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Determinants and Influences of Information Systems Integration in a Public Higher Education Context

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ABSTRACT

In this study, the authors used the technology-organization-environment (TOE) framework and DeLone and McLean's upstream information systems (IS) success model to construct and test a model that describes IS integration and its determinants and influences. The researchers modified the TOE model to include business and knowledge factors. Using a cross-sectional research design, they distributed survey questionnaires to participants at a Malaysian public higher education institution. The authors analyzed the data using partial least squares structural equation modelling. The results suggested that IS integration influences system quality and information quality positively. Contrary to extant findings, only knowledge, environmental, and business factors determined IS integration directly. The authors discuss the implications of these results for IS integration and future research.

KEYWORDS

Higher Education, Information Systems Integration, Information Systems Success, Knowledge, Technology-Organization-Environment

INTRODUCTION

The International Data Corporation recently reported that global spending on information technology (IT) would reach $1.2 trillion by 2023 (IDC, 2023), driven by the widespread application of mobile technologies, social networking, the Internet of things (IoT), robotics, and artificial intelligence. As customer demands grow and technological advancements remain dynamic, organizations must ensure tight integration of their IT infrastructures.

A recent industry report indicated that the system integration market was valued at USD 396.41 billion, in 2022, and was expected to reach over USD 1492.95 billion by 2032 with a compound annual growth rate (CAGR) of around 14.18% from 2023 to 2032 (Precedence Research, 2023). Reduced implementation costs and resource consumption further motivate organizations to integrate information systems (IS) (Liferay, 2021). This resonates with Maiga et al. (2013), who indicated a positive impact

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of the interaction of IT integration and cost control systems on plant financial performance, and Maiga (2015) who provided evidence for the role of: (1) An internal cost management strategy in mediating the link between internal IS integration and profitability, and (2) external cost management strategy in mediating the link between external IS integration and profitability.

REVIEW OF THE LITERATURE AND GAPS

During the 1990s, IS integration was defined simply as the extent to which data and application systems are shared and accessed through communication networks for organizational use (Wyse & Higgin, 1993). Since then, the definition of IS integration has expanded to include application integration that involves electronic linking of autonomous applications (Grant & Tu, 2005) and the connection of disparate systems (Markus, 2001). Systems integration encompasses data and the communication network (Bhatt, 2000; Bhatt & Troutt, 2005), system interoperability, communication among systems, interorganizational process reengineering, and standardization of existing systems (i.e., uniformity), which collectively represent a natural extension of a user or routine (i.e., assimilation) or a system's adoption or diffusion (Modol, 2006). The scope of IS integration has expanded to include both organizational and process integration. Organizational integration indicates coordination among a firm's disparate departments and functions, while process integration means the minimization of communication and coordination within the process of an activity (Berente et al., 2009).

IS integration has been researched in various contexts, including customer relationship management in the pharmaceutical industry (Svoboda et al., 2021), project success in government units (Kolasa et al., 2020), green environment (Bakolo, 2019), small and medium-sizes enterprises (SMEs) (Francalanci & Morabito, 2008; Raymond et al., 2013), supply chains (Hou, 2019; Kauremaa & Tanskanen, 2016; Rajaguru & Matanda, 2013; Zhang et al. 2022), manufacturing (Lee et al., 2022), health informatics (Dlodlo & Hamunyela, 2017), healthcare management (Wu & Trigo, 2021), mergers and acquisitions (Chang et al., 2014; Henningsson & Kettinger, 2017; Tanriverdi & Uysal, 2011), IT spending on cybersecurity measures (Baskerville et al., 2018), and IT vendors (Ceci et al., 2019). IS integration has also been studied from intra- and interorganizational perspectives and in for-profit organizations (Chowanetz et al., 2012; Rajaguru & Matanda, 2013; Wong et al., 2015), but little research has been conducted on IS integration from an intraorganizational perspective in higher education. Recent studies show that systems integration capability predicts firm performance in automotive business environment (Geleilate et al., 2021), promotes reduction of transactional costs (Wróbel & Hernes, 2020), and affects specific cost improvements (Maiga, 2017).

Higher education is a critical area for the development of human capital. According to the UNESCO definition, higher education includes universities, colleges, and institutions that offer tertiary programmes in relation to the conduct of research and development. Higher education represents big business, despite the costs of running such institutions and concerns regarding their performance (Barnett, 1990). The goals of higher education include promoting learning and the development of standards when evaluating ideas and problems (Banta, 1966). The authors built on Chowanetz et al.'s (2012) consolidated framework of IS integration, acknowledging several gaps in this literature, namely:

1. **Population and Sample:** Providing a systematic literature review, the population and sample in Chowanetz et al.'s (2012) study consisted of research from only selected databases, and they cited Google Scholar as a means for identifying articles.
2. **Theoretical Underpinnings:** Chowanetz et al. (2012) acknowledged prevalent use of the technology-organization-environment (TOE) framework in extant research and used the framework to identify antecedents to IS integration. They added business to the TOE framework, and used Shang and Seddon's (2002) framework to define the benefits of IS integration. However, Shang and Seddon's (2002) focus was on enterprise systems, although IS integration covers a broader scope than that of enterprise systems.

3. **Unit of Analysis:** Chowanetz et al. (2012) used organization as the unit of analysis.
4. **Model Testing:** Chowanetz et al. (2012) proposed a framework, but model testing is not evident.

