
An investigation of the impacts of some external contextual factors on ERP systems success assessment: a case of firms in Baltic-Nordic region

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Abstract: Enterprise Resource Planning (ERP) systems are among the largest information systems (IS) investments made by firms, and the use of such systems is spreading globally. Many researchers have discussed their adoption and implementation, few have investigated the impact of external contextual factors on the success of such technologies in adopting firms. This study aims to fill this gap in research by examining the effects of three external contextual factors, i.e., industry type, industry climate, and national economic climate on ERP success assessment. We obtained data from Estonia and Finland and our analysis shows that industry and national economic climates have significant relationships with ERP success.

Keywords: ERP systems success; external contextual factors; industry type; industry climate; national economic climate; firm; Baltic; Nordic; Finland; Estonia; internet and enterprise management.

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1 Introduction

An ERP system is an off-the-shelf, complex business application designed to integrate business processes and functions in a real-time environment (Davenport, 1998, 2000; Markus and Tanis, 2000; Klaus et al., 2000). ERP adoption continues to grow globally (Allnoch, 1997; van Everdingen et al., 2000; Somers et al., 2000; Mabert et al., 2003;

Reilly, 2005), despite the difficulties and risks encountered by organisations when implementing these systems (Martin, 1998; Bancroft et al., 1998; Swan et al., 1999; Markus et al., 2000). Data from studies showed that over 70% of manufacturing firms had adopted ERP systems and more than 60% of the Fortune 1000 had installed such technologies by the late 1990s (Somers et al., 2000; Mabert et al., 2003). Likewise, the penetration rates among European mid-sized firms across differing industries were estimated to be about 65% in 2000 (e.g., van Everdingen et al., 2000). Not surprisingly, most studies in the trade press and IS domain tend to focus on the adoption of ERP systems (Esteves and Pastor, 2001; Ifinedo, 2006a), and only a few discuss the success of such systems in the adopting firms. We define ‘ERP systems success’ as the utilisation of such systems to enhance organisational effectiveness (Hamilton and Chervany, 1981; Myers et al., 1997; Gable et al., 2003). This definition differs in scope from the technical implementation success of such systems (see e.g., Martin, 1998; Bancroft et al., 1998; Markus et al., 2000; Tan and Pan, 2002).

Research in the area of ERP systems success measurement, evaluations or assessment is just beginning to gather momentum (e.g., Nelson and Somers, 2001; Tan and Pan, 2002; Gable et al., 2003; Sedera and Gable, 2004; Wu and Wang, 2005), and the majority of these studies tend to focus attention on the internal or organisational factors or issues. However, nowadays, business organisations are coming under increased pressure because of the rapidly changing external contextual factors, including global competition and dynamic market environments (Powell, 1996; Watson et al., 1997). It is, therefore, critical for management to have insights about some key external contextual factors that may impact upon their adopted Information Technology (IT) systems, in this instance, ERP systems. Clearly, a boundary exists between the organisation and its external factors, and Duncan (1972) provides a distinction between both contexts. He writes,

“... the internal environment consists of those relevant physical and social factors within the boundaries of the organization ... the external environment consists of those relevant physical and social factors outside the boundaries of the organization ...” (Duncan, 1972, p.314)

In particular, we investigate the effect of external contextual factors on the assessment of ERP system success and focus on a few variables, namely, industry type, industry climate (stability and competition), and the national economic climate of the adopting firms. Although external contextual factors might include other components (e.g., government regulations, the influence of suppliers/partners, national culture), we chose our variables for two reasons:

- simplicity/illustration purposes
- the availability of ERP implementation studies related to these issues.

Additionally, our scan of the literature revealed that other researchers (e.g., Chadhar and Rahmati, 2004) have discussed the impact of other external contextual factors, i.e., national culture on ERP success assessment. Overall, there is a shortage of literature dealing with the external contextual factors as antecedents of on ERP success. The paucity of research in this area is motivation for this study. Specifically, this paper is designed to provide answers to the following questions:

- Does industry type matter in the assessment of ERP success?
- Does industry climate influence a firm's assessment of ERP success?
- Does national economic climate influence a firm's assessment of ERP success?

This study is conducted in two small neighbouring technologically advanced Northern European countries, i.e., Finland and Estonia with a combined population of approximately seven million people (WEF, 2004; CIA: World Factbook, 2005). Finland is a Nordic country and Estonia is one of the three Baltic countries. Finland is a high-income developed country, while Estonia is a middle-income emerging economy (HDR, 2005; CIA: World Factbook, 2005). Finnish companies began adopting ERP systems in the late 1990s (van Everdingen et al., 2000), and the software is just beginning to spread to other parts of Europe, including Estonia (Clouter, 2005; Ifinedo and Nahar, 2006). Further, Finland and Estonia share similar cultural values (Ifinedo and Davidrajuh, 2005), and although our data comes from two different countries, we are assured of the homogenous nature of the sample on a major differentiator: cross-national cultural differences vis-à-vis ERP issues (see Soh et al., 2000).

2 Literature review

2.1 Industry type

Previous studies divided industry into various categories according to research objectives (Hrebiniak and Snow, 1980; Bergeron et al., 1991; Wu and Wang, 2003; Kearns and Lederer, 2004). Wu and Wang's (2003) ERP satisfaction study in Taiwan divided industry into two broad classes:

- Electronic/Sciences (ES), including semiconductor, telecommunication, etc.
- traditional industries (plastic, metal, etc.).

