Lee et al. (1995)*
Business Functional Knowledge	
Knowledge of business functions	*Peslak (2005), Lee et al. (1995)*
Willingness to learn in detail a specific business functional area	*Lee et al. (1995)*
Ability to quickly understand the needs of customers	*Lee et al. (1995)*
Ability to understand the business environment	*Lee et al. (1995)*
Ability to interpret business problems	*Lee et al. (1995)*
Ability to develop appropriate technical solutions to business problems	*Lee et al. (1995)*
Interpersonal Skills	
Ability to deal with uncertainty	*Lee et al. (1995)*
Ability to accomplish assignments	*Lee et al. (1995)*
Ability to write effective reports / memos / documents	*Lee et al. (1995)*
Ability to deliver effective presentations	*Lee et al. (1995)*
Ability to be proactive	*Lee et al. (1995)*
Ability to be sensitive to organizational culture	*Lee et al. (1995)*
Ability to teach others	*Lee et al. (1995)*
Team Skills and Knowledge	
Ability to work cooperatively in a team environment	*Lee et al. (1995)*
Ability to work in a collaborative environment	*Lee et al. (1995)*
Ability to plan projects	*Becerra-Fernandez et al. (2000), Davis and Comeau (2004), Lee et al. (1995)*
Ability to lead projects	*Becerra-Fernandez et al. (2000), Davis and Comeau (2004), Lee et al. (1995)*

Table 1 - Potential Key Skills of ERP Graduates

between the variable and other variables", p. 390), thus allowing any interaction between the variables to be identified easier.

Section Three captures on a 9-point Likert-type scale how important it is for an ERP graduate to possess the soft skills presented in Table 1 (i.e., Interpersonal Skills, Team Skills and Knowledge). The final section of the questionnaire presents respondents with a set of open-ended questions in an attempt to have them identify additional skills not presented or further elaborate on skills already presented in the survey. Open-ended questions posed to respondents include:

- What do you feel are the most important enterprise system modules/components an ERP graduate should possess?
- What are the 3 most important human skills ERP graduates should have and why?
- What are the 3 most important technical skills ERP graduates should have and why?
- Are there any additional skills that you would like to add that this survey may have overlooked?
- Are there any issues that you would like to elaborate on?

To determine the key skills required by graduates of ERP programs, 455 IT specialists involved in the implementation, management or support of an ERP system were invited to complete the web-based survey in the Spring of 2005. Of the 455 IT specialists contacted, 118 completed the survey for an overall response rate of 25.9%. Of these 118 respondents, 107 are using SAP R/3, currently the most popular ERP package in both industry and business schools, while the remaining 11 are using some other ERP package (e.g., Oracle/Peoplesoft Enterprise, Oracle/JD Edwards EnterpriseOne). These latter surveys are not included in order to effectively control for the software package used. As a result, this research will focus solely on SAP R/3, subsequently reducing the response rate to 23.5%. Of the remaining 107 surveys, two additional surveys are not included as these respondents are focused on ERP education and not involved with the implementation, management, or support of an ERP system in an organization. The final number of surveys for this study is 105 resulting in a usable response rate of 23.1%.

Respondent's experience working with ERP systems range from 1 year to a few with 20+ years, with the average experience of approximately 8 years. The common job titles represented in the sample include IT manager, IT project manager, systems analyst, ABAP programmer, and IT consultant. Respondents for this study are placed into three groups, specifically IT managers, technical specialists, and IT consultants. The management group include IT managers and project managers and comprise 33.3% (i.e., n = 35) of the sample. The technical specialists group comprises 34.3% (i.e., n = 36) of the sample and include employees of the organization responsible for the implementation or support of the SAP R/3 system such as systems analysts and ABAP programmers. The final IS group represented in this study are IT consultants external to the organization, but currently involved in the implementation of SAP R/3 in a client's organization. This group comprises 32.4% (i.e., n = 34) of the sample. Of the responding organizations, 30.5% (i.e., n = 32) have 1000 or fewer employees, 27.6% (i.e., n = 29) have between 1001 and 5000 employees, while the remaining 41.9% (i.e., n = 44) have more than 5000 employees. Forty percent (i.e., n = 42) of respondents worked in IT departments with less than 50 people, 30.5% (i.e., n = 32) in IT departments with between 51 and 250 people, while the remaining 29.5% (i.e., n = 31) worked in IT departments with more than 251 people.