The authors addressed these limitations by constructing and testing an IS-integration theoretical model that considers the perspective of a higher education institution. As they built on Chowantez et al.'s (2012) study and referred to other recent developments, they used DeLone and McLean (D&M 1992; 2003) to form the basis for influences of IS integration. The authors' unit of analysis was the individual perspective, which represents a particular case for a higher education institution: Faculty members who have experienced multiple phases of IS integration as research participants. Against this backdrop, the authors set out the following research question: What are the determinants and influences of IS integration in the higher education context? This research was exploratory and aimed to fill in the gaps noted above by identifying the determinants and influences of IS integration, building a model and examining its relationships in a higher education context. This research contributes to the literature by shedding light on the determinants and influences of IS integration in higher education, and its results provide researchers with a model of IS integration that explains the higher education context.

THEORETICAL FOUNDATION AND HYPOTHESES

This section presents the theoretical foundations of the study, beginning with a discussion of IS integration. The authors built on D&M's upstream IS success model to explain the influences of IS integration, although prior research suggests that the influences include business performance (Georgantzas & Katsamakas, 2010), supply chain capabilities (Rajaguru & Matanda, 2013), social Web-knowledge sharing (Soto-Acosta et al., 2017), and IT spending on cybersecurity countermeasures (Baskerville et al., 2018). The researchers conceptualized the determinants using a modified TOE framework and the knowledge-based view. Figure 1 shows the conceptual model.

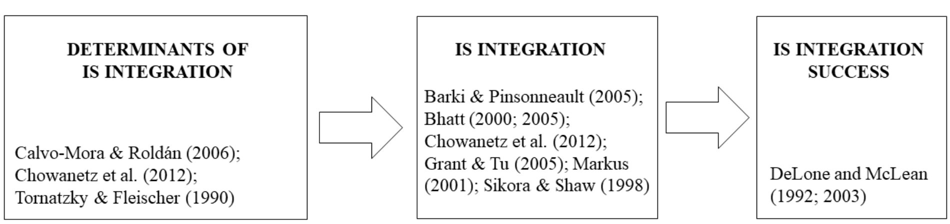
Information Systems Integration

Characterized as a sociotechnical phenomenon, integration covers social, technical, economic, and organizational aspects (Barki & Pinsonneault, 2005). This study proposes that IS integration consists of the integration of data that originate from various sources (e.g., teaching, research, and performance evaluation), application systems integration that supports data processing, infrastructures that span data centres and telecommunication integration, and the integration of organizational functions that leads to the combination of disparate departments and functional units in an organization (Sikora & Shaw, 1998).

Information Systems Integration Success

D&M's IS success model combines several previously reported measures of IS success from the literature, suggesting that IS successes represent multifaceted constructs. The IS success model has been assessed in various contexts, including e-learning (Aldholay et al., 2018), massive open online

Figure 1. Conceptual model



courses (Aparicio et al., 2019), digital library (Alzahrani et al., 2019), and mobile banking services (Sharma & Sharma, 2019). While the original model is a taxonomy of six interdependent variables that measure IS success, in this study the authors assessed relationships between IS integration and quality constructs that appear in the upstream model of IS success (i.e., system quality and information quality), consistent with Sadeh et al.'s (2013) work. The authors did not consider the downstream model of IS success that comprises user satisfaction, individual impact (e.g., job task), and organizational impact (e.g., cost reduction) of IS integration. The downstream model is outside the scope of the study. System quality refers to IS features that produce information, with efficiency (i.e., use of resources to deliver IS to users) and effectiveness (i.e., how well the IS serves users while achieving organizational goals) used as indicators of system quality. Information quality is different from system performance; it is subjective, and represents a user's perspective on information (DeLone & McLean, 1992). Information quality measures attributes including personalization, completeness, relevancy, ease of understanding, and security for users.

Prior studies suggested IT planning and management processes influence system quality, while IT planning, IT infrastructure, management processes, and management support influence information quality (Petter et al., 2013). Negahban et al. (2016) found that IT infrastructure influences the system and data quality perceived by managers in a mobile customer relationship management environment. Individuals who perceive tight IS integration evaluate system and information quality more favorably than those who do not. Thus:

Hypothesis One (H1): IS integration positively influences IT system quality.
Hypothesis Two (H2): IS integration positively influences IT information quality.

Determinants of Information Systems Integration

IS integration is a technological innovation. A significant development in elucidating organizational technology adoption, the TOE framework suggests that implementation of technological innovation is dependent on the technological, organizational, and environmental contexts (Tornatzky & Fleischer, 1990). The framework has been used in various types of technology adoption, including battery-operated vehicles (Bjerkan et al., 2016), mobile reservation systems (Wang et al., 2016), social customer relationship management (Ahani et al., 2017), and cloud computing (Ooi et al., 2018). Over the years, the TOE framework has been expanded significantly with the inclusion of business factors (Chowanetz et al., 2012). Based on technology and research advances in higher education, the authors added business and knowledge factors to the original TOE framework, and discuss the technological, organizational, business, knowledge, and environmental factors relevant to this study.

Technological Factor (Technology Readiness)

Tornatzky and Fleischer (1990) suggested that technological factors consist of internal and external technologies, equipment, and processes relevant to an organization, but this definition has since been expanded to include individual factors, with Parasuraman (2000) suggesting that technology readiness refers to "people's propensity to embrace and use new technologies for accomplishing goals in home life and at work" (p. 308). Successful implementation of IT innovation has been attributed to technology readiness (Venkatesh & Bala, 2012; Zhu et al., 2006), which encompasses two aspects, namely, technology infrastructure and IT human resources (Zhu et al., 2006). From a technology infrastructure viewpoint, IS integration requires a solution that facilitates integration of an organization's processes and systems (Venkatesh & Bala, 2012).