Following the categorisation used by Wu and Wang (2003), we believe that industries can be classified into two main categories, namely, manufacturing and services sectors. Further, Hrebiniak and Snow (1980) categorised them as either low- or high-uncertainty industries: the automotive industry is an example of the former and the semiconductor industry of the latter. Porter and Millar (1985) coined the term 'information intensity' to classify industries. For the purposes of this study, we use an encompassing description of 'information intensity' from Glazer, who states

"More generally, a firm is information-intensive to the degree that its products and operations are based on the information collected and processed as part of exchanges along the value-added chain. Whereas traditional products and operations are relatively static, information-intensive products and operations change as new data from the environment becomes incorporated into them."
(Glazer, 1991, p.5)

In summary, studies suggest that there are differences among industries (e.g., Hrebiniak and Snow, 1980; Johnson and Carrico, 1988; Wu and Wang, 2003; Lee and Kim, 2006). Hrebiniak and Snow (1980) found differences between low- and high-uncertainty industries concerning the variables 'competitor's actions' and 'market forces'. Research shows that information-intensive industries are better at using IT when supporting core

activities (Bergeron et al., 1991). Lee and Kim (2006) found that the effects of IT investment in the high information-intensive industry are significantly higher than in the low information-intensive industry. Busch et al. (1991) found differences between low- and high-information intensive firms, and concluded that the greater the intensity of information in the production process or product, the greater the need for timeliness, information accuracy, and progressive use of IT.

2.2 Industry climate: stability and competition

The nature of the industry might influence the activities of a firm. Grover and Goslar (1993) cite Pfeffer and Leblebici (1977) and suggest that under relatively undifferentiated and stable environments, organisations can process information without using a complex IT system. They indicated that this is not possible in a rapidly changing environment. Miller and Friesen (1982) proposed three components of environmental uncertainty (heterogeneity, dynamism, and hostility), and several studies have used these variables in discussing external contextual factors (e.g., Keats and Hitt, 1988). For simplicity's sake, we narrow our scope of environmental uncertainty to industry competition and stability. According to Lederer and Mendelow (1990), these are the two main factors that can cause IS management problems, because IT systems may have to be modified to respond to them. Davenport (1998, 2000) note that firms are adopting ERP systems to enable them stay competitive, and Hunton et al. (2003) provide empirical evidence indicating that ERP may in fact be helping firms adopting them to gain competitive advantage over nonadopters in ever-changing business environments.

2.3 National economic climate

Differences in the economic status of nations are a major differentiator in the perception of IT benefits (Watson et al., 1997; Dewan and Kraemer, 2000; Huang and Palvia, 2001; WEF, 2004; Gregorio et al., 2005). Dewan and Kraemer (2000) sampled 36 countries concerning the structure of returns from IT capital investments and found significant differences between developed and developing countries. Their results indicate that developed countries had significant positive returns from capital investments, whereas the opposite was true for developing countries. Gregorio et al. (2005) found that early IT adopters (developed countries) gain advantages that are unavailable to late adopters (emerging and developing countries).

Davenport comments, "[ERP] can lead to greater productivity and efficiency in advanced economies" (Davenport, 2000, p.24) to imply that such benefits might be difficult to obtain in developing economies. The WEF (2004) reports suggest that developed countries are more adept at using IT systems for national development than developing countries. Lower levels of IT infrastructure and the lack of financial resources, IT culture, and skills are among the critical issues facing less developed countries in the implementation of IT systems (Bingi et al., 2000; Huang and Palvia, 2001; WEF, 2004). Huang and Palvia (2001) highlight the challenges that developing nations face in the implementation of ERP systems. They conclude that the disparity in the current economic status and poor economic growth for developing nations could inhibit ERP penetration in those regions.

2.4 ERP systems success measurement

ERP systems success measurement is emerging. Gable and colleagues' effort (Gable et al., 2003; Sedera and Gable, 2004) on ERP systems success issues is among the few in the literature. These researchers drew from the IS success evaluation literature (e.g., Hamilton and Chervany, 1981; DeLone and McLean, 1992). DeLone and McLean (D&M) IS success model is the most dominant framework for assessing IT systems success at the micro level; Gable and colleagues developed an additive model that redefines the original D&M IS success model's dimensions. In brief, Gable and colleagues eliminated (through multi-stage data collection and statistical analysis) the Use and User satisfaction dimensions. The literature (e.g., Saarinen, 1996; Ballantine et al., 1997; Seddon, 1997) also support the dropping these dimensions. The ERP success dimensions retained in Gable and colleagues' model are: System Quality (SQ), Information Quality (IQ), Individual Impact (II) and Organisational Impact (OI). Ifinedo (2006a) contribute to knowledge in this area of study with an extended model. Through literature reviews and case interviews, two relevant dimensions not included in the Gable and colleagues model were incorporated; namely, Vendor/Consultant Quality (VQ) and Workgroup Impact (WI) dimensions.

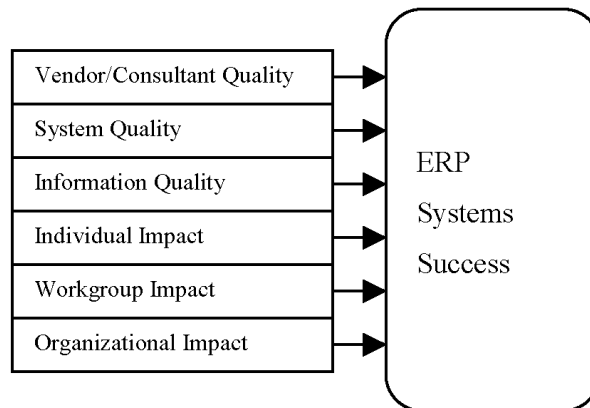
Rousseau (1979, p.536) states "Researcher on technology in organisations has generally given insufficient attention to the level at which technology is assessed". She adds that the individual, sub-unit, and organisational levels are highly interdependent, and it would be worthwhile to have research efforts duly focus on the three levels of analysis. Barua et al. (1995, p.20) found "that the most important significant contributions of IT investments occur at low organisational levels where they are implemented". In this regard, Myers et al. (1996) incorporate WI to the DeLone and McLean IS success measurement model. It is worth noting that our notion of 'workgroup' encompasses sub-units and/or functional departments of an organisation. We contend that the underlying philosophy of ERP systems (see, Davenport, 1998, 2000; Markus and Tanis, 2000) lends support to Myers et al.'s conceptualisation of IS success measurement. ERP systems are usually acquired to enhance efficient cross-functional operations within the adopting organisation. Importantly, 'interdepartmental co-operation' and 'interdepartmental communication' ranked 3rd and 6th, respectively, in a study of 22 Critical Success Factors (CSFs) of ERP implementation by Akkermans and van Helden (2002). Other ERP CSFs studies have produced comparable analyses (see Esteves and Pastor, 2001).