The proposed skills required by ERP graduates are placed into five groups, specifically ERP Technical Knowledge, Technology Management Knowledge, Business Functional Knowledge, Interpersonal Skills, and Team Knowledge and Skills. Test of internal consistency are needed to examine the relationship between the measurement variables (i.e., specific skills and knowledge) and their associated construct (i.e., skill category). The internal consistency test adopted for this research is Cronbach's alpha, which measures the internal consistency of the survey instrument where subjects respond to questions on a scale (e.g. 1-9 for this research). Cronbach's alpha can range between 0 and 1. Cronbach's alpha depends on the strength of the inter-correlations of the items that make up the construct as well as the number of items that comprise the construct (Jackson, 2003). Jackson (2003) argues that since Cronbach's alpha is dependent upon both the number of items in the construct and the inter-item correlation between items in the construct, there is "no easy answer as to how high a value is required ... an alpha of .70 means one thing if there are 5 items in an index, but quite another if there are 14 items" (p. 399). Jackson (2003) highlights that the average inter-item correlations should be greater than 0.3 for a 9-point Likert type scale and develops a table to illustrate the minimum acceptable Cronbach's alpha levels for a given number of items. A subset of this table is illustrated in Table 2.

Results of performing Cronbach's alpha indicates that each group is internally consistent with values exceeding the commonly cited minimum Cronbach's alpha of 0.7 and a mean inter-item correlation of 0.3. Table 3 presents each construct, its alpha value, the number of items comprising the construct, and the minimum alpha needed to achieve a mean inter-item correlation of at least 0.3.

In addition to internal consistency, tests of discriminate validity indicate low correlation between the skills from different categories.

The three groups selected for this study (i.e., IT managers, technical specialists, IT consultants) each have very different responsibilities when implementing or supporting an ERP system. As a result, they may also differ in their perception of the importance of the skills presented in Table 1 for an ERP graduate. Multivariate analysis of variance (MANOVA) is selected to determine if such differences exist. Multivariate analysis of variance is selected over the simpler analysis of variance (ANOVA) for two major reasons. First, MANOVA considers possible interactions among the skills presented in Table 1 which may not be identified if an individual ANOVA was performed on each skill. Second, MANOVA reduces the chances of Type I error when compared to conducting an individual ANOVA on each skill.

Prior to using MANOVA a number of assumptions regarding its use must first be examined, with the major assumptions being normally distributed data and homogeneity of variances across groups. Examining the data for each skill indicates that the data distributions are close to the normal distribution, thus the first assumption holds true. Levene's test of equality of variance is used to test the second major assumption. Performing this test indicates five of the 33

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skills are significant (i.e., p ≤ 0.05), thus violating the homogeneity of variances assumption. However, MANOVA is fairly robust when this assumption is violated as long as the sizes of the groups are equal or very close to equal. As the sizes of our groups are very close to equal (i.e., n = 35, 36, 34), it is appropriate to continue with the MANOVA analysis.

# of Items	Alpha with Mean Inter-Item Correlation = 0.30	# of Items	Alpha with Mean Inter-Item Correlation = 0.30
2	0.462	9	0.794
3	0.562	10	0.811
4	0.632	11	0.825
5	0.682	12	0.837
6	0.720	13	0.848
7	0.750	14	0.857
8	0.774	15	0.865

Table 2 - Minimum Cronbach's Alpha by Mean Inter-Item Correlation and Number of Items

	alpha	# of Items	alpha needed
ERP Tech	0.861	12	0.837
Tech. Mgmt	0.755	4	0.632
Bus. Funct	0.845	6	0.720
Inter. Skills	0.839	7	0.750
Team Skills	*0.752*	*4*	*0.632*

Table 3 - Cronbach's Alpha Values

Results of performing MANOVA indicate no significant differences between the three groups, as illustrated in Table 4. As there are no significant differences between the groups (i.e., IT managers, technical specialists, and IT consultants), they can be combined and the mean for each skill examined. Table 5 presents the importance that IT managers, technical specialists, and IT consultants place on the ERP skills listed in Table 1.