Findings regarding technology readiness are mixed. In a study of radio frequency identification (RFID) adoption in livestock businesses, the interoperability of RFID components concerning technology readiness influenced acceptance, but industry-wide technology readiness did not (Hossain et al., 2017). Kim and Chiu (2019) found that positive technology readiness (i.e., optimism and innovativeness) correlated positively with perceived ease of use and perceived usefulness, but negative technology readiness (i.e., discomfort and insecurity) correlated negatively with the same for sports wearable devices. Blut and Wang's (2020) meta-analysis suggested that technology readiness correlates with perceived ease of use, perceived usefulness, value, quality, satisfaction, quality, use intention, and use of technology. Individuals who perceive that their organizations have technology readiness also perceive that they have enhanced IS integration. Thus:

Hypothesis Three (H3): Technology readiness positively determines IS integration.

Business Factor (Entrepreneurial Orientation and Innovativeness)

Entrepreneurial orientation represents the exploitation of the dynamics of organizational macroenvironments and task environments (Miles & Arnold, 1991). Policies oriented towards technology use reflect the commitment and attitudes of an organization regarding innovation (Ettlie & Bridges, 1982). Extant studies suggest that the influences of entrepreneurial orientation include organizational performance (Semrau et al., 2016), project success (Martens et al., 2018), learning orientation, organizational learning, and innovation performance (Allameh & Khalilakbar, 2018), and venture performance in mature firms (McGee & Peterson, 2019). An innovative organization is characterised by its competence and complementary assets, because it uses knowledge-based resources to discover and exploit new opportunities (Teng, 2007) and drive innovation (Li et al., 2009). Organizational innovativeness is different from entrepreneurial orientation; the former is characterised by openness to new ideas, with an organization's culture signifying organizational innovativeness. Centobelli et al. (2019) found influences of innovativeness on environmental and firm performance, and thus:

Hypothesis Four (H4): Entrepreneurial orientation positively determines IS integration.
Hypothesis Five (H5): Organizational innovativeness positively determines IS integration.

Knowledge Factor (Knowledge Sharing)

Innovation relies on the creation of new knowledge, leveraging existing knowledge through knowledge sharing and the use of such knowledge in the organization (Watson & Hewett, 2006). Thus, knowledge is critical in a learning environment. As individuals communicate in a knowledge-based organization, they transfer knowledge to others, a phenomenon called the cross-functional knowledge exchange process or knowledge sharing (Li et al., 2009). In SMEs, findings suggest knowledge influences essential business results (Calvo-Mora et al., 2015), while social Web knowledge sharing mediates the relationship between human resource practices and innovation performance (Soto-Acosta et al., 2017). A higher education institution is characterised by significant knowledge exchange, and greater knowledge sharing promotes enhanced IS integration. Therefore:

Hypothesis Six (H6): Knowledge sharing positively determines IS integration.

Environmental Factor (External Regulatory Authority)

Tornatzky and Fleischer (1990) argued that an organization's environment consists of the size and structure of an industry, the organization's competitors, the macroeconomic context, and the regulatory environment. Unlike extant research that conceptualizes partners and suppliers as essential resources in the environment (Calvo-Mora et al., 2005), the authors propose that compliance with external regulatory authorities (e.g., government pressure and accreditation bodies) represents higher education institutions' environmental factors, a proposition that corroborates Chau and Hui's (2001) conceptualization of government pressure as an environmental factor. Government pressures drive higher education institutions to design policies of compliance. Higher education institutions are compelled to innovate, but they are also pressed to comply with reform agendas, government requirements, strict budget allocations, and delivery of reporting. While Calvo-Mora et al. (2005) found environmental factors (i.e., partners) influence process management in Spanish universities, Nugroho (2015) did not find support for government pressures influencing technology readiness in Indonesian SMEs. Therefore:

Hypothesis Seven (H7): Compliance with external regulatory authorities positively determines IS integration.

Organizational Factors

Organizational factors refer to a firm's characteristics and resources, its size, degree of centralization, degree of formalization, managerial structure, human resources, amount of slack resources, and links among employees (Tornatzky & Fleischer, 1990). Central to these organizational characteristics is top management support (Dong et al., 2009; Lee et al., 2014), top management in teams (Armstrong & Sambamurthy, 1996; Sperber & Linder, 2018), and leadership (Elenkov & Manev, 2005) characteristics. Viewed as a form of innovation, IS integration requires an organization to redesign its processes, which calls for top managers to set priorities, make decisions about budget allocation, and drive through implementation of integration. Extant research provides evidence for the critical role of top management during IT implementation (Dong et al., 2009), cloud computing adoption (Low et al., 2011), and organization-wide technology integration, infrastructure, and training (Larosiliere et al., 2016).

More recently, relationships between top management and an organization's entrepreneurial activities are being increasingly investigated, as Wales et al. (2020) called for more research on the topic. Empirical evidence suggests that contributors to entrepreneurial orientation include motivation and personality in three strategic leadership situations (Pittino et al., 2016), entrepreneurship education (Marques et al., 2018), and international managerial exposure (Bogatyreva et al., 2019). Executive competence partially mediates the relationship between entrepreneurial orientation and corporate performance (Jia et al., 2014).

Research offers inconclusive evidence regarding the influences of top management support on innovativeness. While Yuan et al. (2014) and Radmila et al. (2019) found that top management contributed positively to innovativeness, Schultz et al. (2019) argued that top-management involvement during innovation projects reduced hospital innovativeness. The role of top management during knowledge sharing continues to receive immense intention (Al-Kurdi et al., 2018; Lee et al., 2016; Singh et al., 2021). Effective leaders mobilize fulfilment of external demands while enabling the achievement of strategic goals. Compliance with pressures from the external environment warrants top managers' designing policies to mobilize resources when addressing such external requirements. Evidence supports the influence of leadership on people, policies, and resources in higher education (Calvo-Mora et al., 2005), and thus:

Hypothesis Eight (H8): Top management support positively determines technology readiness.
Hypothesis Nine (H9): Top management support positively determines entrepreneurial orientation.
Hypothesis Ten (H10): Top management support positively determines organizational innovativeness.
Hypothesis Eleven (H11): Top management support positively determines knowledge sharing.
Hypothesis Twelve (H12): Top management support positively determines compliance with external regulatory authorities.