We believe VQ can be incorporated into the Gable and colleagues ERP success measurement model. Empirical evidence from 16 senior personnel in seven case companies in Finland and Estonia revealed that these ERP adopting firms tend to associate the overall success of their software with the quality of services, relationships, and so forth received from the system's vendors and consultants (Ifinedo and Nahar, 2006). Markus and Tanis (2000) highlight 'dependence on vendors' as a key issue in ERP implementations initiatives. Additionally, our study benefited from Ballantine et al.'s (1997) 3-D model of IS success where technical development was seen as an important dimension. More importantly, a recent work by Wu and Wang (2005) discussing ERP systems also recognises the relevance measures relating to the providers (e.g., suppliers, vendors, and consultants) as success measures for the software. We grouped both vendors and consultants together because they represent an external source of expertise to the organisation regarding ERP implementation. Sedera et al. (2003, p.1411) found that

“consultant and vendor items loaded together, yielding a new factor named external knowledge player”.

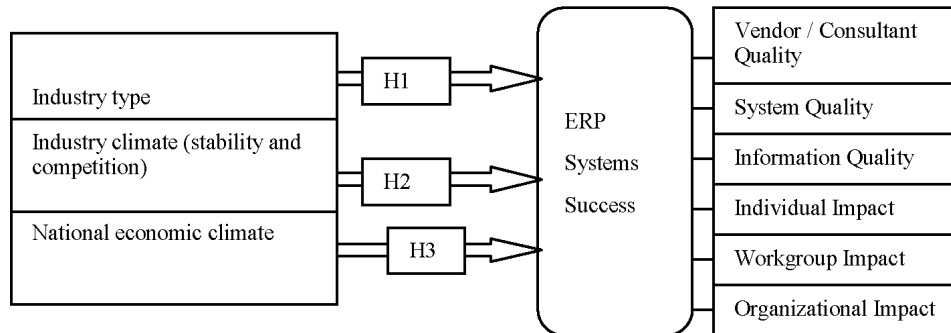
Figure 1 illustrates our extended ERP success measurement model. Full discussion on the framework is available elsewhere in Ifinedo (2006a) and Ifinedo and Nahar (2006), where each dimension of success was represented by differing numbers of measures (i.e., there were 45 measures in total). For the purposes of this study, we chose an equal number of measures (i.e., five of them) for each dimension. The VQ had five measures in Ifinedo (2006a). In short, the 30 ERP success measures used in this study compare with 45 measures in Ifinedo (2006a) and Ifinedo and Nahar (2006) in terms of reliability (see Appendix 2), and also compares with the 27 ERP success measures used in other studies (e.g., Sedera et al., 2003). The 30 measures chosen from the available 45 measures were the ones that yielded the most favourable loadings on PLS Graph 3.0 (see discussions below), and had better communalities in a Principal Component Analysis compared to similar measures for each dimension (Hair et al., 1998).

Figure 1 The extended ERP systems success measurement model



3 Hypotheses formulation

Based on the foregoing discussion, we develop the research model illustrated in Figure 2 in which the research hypotheses (H1–H3) are shown. The impacts or effects of the selected external contextual factors on ERP systems success are highlighted as hypotheses. Importantly, in the subsequent analyses of the data, we use the structural equation modelling techniques to test hypotheses (H2 and H3) because the questionnaire design and the collected data (please see the Research Methodology section) more readily permits the testing of variance analysis using that approach. For example, future studies desiring to replicate or extend this present study can easily incorporate developing countries (consistent with our approach such countries can be represented with ‘3’) given that countries of the world can be classified into any of the three: developed, emerging, and developing economies (WEF, 2004; CIA: World Factbook, 2005; HDR, 2005, Ifinedo and Davidrajuh, 2005). On the other hand, due to the dichotomised nature of the data collected for industry type, and the inherent difficulty in classifying firms by their industrial sector or information intensity, we believe analysis using non-parametric tests would suffice for the hypothesis related to it, i.e., H1.

Figure 2 Hypothesised impacts of the contextual external factors on ERP systems success

3.1 Industry type and ERP success

As indicated above, the firm's related industry is relevant to how the firm responds to the strategic use of IT systems (Johnson and Carrico, 1988; Kearns and Lederer, 2004; Wu and Wang, 2003). Evidence exists that support differences among industries concerning the nature of their information intensity and IT usage, and success (Hrebiniak and Snow, 1980; Busch et al., 1991; Powell, 1996; Wu and Wang, 2003; Lee and Kim, 2006). Firms in industries that have a need for complex IT systems, such as ERP in their business processes and operations, procure such systems as part of their strategic moves to be competitive (Davenport, 1998, 2000). Moreover, ERP might be appropriate in certain industries (e.g., banking and retail) that generate information as part of the exchange in the value-added chain (Porter and Millar, 1985; Glazer, 1991). Traditional, relatively static industries (e.g., metal and cement manufacturing) with low information-intensive products might find ERP useful but not essential (Busch et al., 1991). Indeed, Wu and Wang (2003) found that the overall ERP satisfaction level in industry with high information intensity is significantly higher than that in traditional industry. Based on the aforementioned findings, it is likely that the ERP success might differ according to industry type. Thus, we hypothesised:

H1a: Firms in different industrial sectors will assess ERP success differently.