5. DISCUSSION

Lee et al. (1995) suggest that IS graduates require breadth and depth in the areas of technology, business, and human relations. Similarly, Stewart and Rosemann (2001) highlight the need for IT graduates to possess personal skills, interpersonal skills, and technical knowledge and skills. Our findings indicate that for ERP students this is indeed the case, with a strong emphasis placed on the business and human aspects. Examining the mean score for each group, the most important set of skills an ERP student should posses is business functional knowledge (i.e., group mean = 7.60). Although, ERP emphasizes a process view of business activities, our findings emphasizes that in-depth exposure to the traditional business functions is still critical in an ERP program. Within this group the most essential skills are the ability to understand the business environment, knowledge of the core business functions, and the ability to interpret business problems.

The second most important set of skills is technology management knowledge (i.e., group mean = 7.51). Due to the changing nature of ERP, and information systems in

general, ERP graduates must possess the ability to learn new technology and understand the strategic impact of ERP systems and emerging technologies on the organization as a whole. Based on our findings, this can be achieved by ensuring ERP graduates possess knowledge of ERP concepts, understand technology as a means, not an end, can learn new technologies, and understand technological trends. The most important skills in this category are the ability to focus on technology as a means not an end and the ability to learn new technologies.

The next two sets of skills that ERP students are expected to have are interpersonal (i.e., group mean = 7.47) and team skills and knowledge (i.e., group mean = 7.38). Within these two groups the most important skills are the ability to work cooperatively in a team environment, accomplish assignments, be self-directive and proactive, and the ability to work in a collaborative environment. Respondent comments from the open-ended sections of the questionnaire also highlight the importance of effective interpersonal and team skills. Analyzing this data using content analysis with the theme as the unit counted, the most commonly cited interpersonal and team skills ERP graduates should possess include: understanding the culture of the organization, able to effectively work as a member of a team, effective communication skills, excellent listening skills, be proactive, and able to explain concepts in non-technical terms. Other less cited, albeit still important, business, interpersonal, and team skills taken directly from the open-ended sections of the surveys include:

- "The ability to understand group dynamics -- some like the warm fuzzy stuff and don't think the group is doing well unless it's a love fest, others think things are fine if there are no active wars and people are being productive".
- "Dealing with difficult people (vital skill for consultant and important in any corporate environment)".
- "Ability to build support with a wide net of stake-holders. ERPs by their nature cut across many people's turf, and to achieve your goals you'll often need to need the support of people that you may not otherwise think much of. Understand the internal politics of a company - you don't need to play the games yourself (can be a recipe for disaster), but don't be naive to it either. Be nice, understand people's differences, get them on board and make sure you're satisfying their needs".
- "Listening, lateral thinking and patience. Need to understand what is required by listening, need to be able to devise solution that fits the whole business (not individuals) and patience to deal with non system people who are trying to solve problems without having the technical or thinking skills to do so".
- "Sense of humor - Stress can set in during long projects with tight timescales - humor can relieve not only the stress of an individual but an entire team".
- "The ability to listen, remain calm and be organized. No one knows all solutions and the needs so listen carefully to those that do. All projects go through difficult times. Those that do not panic survive. There is so much data, ideas and the field is so complex that only by organizing oneself can you survive".