METHODS

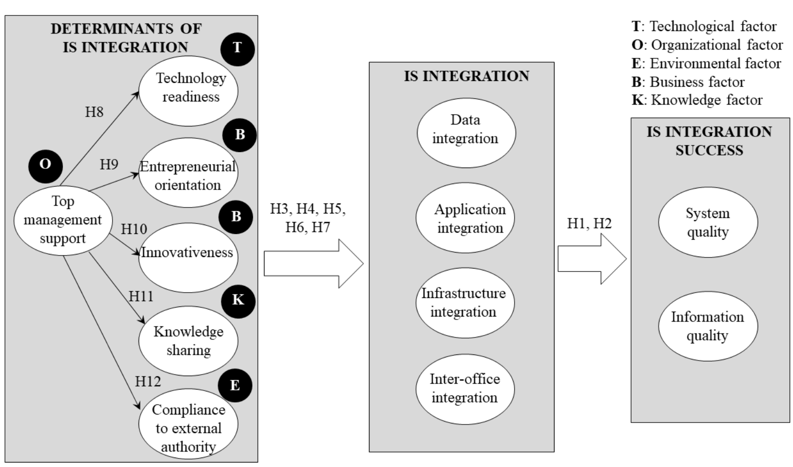
Given the hypotheses discussed above, the authors grouped system and information quality into IS integration success. Technology comprises technology readiness, organizational factors consist of top management support, business factors are represented by entrepreneurial orientation and innovativeness, knowledge sharing represents the knowledge factor, and the external environment is represented by compliance with external regulatory authorities. Figure 2 shows the authors' research model.

Study Context, Population, and Sample

In this study, the authors used a large public Malaysian university as the context. They selected Malaysia due to its position as an emerging economy, an upper middle-income nation that has set out to achieve high-income status by 2024. Supporting this goal, Malaysia developed higher education systems that rank among the world's most prominent, and thus the country has established several offshore campuses during the last two decades. Positioning itself as an international higher education hub, Malaysia is transitioning away from being a regional hub (Munusamy & Hashim, 2019). The university is one of the largest public research universities in Malaysia. The researchers selected it due to its distinctive position as a public research university that has consistently attracted a high number of international students during the last decade, in comparison to other private universities. The use of innovative technologies has remained its emphasis. At that point of the research, the institution was undergoing its Global Transformation Plan (2012–2020) that emphasized innovation, risk taking, and entrepreneurial character, which was not typical of a public higher education institution. The university has a student population of more than 30,000, and, although it is known for its engineering and science disciplines, it offers a variety of other study programmes, including business, education, and administrative policy studies. It is distinguished from other public universities through its focus on graduate programmes and having a large population of international students. The university has broad programme offerings at various levels, especially its undergraduate and postgraduate programmes, as well as in continuing and executive and professional education.

In this study, the authors used faculty members as the study population. The university has an academic staff population of 2,100, of whom 884 are outbound visiting faculty members. In selecting a sample as heterogeneous as this population, the researchers constructed subgroups comprising diverse elements. To ensure that quotas in the subgroups were dissimilar, they drew a sample from 12 faculties and three schools as the subgroups. They used the quota sampling technique to ensure that various subgroups in the population were representative of pertinent sample characteristics (Zikmund et al., 2009). The logic of classifying a population across pertinent subgroups might sound like a haphazard selection of participants based on convenience sampling rather based on probability (e.g., stratified sampling), and was acknowledged as inviting bias. In responding to the criticism, the authors draw all

Figure 2. Research model



participants from a similar institution who share common beliefs toward reducing the bias in result. Two criteria for sample selection were full-time faculty member status and having experience with the university's integrated IS. The authors excluded adjunct and visiting faculty members because they did not fulfil the latter criterion. Given similarities regarding faculty member characteristics, the researchers selected the minimum sample size required for data analysis. They used partial least squares structural equation modelling (PLS-SEM) to analyze the data. The 10-times rule (Barclay et al., 1995; Hair et al., 2013; Hair et al., 2022) suggests that the sample size should be equal to or larger than 10 times the largest number of structural paths directed at a construct in the structural model. The determination of sample size for this study, therefore, follows the guideline and recommendations as provided in Hair et al.'s (2022) study under the minimum sample size requirement.

Instrument

The authors used a survey questionnaire (comprising two main sections) to collect data. The first contained 64 items to collect faculty member's perceptions. To ensure reliability and validity, the researchers took scale items from standardized questionnaires that appeared in extant studies and adapted them to the context of this study. They selected specific items related to the institution's emphasis on innovation, risk taking, and entrepreneurial character accordingly.

Participants rated items using a 6-point Likert-type scale that ranged from strongly disagree (1) to strongly agree (6); no neutral rating was provided on the scale. Following Griethuijsen et al. (2014) and Taber (2018), the authros used only scales with a Cronbach's alpha above 0.6. Table 1 shows the sources of each item. The second section included eight questions to collect profile responses.

Data Collection Strategy

Due to the cross-sectional design of the data collection, the questionnaire was self-administered by those present in their offices at the time of data collection. Respondents were introduced to the purpose of the study, and they received clarification on items about which they were unclear to ensure a higher response rate, decrease missing values, and fulfil the target respondent requirement.