H1b: ERP success assessment in firms will differ according to their information intensities.

3.2 Industry climate (stability and competition) and ERP success

Grover and Goslar (1993), citing Pfeffer and Leblebici (1977), suggest that organisations in relatively undifferentiated and stable environments may find IT systems adoption unnecessary. However, firms in unstable environments (characterised by ever-changing landscapes) see IT systems as critical and necessary infrastructure, and seamlessly use such systems to gain competitive advantage (Porter and Millar, 1985; Glazer, 1991), and are adept at strategically using them (Busch et al., 1991; Johnson and Carrico, 1988; Lee and Kim, 2006). In other words, in the bid to be competitive, firms experiencing more competition and instability in their industries will be better poised to respond to change by using relevant IT systems (Johnson and Carrico, 1988; Lederer and Mendelow, 1990; Glazer, 1991; Segars and Grover, 1995). Such firms can more readily modify or adapt

their IT systems to meet these changes than those in stable and less competitive environments (Pfeffer and Leblebici, 1977; Glazer, 1991). Therefore, we formulate the following hypotheses:

H2: ERP success assessment will differ according to industry climate.

3.3 National economic climate and ERP success

Differences in the economic status of nations are a major differentiator in the perception of IT benefits (Dewan and Kraemer, 2000; WEF, 2004; Gregorio et al., 2005). As mentioned above, Huang and Palvia (2001) suggest that the poor economic capabilities in developing countries present a problem regarding ERP penetrations. Seeking new sources of income, ERP vendors increasingly target newly emerging economies, including Estonia (Clouther, 2005). Thus, it is likely that countries that have just started adopting these systems may not have sufficient experience with them, and could be realising lesser benefits from their systems (Pyun, 2002; Gregorio et al., 2005), compared to countries such as Finland that adopted such systems earlier (van Everdingen et al., 2000). Accordingly, we expect the diverse levels of expertise and the availability of resources between nations to be influential factors in how IT systems success assessments are made. The findings in the work of Watson et al. (1997) provide empirical evidence in support of the foregoing statement. Therefore, we propose the following hypothesis:

H3: ERP success assessment will differ according to national economic climate.

4 Methodology

4.1 Research method

We sampled firms generated from local contacts and companies directories in the two countries (e.g., online database of Finnish companies: <http://www.yritysopas.com/> and Estonian Chamber of Commerce and Industry Directory 2004: http://mail.koda.ee/ektk/koda_eng). Firms were chosen by our ability to obtain contact addresses for key organisational personnel in the selected firms. We identified 350 firms in Finland and 120 in Estonia from the aforementioned sources. Admittedly, the population of firms adopting ERP in Finland and Estonia is unknown to us, and the resources to determine the number were unavailable to us during this study. We concentrated on private organisations in the two countries because we believe the adoption of ERP systems might be higher there than in public sector organisations. Of note, the few studies relating to ERP systems success in the literature used data from public sector organisations (e.g., Gable et al., 2003; Sedera and Gable, 2004). It is a known fact that the operational environments of public and private sector organisations differ considerably (e.g., Khandelwal, 2001; Ifinedo, 2006b), and insights from private sector organisations on ERP success issues as we intend to present with our findings add to the emerging body of knowledge in this area of study. Since the unit of analysis of this study was at the firm level, only key organisational informants including senior and unit managers received a packet consisting of a cover letter, questionnaire, and a self-addressed, stamped envelope. These groups of respondents are among the most knowledgeable informants regarding ERP success in organisations (Gable et al., 2003; Sedera et al., 2003).

About 60% of the mailings to the participants included only one questionnaire; the rest (40%) of the mailings had two questionnaires. It was decided that multiple respondents from one organisation would enhance the validity of the study as a common source bias would be minimised. In addition, low response rates seen with IS research in the two countries as discussed by Nissinen (2002) prompted us to use this approach. In instances where we sent out two questionnaires, the recipients were instructed to give one of the questionnaires to an appropriate person within their organisation. We encouraged the subjects to present views representative of their organisation. To ensure that organisation-wide perspectives are being reflected, we posed the questions in the questionnaire appropriately (please, see Appendix 1). To ensure data validity and reliability, four knowledgeable individuals (i.e., 2 IS faculty, 1 ERP consultant and 1 ERP managerial level user) completed the questionnaire before our mailing it out, and their comments helped us improve its quality. To determine the minimum number of completed responses required for a meaningful analysis we used the G*Power software (source: <http://www.psych.uni-duesseldorf.de/aap/projects/gpower/>). By applying a high effect size of 0.80 (Cohen, 1988), a significant (alpha) level of 0.05, and a power of 0.90, the software recommended an effective sample size of 56, which is lower than our sample size.

4.2 Instrument development, reliability and validity

We classified firms into low high and low information intensity firms using '1' and '2', respectively. Similarly, the two industrial sectors: 'manufacturing' and 'services' were represented with dichotomised variables similar to those used for information intensity. Participants were instructed to use a 4-point Likert-type ordinal scale indicating how stable their industries were in terms of changes and innovations (1 = extremely stable, 2 = stable, 3 = moderately stable, and 4 = unstable). Similarly, a 4-point Likert-type scale was used to determine competitiveness of their industry (1 = non-competitive, 2 = moderately competitive, 3 = competitive, and 4 = very competitive).