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	Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power
Pillai's Trace	.650	1.036	66.000	142.000	.423	68.374	.971
Wilks' Lambda	.451	1.036	66.000	140.000	.423	68.395	.971
Hotelling's Trace	.991	1.036	66.000	138.000	.423	68.392	.970
Roy's Largest Root	.641	1.379	33.000	71.000	.130	45.493	.928

Table 4 - Multivariate Results

Classification	Skill Description	Mean
ERP Technical Knowledge Group Mean = 5.79	Administration: Support end user computing	6.556
	Administration: Support the existing portfolio of applications	5.689
	Administration: Support hardware	3.542
	Networks	4.160
	Operating systems	4.388
	Systems analysis	7.212
	Systems design/integration	6.764
	Systems life cycle management	6.665
	Relational databases	5.812
	ERP related programming language (e.g., ABAP)	5.721
	Data management (e.g., data modeling)	6.714
	Decision support systems	6.250
Technology Mgmt Knowledge Group Mean = 7.51	Knowledge of ERP concepts	7.580
	Ability to learn new technologies	7.705
	Ability to focus on technology as a means, not an end	7.717
	Ability to understand technological trends	7.026
Business Functional Knowledge Group Mean = 7.60	Knowledge of business functions	7.829
	Willingness to learn in detail a specific business functional area	7.268
	Ability to quickly understand the needs of customers	7.435
	Ability to understand the business environment	8.129
	Ability to interpret business problems	7.776
	Ability to develop appropriate technical solutions to business problems	7.191
Interpersonal Skills Group Mean = 7.47	Ability to deal with uncertainty	7.679
	Ability to accomplish assignments	8.097
	Ability to write effective reports / memos / documents	7.322
	Ability to deliver effective presentations	7.160
	Ability to be proactive	7.975
	Ability to be sensitive to organizational culture	7.183
	Ability to teach others	6.849
Team Skills and Knowledge *Group Mean = 7.38*	*Ability to work cooperatively in a team environment*	*8.127*
	Ability to work in a collaborative environment	*7.973*
	Ability to plan projects	*7.057*
	Ability to lead projects	*6.343*

Table 5 - ERP Skills Means

➤ "Grads should go head first into projects (be proactive), Should have ability and desire to learn, Have good knowledge of business aspect so they can understand the business environment".

➤ "Thirst for learning (always something to learn because of size), Be flexible (be able to change based on needs of organization), Ability to learn (ability to take on more), Have a customer focus (It can get technical but need to be able to deal with customer)".

➤ "For international implementations, graduates need to have an awareness of cultural differences and behavioral norms that impact on workplace relations and individual contributions. Don't bring a US/Canadian/Australian centric view without any flexibility and openness to different ways of doing

things - you'll find it tough going and not be able to contribute effectively".

With a group mean of 5.79, the ERP Technical Knowledge category is somewhat less important than the other groups. Regardless, there are still a number of general IS skills and specific ERP focused skills that graduates should possess. Examining Table 5, the general IS skills ERP graduates should possess include knowledge of systems analysis, systems design/integration, data management, systems life cycle management, and decision support systems. The ERP specific skills and knowledge important for graduates to posses include exposure to ERP systems administration (i.e., support the end users), relational databases, and an ERP programming language. The qualitative data also supports

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the quantitative findings. Based on respondents comments, the most important technical skills required by an ERP graduate include systems analysis and modeling, databases, programming in JAVA, ABAP, and SAPscript, and data management (e.g., R/3 Master Data). Other key skills not addressed in the quantitative analyses but highlighted by respondents include the ability to test systems and understand ERP security measures.

Our findings empirically validate the technical requirements of Hawking et al.'s (2001) and Peslak's (2005) model curricula in ERP. Specially, Hawking et al. (2001) highlight the need to offer courses in ERP concepts, ERP programming, telecommunication and networks, database design and management, systems analysis and design, in order to better meet the needs of industry. Similarly, Peslak (2005) highlights the need for students to have knowledge of the ERP application, hardware and user administration, ABAP programming, and SAP R/3 reporting. Our findings empirically show that by following either one of these programs, business schools, at a minimum, will meet the majority of the technical expectations that industry places on ERP graduates.