Data Analysis Approach

Due to its exploratory nature, which builds on an earlier conceptual framework, authors used PLS-SEM. They selected this data analysis approach in line with its key research objective to develop a model and to gain insights into the determinants and influences of IS integration consistent with prediction and theory development fundamentals. In contrast, covariance-based structural equation

Table 1. Sources of measures

Construct	Items	No. of Items	Source
IS integration success	System quality Information quality	6 8	DeLone and McLean (2003) Xu et al. (2013)
IS integration	Data integration Application integration Infrastructure integration Interoffice integration	3 8 4 4	Bhatt and Troutt (2005) Francalanci and Morabito (2008) Francalanci and Morabito (2008) Roberts and Grover (2012)
Determinants	Top management support Technology readiness Entrepreneurial orientation Organizational innovativeness Knowledge sharing Compliance to external regulatory authority	8 3 5 3 6 6	Calvo-Mora et al. (2006) Venkatesh and Bala (2012) Li et al. (2009) Venkatesh and Bala (2012) Teo et al. (2009) Chau and Hui (2001) and Teo et al. (2009)

modelling (CB-SEM) is used in theory testing and confirmation with an alternate theory (Dash & Paul, 2021; Ramayah et al., 2018).

In the research, the authors followed a three-step data analysis approach. In the first step, they analyzed the responses and respondent characteristics. In the second step, they examined the measurement model, while they identified the structural model in the final step. While a structural model characterizes the causal-predictive relationships among constructs, measurement models concern the relationships between each construct and the corresponding indicators (Sarstedt et al., 2017).

RESULTS

Response Rate

Of 200 questionnaires distributed, 154 respondents returned the survey, yielding a response rate of 77%. Because the survey was self-administered, the response rate and number of missing values were low. Missing values were random, suggesting that they were not based on a systematic pattern and that any method could be applied to replace them (Hair et al., 2010). Following Osborne (2008), the authors used the expectation-maximization technique to replace missing values. The analysis included all 154 responses. While this number may be considered small, PLS-SEM has demonstrated its capability with small sample sizes in models having many constructs and several items (Hair et al., 2019; Sarstedt et al., 2017).

Profile of Respondents

Table 2 shows the respondents' profiles. Male (52%) and female (48%) respondents were distributed nearly equally, and most faculty members were aged between 31 and 40 years old (37%), or between 41 and 50 years old (28%). To ensure that the data were as heterogeneous as possible, the researchers collected data from various schools. Most respondents' expertise lay in engineering and science, which represents the overall population. A higher proportion were from informatics, civil engineering, and science (equally, 9.74%). In terms of job title, most respondents jointly comprised lecturers (32.1%) and senior lecturers (26.4%). These figures corroborate the diversity among respondents and the data's heterogeneity.

Reliability and Validity

The authors used SEM to assess the relationships among constructs. They tested all reflective measures for first- and second-order variables for reliability (i.e., internal consistency) and validity (i.e., convergent and discriminant validity (Chin, 2010). Convergent validity represents the degree to which multiple items that measure the same concept agree. Following Hair et al. (2010), the researchers analyzed factor loadings, composite reliabilities (CRs), and average variance extracted (AVE) for convergent validity. Recommended values for loadings were greater than 0.7, AVE greater than 0.5, and CR greater than 0.7.

Evaluation of the measurement model showed only two reflective indicators had outer loadings less than 0.7. Although the item "The top management at our institution develops the mission, vision, and values" (representing top management) had a loading less than 0.7, the authors did not remove it because, according to Hair et al. (2013), removal does not change CR. Hence, the indicators in the reflective measurement models had satisfactory indicator reliability (Table 3). All CRs ranged from 0.885 to 0.954, evidencing internal consistency. All AVE values were higher than the threshold of 0.50, supporting the measures' convergent validity (Table 3). The authors used two approaches to examine discriminant validity. First, they assessed the cross loadings of all indicators. Following Chin (2010), they compared the squares of the cross loadings, with no indicator loading higher onto any opposing construct (Table 4). All construct measures were reliable and valid, as the square root of the AVE was greater than the correlations of the construct (Fornell & Larcker, 1981).

Table 2. Profile of respondents

Profile	Item	Frequency	Percent
Gender	Female	74	48.0
	Male	80	52.0
	Total	154	100
Age	21 to 30	27	17.5
	31 to 40	57	37.0
	41 to 50	43	27.9
	51 and above	27	17.5
	Total	154	100
Educational Level	Bachelor's degree	9	5.8
	Master's degree	46	29.9
	Doctorate	99	64.3
	Total	154	100
Discipline of specialization	Informatics	15	9.74
	Engineering Management	9	5.84
	Policy Studies	6	3.9
	Mechanical Engineering	11	7.14
	Education	3	1.95
	Civil Engineering	15	9.74
	Built Environment	10	6.5
	Science	15	9.74
	Bioscience and Engineering	13	8.44
	Theology	11	7.14
	Management	13	8.44
	Geoinformation and Real Estate	11	7.14
	Petroleum	7	4.55
	Computer Science	8	5.2
	Electrical Engineering	7	4.55
	Total	154	100
Job title	Tutor	21	13.63
	Lecturer	50	32.5
	Senior Lecturer	40	25.97
	Associate Professor	26	16.9
	Professor	14	9.1
	Postdoctorate	3	1.95
	Total	154	100