We classified the two countries by national economic development with '1' = developed country – Finland, and '2' = emerging economy – Estonia (WEF, 2004; CIA: World Factbook, 2005; Ifinedo, 2006b); this we believe is indicative of their respective human development indices (HDR, 2005). Finland and Estonia ratings were 0.941 and 0.853, respectively on this index, which we also incorporated into our analysis. The dependent construct of ERP systems success was operationalised using 30 measures (i.e., 5 per dimension) adapted from Gable et al. (2003) and Ifinedo (2006a). Respondents indicated agreement with statements using a 7-point Likert-type scale, where 1 = strongly disagree and 7 = strongly agree. The construct reliability of the ERP systems success construct as assessed by Cronbach alpha is 0.932, which is high, and compare with recommended values in the literature (Nunnally, 1978). A pilot test and case studies on ERP success issues in the two countries (Ifinedo and Nahar, 2006) enhanced the validity of the study. We also noticed that for firms with more than one respondent, the responses on key issues were comparable; this enhances the validity of the responses from such firms as well as our data in general.

4.3 Results

We used SPSS 13.0 to analyse the data. Our respective response rate, excluding the unusable received questionnaires was 29 firms (8.5%) for Finland, 15 firms (12.5%) for Estonia, and 44 (9.5%) combined for the two countries. We received 62 individual responses: 39 from Finland and 23 from Estonia. Our data collection effort reflects the typically low responses that are commonly seen with surveys targeting senior employees in organisations (Kearns and Lederer, 2004). Our data classified by organisational hierarchy comprised of 26 (42%) top-level management and 36 (58%) mid-level managers, and by occupation 20 (32.3%) IT professionals/managers and 42 (67.7%) business managers. Their job titles included chief executive officer, chief information officer, chief accountant, IT manager and finance manager. There were 35 (56.5%) men and 27 (43.5%) women in our sample.

On average, they had nine years of work experience in their respective organisations. Of the respondents, 40% had college degrees, 20% had technical and other vocational education, and 43 (69.3%) were between 31 and 50 years old. Of the 62 respondents, 33.9% had SAP in their organisations, 14.5% had Movex, 9.6% had Scala, 8.1% had Hansa, and the remaining 33.9% had other mid-market ERP products, including Concorde, Nova, etc. The annual turnover of the firms in the sample ranged from €1 million to a little over €2 billion, with €19 million as the median. The workforce ranged from 10 to 13,000 employees, with a median of 120 employees. We received responses from a wide range of industries, including manufacturing, financial services, IT firms, pharmaceuticals, food processing, retail, and warehouse businesses. Our sample classified by size of workforce following guidelines provided by EC (2003) and Laukkanen et al. (2005) included 15 (24%) small, 25 (40%) medium-sized, and 22 (36%) large firms.

We are hard-press to posit that the firms in our sample are representative of the population of firms in the two countries that have adopted ERP, because no demographic information on ERP adoption is available, and because the resources available to this research did not permit us to uncover such information. Nevertheless, our data is consistent with the study by Laukkanen et al. (2005) indicating that ERP adoption in Finland is more widespread in the retail and manufacturing sectors, and our earlier case studies (Ifinedo and Nahar, 2006) suggest that SAP is the most common ERP software among large firms in Finland. Our informal discussions with ERP consultants in the two countries confirmed that small and medium-sized firms in the region usually adopt mid-market ERP products (i.e., Movex, Scala, Hansa, etc.), which is in line with our data. As suggested by Armstrong and Overton (1977), we assessed whether our respondents reflect the sampling frame of ERP adopting firms in the two countries by comparing early and late respondents (i.e., nonresponse bias) in the study on key organisational characteristics such as size, industry type, year of ERP adoption, and ERP type, among others. The results of the chi-square tests (significant at <0.05) showed there were no significant differences along these key characteristics.

5 Data analysis

The research model (without hypothesis 1) is assessed using PLS Graph 3.0 for the reason explained above. The Partial Least Squares (PLS) procedure is a

second-generation multivariate technique used to estimate structural models, and it is particularly useful for variance analysis (Chin, 1998, 2000). This approach is suitable for this discourse for three reasons:

- it is not sensitive to normality of data (our data is non-normal as indicated by Kolmogorov-Smirnov statistic)
- the small-sized nature of our data
- the developing knowledge regarding ERP systems success assessment (Gable et al., 2003; Ifinedo, 2006a).

PLS is capable of testing complex models consisting of multiple interactions measured with multiple indicators. Unlike the traditional multiple regression analysis that is less efficient in assessing measurement errors, PLS recognises two components of a casual model: the measurement model and the structural model (Chin, 1998, 2000).

The measurement model consists of relationships among the conceptual factors of interest (the observed items or variables) and the measures underlying each construct, and it demonstrates the construct validity of the research instrument, i.e., how well the instrument measures what it purports to measure. The main criteria are the item loadings, convergent validity (composite reliability), and the discriminant validity. PLS Graph 3.0 computed the composite reliability of each dimension or construct. The composite reliabilities of the constructs are: Industry climate – 0.910, National economic climate – 0.905, and ERP systems success – 0.975, which is adequate for this study (Fornell and Larcker, 1981; Chin, 1998). These authors recommend that individual item loadings and internal consistency values greater than 0.7 are adequate. The item loadings for all the indicators are shown in Appendix 1. Our data's item loading were persistently higher than the recommend value, except for two items in the VQ measure. Some researchers (e.g., Barclay et al., 1995) suggest that construct reliability is similar to Cronbach alpha and can be interpreted in the same way. Thus, the composite reliabilities obtained for the constructs in this study are sufficient for this study (Nunnally, 1978; Hair et al., 1998). Furthermore, Chin (1998) recommends that a confirmatory factor analysis should be conducted to refine the measure measurement model. Without specifying the number of factors to be extracted, SPSS 13.0 extracted eight factors; the results are shown in Appendix 3. This might be interpreted to mean that the two external contextual factors are clearly delineated, and so are the six other constituting dimensions of the ERP systems success construct. In brief, each indicator loads fairly well under its assigned construct (or sub-construct). The results also indicate that the measures or constructs (or sub-constructs as the case may be) together account for 74.4% of the variance in the analysis.