Of the ERP technical skills, the importance of systems analysis is considerably higher than the other skills. One of the key components in systems analysis is adopting a macro view of information systems, specifically how various information system are related and how changes in one system impact other systems throughout the organization. The importance of adopting a macro view of the ERP system was stressed by a number of respondents. Comments from one such respondent provides an explanation why this key skill is needed:

➤ "You need to be able to keep hold of the wider picture. There can be a tendency to focus on specific technical or process issues when, although important, they could have absolutely zero impact on the reason for implementing an ERP. Don't forget the big picture objectives of how an ERP fits into a company's overall corporate strategy. For multi-country or global implementations, it is important to double check that all those standardized business processes are going to work. What seems logically sensible and best practice in the US or Canada may not at all be feasible in other places. It could be geography, cultural norms or government regulations. These differences can easily undermine the goals of an ERP if they're not expected or catered for in your initial design".

The final two open ended questions invited respondents to discuss additional skills not addressed in the questionnaire, but viewed as important for ERP graduates to possess. A wide variety of skills and knowledge were provided including the ability to develop request-for-proposals, ability to work with consultants, knowledge of modeling business processes, and change, time, and stress management skills. Some of these skills are subsets of those presented in Table 1. The ability to develop request-for-proposals is an important area of project management, and can be considered part of the *ability to plan projects* skill.

Likewise, knowledge of how to model business processes is a core systems analysis activity and thus an important aspect of the *systems analysis* skill. The ability to work with consultants is an area that seems to be missing from existing ERP programs. This key skill must not be overlooked given the fact that an ERP implementation typically involves a large number of consultants. Students must understand the role of the consultant, the process of knowledge transfer, how to ensure that effective knowledge transfer takes place between consultants and employees, and remedies if such transfer is not taking place. Skills focused on working with and managing consultants can be incorporated into a number of courses, including those in knowledge management, project management, organizational behavior, and ERP implementation.

In addition to specific knowledge or skills, a number of respondents highlighted the need for students to have some industry experience with ERP systems before graduating in the form of a coop term or internship. In addition, or possible alternative, to traditional coops or internships, a capstone project may also provide some industry exposure to ERP systems; giving students the chance to experience many of the challenges faced when implementing an ERP system, and thus the opportunity to develop many of the key skills presented in Table 5. Detailed examples of such projects include those reported by Cannon et al. (2004), Draijer and Schenk (2004), Johnson et al., (2004), and Stewart and Rosemann (2001).

The final list of key skills required by ERP graduates combines both the quantitative and qualitative analysis. The key skills from the quantitative analysis are limited to those that have a mean greater than or equal to 5 (i.e., midway on the survey scale). Based on this requirement, a number of proposed skills from Table 1 have been dropped. These skills are from the ERP Technical Skills category and include knowledge of networks, operating systems, and how to support hardware. Based on the qualitative analysis a number of new skills not directly presented in Table 1 are also important for ERP graduates to possess. These skills include ERP security, developing request-for-proposals, understanding the strategic impact of ERP systems, understanding group dynamics, ability to work with consultants, ability to work with difficult people, excellent listening, stress, and time management skills, desire to learn, and regional / national cultural sensitivity. Combining both the quantitative (i.e., skills with a mean ≥ 5) and qualitative analysis, Figure 1 presents the final model of the skill requirements of ERP graduates.

6. LIMITATIONS, IMPLICATIONS, AND FUTURE RESEARCH

This research presents a list of the key skills that industry expects from ERP graduates. Now that such key skills have been identified, attention must turn to creating curricula that incorporates these skills. Developing ERP curricula will require, for example, addressing issues of skill delivery and the extent of exposure to each skill. Although each skill must be taught, the extent in which they are taught will depend

upon the nature of the program for which ERP is introduced into. For example, a traditional undergraduate business degree (e.g., Paslak, 1995; Watson and Schneider, 1999) is more likely to focus on the business aspects of ERP systems, business process integration, ERP software navigation, and provide some exposure, but not dedicated courses, in the technical aspects such as ABAP programming or ERP administration. A more technical program, such as a computing or information technology degree program is likely to have dedicated courses in each of the ERP technical components, such as a complete term courses in ABAP programming and ERP administration, and fewer courses in the traditional business functional areas. An MBA program should focus more on the strategic, managerial, and change management issues of ERP systems and less on ERP technology and software navigation. Future research is therefore needed to develop benchmark quality ERP curricula that will include the skills in Figure 1, but not sacrifice the overall purpose of the specific degree program. Related to how ERP should be integrated into university curricula, its is also important to determine how outcome assessments might be performed. Outcome assessment is needed to ensure that the key skills and knowledge presented in Figure 1 are being taught. How might outcome assessment for these skills be determined is another critical area of future research.