Table 3. Loadings, AVE, and CR

Construct (Item Code)	Items	Loading	AVE	CR
System quality (SQ)	Our systems operate reliably and dependably, when I perform my task.	0.799	0.652	0.918
	Our systems are very easily and readily accessible, when I perform my task.	0.795		
	Our systems are able to flexibly address, adapt or adjust to new demands, needs or conditions, when I perform my task.	0.858		
	Our systems respond quickly and in a timely fashion, when I perform my task.	0.786		
	Our systems are available, when I perform my task.	0.839		
	Our systems are usable, when I perform my task.	0.763		
Information quality (IQ)	Our systems provide me with the most recent, current, and up-to-date information, when I perform my task.	0.723	0.580	0.916
	Our systems provide me with a complete and comprehensive set of information, when I perform my task.	0.776		
	The information provided by our systems is well formatted, laid out, and well-presented, when I perform my task.	0.797		
	The information provided by our systems is accurate, correct, and error-free, when I perform my task.	0.780		
	The information provided by our systems is easy to understand (understandable), when I perform my task.	0.781		
	Our systems provide me with highly personalized information, when I perform my task.	0.759		
	Our systems provide me with highly relevant information when I perform my task.	0.751		
	Our systems provide me with highly secure information, when I perform my task.	0.722		
Technology readiness (TR)	Our current systems are able to support future integration with new technologies.	0.866	0.736	0.892
	Our institution has the information technology infrastructure that we need to implement future systems integration.	0.888		
	Our institution has in-house expertise to implement future systems integration.	0.818		
Entrepreneurial orientation (EO)	Our institution has a strong emphasis on research and development (R&D), technological leadership, and innovation.	0.658	0.610	0.885
	Our institution has a strong tendency for high-risk projects which have a chance for very high returns.	0.713		
	Our institution has an attitude of adventure and proactiveness when faced with uncertainty.	0.847		
	Our institution has a tendency to initiate actions for other universities to respond to.	0.873		
	Our institution has a tendency to be a leader, always first in introducing new services or technologies.	0.793		
Organizational innovativeness (IN)	Our institution readily accepts innovations based on research results.	0.859	0.736	0.893
	The top management in our institution actively seeks innovative ideas.	0.847		
	Innovation is readily accepted in our institution.	0.868		

continued on following page

Table 3. Continued

Construct (Item Code)	Items	Loading	AVE	CR
Knowledge sharing (KS)	Information sharing is encouraged within and amongst faculty members.	0.797	0.70	0.932
	Information sharing is encouraged within and amongst our offices.	0.860		
	Our institution has a culture of sharing information.	0.887		
	Our institution values information sharing.	0.832		
	Information sharing is practised by employees.	0.838		
	We usually share information among different faculties/schools/offices.	0.779		
Compliance with external regulatory authority (EX)	Our institution provides reporting on the employability of our graduates to the ministry.	0.793	0.691	0.930
	Our institution provides reporting on research output (e.g., publications/patents/trademarks) to the ministry.	0.824		
	Our institution provides reporting on utilization of budget to the ministry.	0.873		
	Our institution provides reporting on employability of our graduates to the accreditation agency (e.g., Board of Engineers/Washington Accord/AACSB).	0.863		
	Our institution provides reporting on research output (e.g., publications/patents/trademarks) to the accreditation agency (e.g., Board of Engineers/Washington Accord/AACSB).	0.865		
	Our institution provides reporting on utilization of budget to the accreditation agency (e.g., Board of Engineers/Washington Accord/AACSB).	0.763		
Top management support (TS)	The top management at our institution develops the mission, vision, and values.	0.558	0.559	0.909
	The top management at our institution communicates the mission, vision, and values to all levels of the faculties/schools/offices.	0.727		
	The top management at our institution improves their actions, making them fit in with the present and future needs of the faculties/schools/offices.	0.786		
	The top management at our institution designs an organizational structure suitable for the policies and strategies of the faculties/schools/offices.	0.780		
	The top management at our institution implements a system of key processes or activities supporting the policies and strategies the faculties/schools/offices, and its goals.	0.845		
	The top management at our institution keeps in touch with the different stakeholders to know their expectations and opinions.	0.778		
	The top management at our institution encourages student and staff involvement in improvement actions.	0.730		
	The top management at our institution publicly acknowledges the successes of people and groups in quality improvement actions.	0.745		
Data integration (DI)	In our institution, the same data (e.g., student data, staff CV/financial/research data) are recorded only once into the system.	0.891	0.782	0.915
	In our institution, the same data (e.g., student data, staff financial/research data etc.) are stored in one system for use in different application areas.	0.878		
	In our institution, there are integrated student management data.	0.885		

continued on following page

Table 3. Continued

Construct (Item Code)	Items	Loading	AVE	CR
Application integration (AI)	In our institution, all software systems are designed to be fully integrated.	0.790	0.694	0.947
	In our institution, application for admission, academic information management systems, and graduate studies management systems are integrated.	0.783		
	In our institution, the administrative systems (e.g., financial and human resources) are integrated.	0.839		
	In our institution, all research and administrative systems are integrated.	0.896		
	In our institution, all learning support systems are integrated.	0.883		
	In our institution, all library systems are integrated.	0.822		
	In our institution, all evaluation systems are integrated.	0.771		
	In our institution, all learning support systems and administrative systems are integrated.	0.870		
Infrastructure integration (II)	In our institution, all infrastructure systems are fully integrated.	0.870	0.827	0.950
	In our institution, all Internet gateway systems are fully integrated.	0.920		
	In our institution, all wireless access points are fully integrated.	0.914		
	In our institution, all data centres points are fully integrated.	0.931		
Interoffice integration (OI)	In our institution, data are entered only once to be retrieved by most applications in other offices.	0.871	0.840	0.954
	In our institution, we can easily share our data with other offices within the institution.	0.933		
	In our institution, we have successfully integrated most of our software applications with the systems of other offices.	0.942		
	In our institution, most of our software applications work seamlessly across all/several offices.	0.918		
IS integration (IT) Second order	Data integration	0.847	0.804	0.943
	Application integration	0.933		
	Infrastructure integration	0.909		
	Interoffice integration	0.896		