The discriminant validity is assessed by checking the extent to which items measure a construct. This is assessed by checking the square root of the Average Variance Extracted (AVE) for each construct. When the correlation between the constructs is lower than the squared root of AVE (usually in the leading diagonal), this provides an indication that variance shared between a construct and its indicators is sufficient in distinguishing between that construct and the others in the model (Fornell and Larcker, 1981; Chin, 1998). Fornell and Larcker (1981) recommend values higher than 0.50. Table 1 presents the inter-correlations among the constructs, AVE and the square root of AVE. In no case was any correlation between the constructs equal to or greater than the squared root of AVE (leading diagonal) (Fornell and Larcker, 1981). This suggests that our measures are

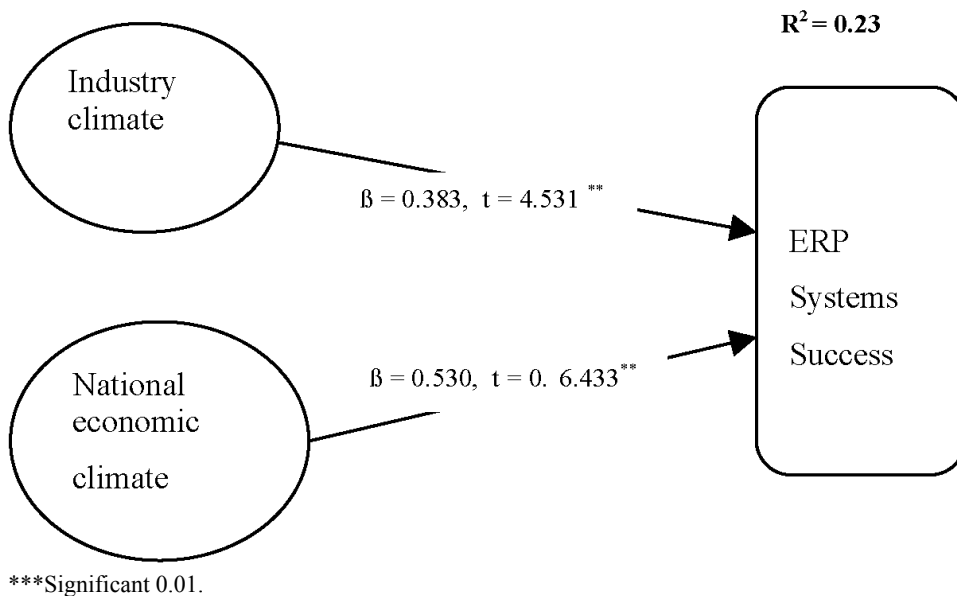
distinct and unidimensional. Thus, we can say that the convergent and discriminant validity of our data are psychometrically adequate for an exploratory study such as this one (Nunnally, 1978; Hair et al., 1998; Chin, 1998, 2000).

Table 1 Inter-construct correlations, AVE, and the square root of AVE (in italic font)

<i>Construct</i>	<i>AVE</i>	<i>Industry climate</i>	<i>National economic climate</i>	<i>ERP systems success</i>
Industry climate	0.834	<i>0.913</i>	–	–
National economic climate	0.827	0.671	<i>0.909</i>	–
ERP systems success	0.663	0.739	0.787	<i>0.814</i>

The structural model gives information as to how well the theoretical model predicts the hypothesised paths or relationships. PLS Graph 3.0 provides the squared multiple correlations (R2) for each endogenous construct in the model and the path coefficients (β). The R2 indicates the percentage of a construct’s variance in the model, while the path coefficients indicate the strengths of relationships between constructs (Chin, 1998, 2000). PLS does not generate a single goodness-of-fit metric for the entire model, but the path coefficients and the R2 are sufficient for analysis, and Chin (2000) recommends that path coefficients (β) should be at least 0.20 and ideally above 0.30 to be considered meaningful. We also tested the significance of paths using *t*-values obtained in the bootstrapping procedure in PLS Graph 3.0 by generating 200 sub-samples with 0 cases (Chin, 1998). The PLS Graph 3.0 results for β s and *t*-values are shown in Figure 3. The β s in the study are much higher than the recommended range as suggested by Chin, which indicates the strength of the relationships among the constructs in our research model.

Figure 3 The PLS graph 3.0 results for the research model



Regarding hypothesis H1, we used the Mann-Whitney U and Wilcoxon tests significant at $p < 0.05$. The results indicate that there are no significant differences across industry types (as operationalised by industrial sector (manufacturing/services) and the nature of information intensity of the firms) vis-à-vis ERP success assessment or evaluations. The results are summarised in Table 2.

Table 2 Test results for the *Industry Type* variable

<i>Test</i>	<i>VQ</i>	<i>IQ</i>	<i>SQ</i>	<i>II</i>	<i>WI</i>	<i>OI</i>
<i>Results for each dimension for the measure: information intensity</i>						
Mann-Whitney U	471.500	470.500	387.500	430.500	417.500	471.500
Wilcoxon W	1032.500	1031.500	822.500	991.500	978.500	906.500
Asymp. sig. (2-tailed)	0.921	0.910	0.199	0.497	0.388	0.921
<i>Results for each dimension for the measure: industrial sector</i>						
Mann-Whitney U	335.500	362.500	449.500	332.500	336.000	366.000
Wilcoxon W	1076.500	1103.500	1190.500	1073.500	1077.000	1107.000
Asymp. sig. (2-tailed)	0.081	0.176	0.925	0.073	0.082	0.193

See Section 2 for the acronyms' meanings.