There are also a number of possible future research initiatives stemming directly from the limitations of this study. This study is focused on the SAP R/3 software package. Applying these findings to organizations using other ERP systems (e.g., Oracle/Peoplesoft Enterprise, Oracle/JD Edwards EnterpriseOne) must be approached with caution. Future research should focus on expanding this study in terms of ERP packages used and identifying any

differences in skills based on the ERP package. This research presents a list of key skills based on surveying IT managers, IT project managers, IT consultants, and technical staff (e.g., systems analysts, ERP programmers). There are a number of additional groups that may have provided valuable insight into the key skills of ERP graduates, examples include ERP end-users and functional managers (e.g., accounting managers, operations managers). Future research should focus on surveying additional ERP stakeholders in order to develop a more holistic list of the key skills required by ERP graduates.

Despite these limitations, this research offers a number of benefits to business schools in the process of implementing ERP programs. This study presents a list of the key ERP skills as identified by ERP practitioners and thus those to implement to ensure that ERP programs adequately meet the needs of industry. To business schools wishing to implement one of the many existing ERP curricula (e.g., Boykin and Martz, Jr., 2004; Cannon et al., 2004; Hawking et al., 2004; Johnson et al., 2004; Joseph and George, 2002; Peslak, 2005), this study provides a means of evaluating the various curricula prior to the adoption decision. A wide variety of skills are presented in Table 5. If a new program in ERP is not given adequate resources (e.g., monetary, time, instructors, hardware) it is likely that not all skills, especially the technical ones, will be taught. The quantitative analysis indicates the relative importance of each skill, and thus where tradeoffs should and should not be made. To business schools with ERP programs in place, this research provides a list of key skills that can be used to help gauge the quality of their ERP programs and where improvements are needed. To researchers of ERP, this study provides a starting point in examining the expectation gap between what is being taught in business schools and industry expectations of ERP
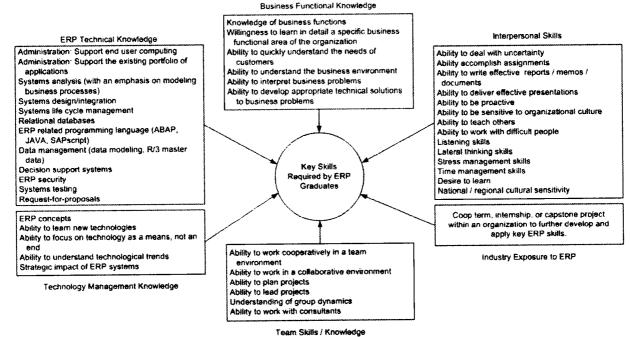

Figure 1 - Key Skills Required by ERP Graduates

graduates, thus helping to address a major gap in the ERP literature.

7. CONCLUSION

This study empirically identifies the key skills and knowledge organizations expect from recent graduates of university programs in enterprise resource planning. To achieve this objective, the list of skills required by IS professionals as identified by Lee et al. (1995) is used as a starting point, with additional skills tailored to ERP added based on a review of the ERP literature. Data analysis of 105 surveys from IT professionals directly involved with the implementation or support of ERP systems indicates a wide variety of skills needed by ERP graduates, classified as ERP Technical Knowledge, Technology Management Knowledge, Business Functional Knowledge, Interpersonal Skills, and Team Skills and Knowledge. The main benefit of this study is that it presents a list of key skills that business schools must consider teaching when implementing their own ERP programs. For business schools with existing ERP programs, this research provides a list of skills that can be used to determine how well their program is meeting the needs of industry. Future research should focus on surveying a wide variety of ERP stakeholders and including multiple ERP software packages.

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