Table 4. Intervariable correlations

	SQ	IQ	ITI	TR	EO	IN	KS	EX	TS
SQ	0.807								
IQ	0.738	0.761							
ITI	0.597	0.616	0.897						
TR	0.456	0.465	0.329	0.858					
EO	0.372	0.382	0.360	0.534	0.781				
IN	0.177	0.283	0.152	0.417	0.591	0.858			
KS	0.490	0.516	0.487	0.459	0.530	0.272	0.835		
EX	0.293	0.394	0.336	0.271	0.105	0.205	0.314	0.831	
TS	0.411	0.512	0.409	0.559	0.471	0.412	0.580	0.511	0.748

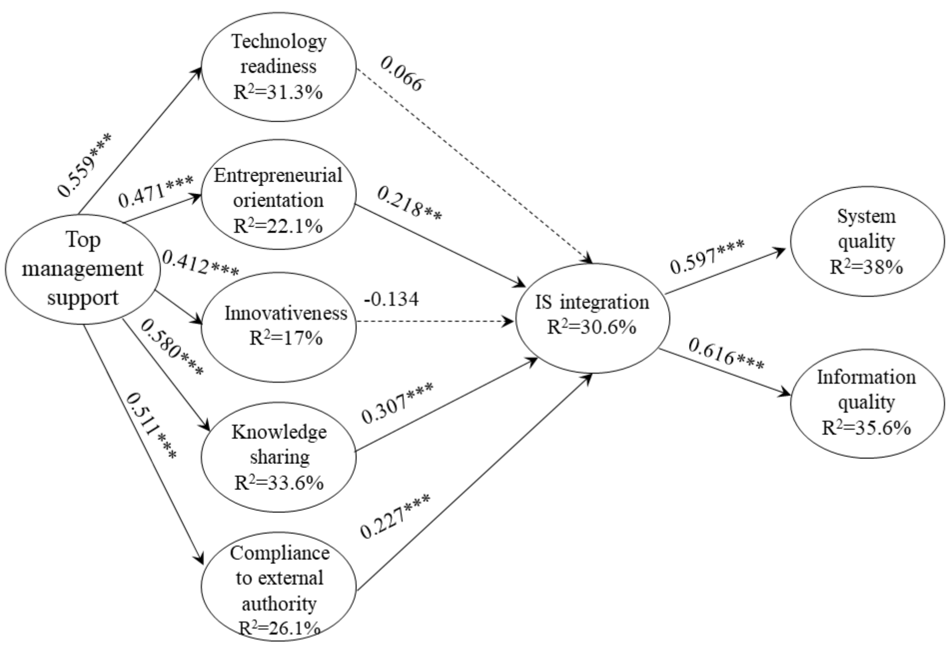
Discussion of Findings and Support for Hypotheses

The authors used a bootstrapping technique with resampling of 5,000 to calculate path estimates and t-statistics for the hypothesized relationships (Table 5 and Figure 3), in line with the recommendations

Table 5. Summary of path estimates and support for hypotheses

Hypothesis	Path	β	SE	t-statistic	Support for hypotheses
H1	IS integration → System quality	0.597	0.058	10.218	Yes
H2	IS integration → Information quality	0.616	0.051	12.117	Yes
H3	Technology readiness → IS integration	0.066	0.089	0.742	No
H4	Entrepreneurial orientation → IS integration	0.218	0.105	2.066	Yes
H5	Organizational innovativeness → IS integration	-0.134	0.092	1.458	No
H6	Knowledge sharing → IS integration	0.307	0.086	3.59	Yes
H7	Compliance to external regulation authority → IS integration	0.227	0.086	2.632	Yes
H8	Top management support → Technology readiness	0.559	0.069	8.17	Yes
H9	Top management support → Entrepreneurial orientation	0.471	0.087	5.402	Yes
H10	Top management support → Organizational innovativeness	0.412	0.073	5.668	Yes
H11	Top management support → Knowledge sharing culture	0.58	0.071	8.16	Yes
H12	Top management support → Compliance to external regulation authority	0.511	0.074	6.876	Yes

Figure 3. Theoretical path results (Note: → Significant path; ⇢ Not significant path. **, * Path is significant at p<0.01 and p<0.001, respectively)**



of Hair et al. (2010). IS integration positively influenced system quality (β=0.597; t=10.218), supporting H1. The authors also found a positive relationship between IS integration and information quality (β=0.616; t=12.117), so H2 was supported, a finding that is in line with Sadeh et al. (2013), Petter et al. (2013), and Negahban et al. (2016).

H3 suggested that technology readiness positively determines IS integration, but no support was found for this relationship (β=0.066; t=0.742). This finding corroborates Hossain et al. (2017) regarding the influence of industry-wide technology readiness on RFID acceptance, but is inconsistent with Kim and Chiu's (2019) and Blut and Wang's (2020) results. H4 suggests that entrepreneurial orientation positively determines IS integration, and the authors found support for this relationship (β=0.218; t=−2.066), consistent with Semrau et al.'s (2016), Martens et al.'s (2018), Allameh and Khalilakbar's (2018), and McGee and Peterson's (2019) studies.

H5 suggested that organizational innovativeness positively determines IS integration, but no evidence was found for this relationship (β=−0.134; t=−1.458), which contradicts the findings of Centobelli et al. (2019). The authors found evidence for a positive relationship between knowledge sharing culture and IS integration (β=0.307; t=3.59), supporting H6 and consistent with Calvo-Mora et al.'s (2015) and Soto-Acosta et al.'s (2017) findings. H7 suggested that compliance with external regulatory authorities positively determines IS integration. The authors found evidence for this relationship (β=0.227; t=2.632), supporting both the hypothesis and findings from Calvo-Mora et al. (2005), but contradicting Nugroho (2015).