6 Discussions and conclusion

Together the two external contextual constructs (i.e., industry climate and national economic climate) that lend themselves to analysis using structural equation modelling account for 23% in the variation of ERP systems success construct. Industry climate and national economic climate positively and significantly impact ERP systems success assessment, as hypothesised. Their path coefficients as shown in Figure 3 are 0.383, and 0.530, respectively. Their t -values indicate significant strengths in the relationships between the two variables and the ERP systems success construct. In brief, our data support the predictions for hypotheses H2 and H3. With regard to hypothesis H1 which concerns industry type, this we split into two sub-hypotheses (i.e., H1a and H1b) to facilitate insight. For the sub-hypotheses, we used seemingly appropriate statistical tests; and the results from those tests suggest that no differences exist between the firms in our sample with respect to how ERP success is assessed by the participating key organisational members in those sampled firms.

Understanding the impacts or effects of external contextual factors on ERP systems success evaluations is crucial for management. As argued by Pfeffer and Salancik (1978) management is likely to better control any emerging constraints arising from the influence of external contextual factors if attention is paid to such factors. In this study, our data revealed that industry climate as operationalised by stability and competition has a positive relationship on how ERP systems success is assessed by adopting firms. This finding indirectly supports claims that complex IT systems may in fact be paramount for firms operating in competitive and ever-changing landscapes such that their rewards (e.g., success) for acquiring such systems may be higher (Porter and Millar, 1985; Johnson and Carrico, 1988; Glazer, 1991; Busch et al., 1991; Davenport, 1998, 2000). As discussed above, firms experiencing more competition and instability in their

industries will be better poised to respond to change by using relevant IT systems (Johnson and Carrico, 1988; Lederer and Mendelow, 1990; Glazer, 1991; Segars and Grover, 1995). Our analysis supports this viewpoint.

Our data seems to be indicating that industry type does not matter (or, should not be a major concern) in the assessment of ERP success for the adopting organisations. Our finding is inconsistent with studies that suggest that firms in certain industries, especially in industries that are highly information intensive, would experience higher levels of satisfaction or success with their IT systems (Hrebiniak and Snow, 1980; Busch et al., 1991; Powell, 1996; Wu and Wang, 2003; Lee and Kim, 2006). A closer look at the results of our data analysis for sub-hypotheses H1a and H1b, however, reveals the following salient facts. Manufacturing firms (number (n) = 24) in our sample rated ERP systems success (averaged for the dimensions) higher than did firms classified as belonging to the services sectors (n = 38). The ERP success mean scores and the standard deviations for manufacturing (Mn) and services (Sv) firms are: Mn (5.21, 1.17) and Sv (4.85, 1.11), respectively. With regard to the information intensity, firms characterised by low information intensity industry have a mean score and the standard deviations of 4.98 and 1.04, respectively, which compares with the 5.00 and 1.25 seen for high information intensity firms. These results seem to be suggesting that the higher the information intensive of firms, the lesser the success with their ERP systems, and vice versa.

As noted, these findings contradict views in the literature. We believe future efforts are necessary to validate our finding as it is impossible to establish the validity of findings on the basis of a single study. Furthermore, this research is not designed to answer the why question(s); however, in brief, our analysis with the industry type variable seems to be suggesting that the type of industry in which a firm is situated may not be significant in differentiating between firms on how ERP success is assessed. Historically, the origins of ERP can be traced to Manufacturing Resource Planning (MRP) systems commonly used in the traditional, manufacturing sectors (Abdinnour-Helm et al., 2003); however, over the years, thousands of 'best practices' and procedures from differing industries have been added to ERP systems (Swan et al., 1999; Davenport, 2000). Klaus et al. (2000, p.143) in their work that provided background information on ERP systems noted "ERP targets multiple industries with very different characteristics ... ERP supports multiple industries ...". Against the backdrop of this evolutionary trend, it comes as no surprise that ERP have become easy to adopt in vast number of industries (Allnoch, 1997; van Everdingen, 2000; Mabert et al., 2003), and the benefits accruing from the acquisition of such systems across differing industries may, in some respect, compare (e.g., Mabert et al., 2003; Laukkanen et al., 2005; Ifinedo and Nahar, 2006). In view of the popularity of ERP systems in modern businesses, some have described them as the "price of entry for running a business" (Kumar and van Hillebergersberg, 2000, p.24). Our data analysis suggesting that no variance exists with regard to the relationship between industry type and ERP success may be reasonable, and is consistent with trends in ERP adoption across differing sectors and industries (Somers et al., 2000; van Everdingen et al., 2000).

Regarding the national economic climate construct, although the data set of countries in this study is limited, our analysis nonetheless shows that the perception of ERP systems success might vary according to national economic status or climates. The direction and strength of the relationship in Figure 3 is indicative. Thus, we can tentatively say that our analysis lends credence to the claim that IT (and ERP) evaluation

issues might be impacted by national economic differences such that success evaluation might be higher in advanced economies because of the availability of resources and expertise (Watson et al., 1997; Bingi et al., 2000; Dewan and Kraemer, 2000; Davenport, 2000; Huang and Palvia, 2001; Ifinedo and Davidrajuh, 2005). Additionally, we found support for this proposition in the course of interviewing case companies in the two countries. For example, when asked how the decision to adopt ERP are made. A Finance/Administration Manager in an Estonian subsidiary of a large multinational courier company responded as follows:

“The HQ [in a developed Western country] makes the adoption decisions; mainly, countries in Eastern Europe are to implement mid-market products, in our case Scala, and Western developed countries, SAP.”

These foregoing remarks might be suggesting that corporate managers are aware of the impact of cross-national differences on strategic IT systems (e.g., ERP) use and adoption. And, it is worth noting that the same courier firm in Estonia is changing from its Scala, which it implemented in 1998 to SAP (top-of-the-line ERP product) in 2005 perhaps thus affirming the need to gain on exposure and experience regarding complex IT systems like ERP.