H8 suggested that top management support positively determines technology readiness. The authors found evidence for this relationship (β= 0.559; t=8.17), supporting the hypothesis and both Low et al. (2011) and Larosiliere et al. (2016). The authors also found evidence for a positive relationship between top management support and entrepreneurial orientation (β=0.471; t=5.402), supporting H9 and the extant findings from Jia et al. (2014) and Wales et al. (2020). H10 suggested that top management support positively determines organizational innovativeness. The authors found evidence for this relationship (β= 0.412; t=−5.668), supporting both the hypothesis and the findings of Yuan et al. (2014) and Radmila et al. (2019). H11 suggested that top management support positively determines knowledge sharing. The authors found support for this relationship (β=0.58; t=8.16), consistent with the hypothesis and the findings of Lee et al. (2016), Al-Kurdi et al. (2018), and Singh et al. (2021). H12 suggested a positive relationship between top management support and compliance with external regulation authorities. The authors found support for this hypothesis (β= 0.511; t=6.876), consistent with Calvo-Mora et al. (2005).

Top management support is a determinant of technology readiness, entrepreneurial orientation, organizational innovativeness, knowledge sharing, and compliance with external regulatory authorities. Entrepreneurial orientation, knowledge sharing, and compliance with external regulatory authorities jointly explained 30.6% of the variation in IS integration. Of these three, knowledge sharing was the strongest determinant. IS integration strongly influenced both system and information quality. System quality and information quality were explained through 38% and 35.6% respectively of the variation in IS integration. Of the 12 hypotheses, 10 were supported.

CONCLUSION

At the onset, the authors put forth the research question: What are the determinants and influences of IS integration in higher education context? Accordingly, the authors discuss the major findings and research implications, as well as the limitations and areas for future research.

Major Findings

In this study, the authors identified IS integration as an innovation in organizations, using the TOE framework from Tornatzky and Fleischer (1990) to conceptualise determinants. They built on D&M's upstream IS success factors to conceptualize influences of IS integration. To explain the research context, the authors extend TOE using the business and knowledge view of the institution, explaining influences of top management support on the organization. However, the business factor (only entrepreneurial orientation) partially explained the determinant of IS integration, and knowledge and compliance with regulatory authorities (environmental factor) explained the determining factors that affect IS integration. Contrary to extant literature, technology readiness and innovativeness did not explain IS integration. Since the institution was research-oriented and promoted engineering and science education, these two factors were apparently no longer vital as they were already ingrained in the institution.

Consistent with extant research, this study demonstrated that top management support is a determining factor in preparing an organization's technological readiness, setting the course for entrepreneurial orientation, driving innovativeness, inculcating knowledge sharing, and driving compliance with external regulatory authorities. The findings suggest that top management support is a strong determinant of technological readiness, entrepreneurial orientation, innovativeness, knowledge sharing, and compliance with external regulations. Three determinants of IS integration that emerged were entrepreneurial orientation, knowledge sharing, and compliance with external regulatory demands. Organizations that seek to integrate IT must consider these factors. As organizations experience higher degrees of proactiveness from within, more intensified research and development, increased sharing of knowledge across offices, and greater demands for compliance with regulatory authority bodies, they can expect tighter data, applications, infrastructures, and interoffice integrations. With tighter IS integration, organizations can, in turn, expect more reliable and flexible systems that produce better information accuracy and relevance.

Research Implications

IS integration has persistently attracted a wide audience among researchers and practitioners, stemming from advances in big data from adoption to diffusion of technology in organizations. While IS integration research continues to expand, the intra-organizational perspective at the individual unit of analysis of IS integration (especially the higher education perspective) remains rare.

In this study, the authors assessed determinants and influences of IS integration, and, in line with their research question, they constructed and tested a theoretical model of IS integration to explain the higher education context. The researchers selected a public research university in Malaysia as the research context. Selection of a higher education institution was paramount, since it supports national human capital development and the fourth industrial revolution agenda. Higher education is a pillar of human and IT development in an emerging economy such as Malaysia. From theoretical implication, the authors achieved their objectives in developing a model that explains this institution, and its findings add to the body of IS integration knowledge. The authors used insights from TOE and D&M's success factors to predict IS integration and its influences, respectively. TOE appears capable of explaining determinants of IS integration to a limited extent in higher education. This study emphasizes a modified TOE that considers the knowledge era and business orientation. Both are characteristics of a unique public higher education technical institution chosen as the study context. Institutions that strive for IS success should ensure that they have tight IS integration and necessary organizational, knowledge, and business fundamentals. D&M's upstream IS success model appears capable of explaining IS integration's influences.

Each public higher education institution competes for public funding. IS integration is critical to supporting a university's core business processes. Business performance is commonly cited as influenced by IS integration (Georgantzas & Katsamakas, 2010), but one particular study has suggested that business process performance enhances organizational performance only to a degree (Dijkman et al., 2016). From the managerial and practical implications standpoint, understanding the determinants of IS integration in higher education identifies the requirements that make IS integration support the degree of business process maturity required to enhance organizational performance. Chief information officers in similar contexts may use the model and instrument to assess institutional readiness for IS integration and faculty members' perceived success of IS integration. Current findings can also be used to compare, in whole or in part, both determinants and influences. In terms of social implications, the findings can be compared with other public institutions that compete for national funding. This provides further evidence on how IS integration supports other institutions' business processes and indicators of benefits achieved out of investments in IS integration at a broader level.

Limitations and Future Research

In this study, the authors used a cross-sectional and static survey design. Gathered using a convenience approach, the sample represents a single higher education institution that emphasises science education in a single country. The sample did not consider other types of institutions, such as other public universities that might have alternate educational emphases (e.g., the arts, entrepreneurship and theology), offshore establishments, and private institutions. Other cultural factors might be present in institutions with a physical location in another country. Future research should consider other samples, longitudinal designs, and cross-cultural comparisons. Qualitative interviews might also offer insights into factors not discernible in a survey.

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