6.1 Implications, limitations and future study

Practitioners in the region (and elsewhere) can benefit from our study. First, knowing that there is a strong positive relationship between industry climate, i.e., levels of instability and competition and ERP system success assessment would enable those responsible for organisational IT issues to make recommendations to superiors who might be seeking a justification for investing in such complex and costly technologies (Ward and Peppard, 1999; Willcocks and Sykes, 2000; Markus and Tanis, 2000). Our finding suggests that acquiring such systems may not be wasteful to the organisation because other firms operating in highly competitive and unstable environments may be adopting the systems to cope with the changing business environments (Watson et al., 1997; Davenport, 1998, 2000; Mabert et al., 2003; Hunton et al., 2003). Indeed, our data seems to be indicating that the more unstable and competitive the business environment, the higher the success with adopted ERP systems thus indirectly adding support to findings in prior studies (e.g., Pfeffer and Leblebici, 1977; Johnson and Carrico, 1988; Glazer, 1991; Segars and Grover, 1995).

Second, the information that industry type has no significant bearing on the way ERP systems success assessment is made in adopting organisations may be useful for firms that otherwise might have believed that ERP would not be relevant to their business operations. With respect to industry type and to some extent, industry climate, the comments made by Davenport are enlightening. He asserts “You may also be predisposed to using an [ERP] if other companies in your industry have already adopted one” (2000, p.147). In this light, vendors of such systems in the region (and elsewhere) can use the information to intensify their promotional campaigns. Third, against the backdrop of increasing cross-border investments in the IT and related industries between countries in the Baltic-Nordic region (Nissinen, 2002; CIA: World Factbook, 2005), corporate managers in the advanced countries of the region can benefit from the findings in our study to strategically plan for the deployment of similar complex IT systems in the emerging nations of the region where they have interests. Our study underscored the

pertinence of cross-national considerations in IS success evaluations to support prior literature. We believe managers desiring to deploy complex IT systems such as ERP to less developed parts of the world should not downplay the need to allow their partners and/or employees in such developing parts of the world to gain on experience and exposure. Our case studies showed when such is the case, the transition to more sophisticated systems can then be effected with fewer problems (Ifinedo and Nahar, 2006). Considering the variance noticed in the evaluations of ERP success between firms in Finland (advanced country) and Estonia (an emerging economy country), it might be safe to suggest that relevant ERP exposure and training for personnel in Estonia (and comparable less developed countries) might be worthwhile.

There are implications for the research community as well. Our research posits and finds support for the claim that ERP systems success assessment could be influenced by external contextual factors; we illustrated this with three selected variables for this study. Accordingly, our study and its findings might stimulate future inquiry in areas. At a general level, our study supported prior studies suggesting a relationship between a firm's environment and its use or success with complex IT systems (Johnson and Carrico, 1988; Lederer and Mendelow, 1990; Glazer, 1991). We also found evidence in support of the notion that IT systems evaluation might have a relationship with the economic status among nations, which would support findings in other studies (e.g., Watson et al., 1997; Dewan and Kraemer, 2000; Gregorio et al., 2005). Specifically, our data lends credence to Huang and Palvia (2001) who suggest that ERP issues might differ by economic development of nations. Further, our data analysis supports other researchers (e.g., Jarvenpaa and Ives, 1990; Kearns and Lederer, 2004) who found no support for the notion of information intensity as a differentiator between firms.

We caution against generalising the findings of this study to all contexts because there are limitations that need to be taken into account as the findings of this study are interpreted. First, this study is exploratory, and although a convenient sample of 62 respondents may be statistically adequate, it is insufficient for a conclusive understanding of the issue. Nonetheless, our sample size compares favourably with other ERP studies originating from the region (see Laukkanen et al., 2005). Second, our sample is not random; as such, we do not stake out a claim for its representativeness for ERP adopting firms in the two countries. Nor can we rule out personal bias, not even in cases where the respondents claimed to present an average view for their respective organisations on selected issues. Moreover, the views expressed in this study relate only to private sector organisations, opinions in the public sector may differ. Third, we did not control for the types of ERP used by the participating firms. Our sample comprised mixed ERP software, including top-brand names (e.g., SAP and Oracle) and mid-market products (e.g., Hansa, Scala and Nova). It is possible that the heterogeneous nature of the ERP systems used for our study is limiting. Fourth, more useful insights would have emerged were our choice of countries more than the two we used.

Fifth, it is difficult to say with certainty that these findings would emerge elsewhere; however, firms in the region sharing similar characterisation as the samples studied in this research may reflect our findings. Thus, this research may be replicable and applicable to firms in small countries in the region, including Latvia, Lithuania, Iceland, and Norway. Comparable studies in the region (and elsewhere) are needed to validate the findings in this research. The use of more countries in the analysis would be enlightening. Other research approaches, including case studies, may enhance insights. Future studies could examine the effects or impacts of other external contextual factors to include the

influence of suppliers/partners and government regulations on the ERP success assessment in adopting firms. A large data sample should be sought in future studies to permit robust analyses. For example, Multi-group analysis (a facility that is supported by PLS Graph 3.0) when performed can offer deeper understanding.

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Appendix 1: Questionnaire's measures, loadings and construct reliability

<i>Measures and constructs</i>	<i>Loading</i>	<i>Construct reliability</i>
<i>Industry climate</i>		
IND1: competitiveness of the industry	0.9123	0.910
IND2: stability of the industry	0.9146	–
<i>National economic climate</i>		
NAT1: economy type (i.e., developing and emerging)	0.9261	0.905
NAT2: human development indices	0.8921	–
<i>Industry climate</i>		
<i>ERP systems success</i>		
E1: Our ERP has accurate data	0.7086	0.975
E2: Our ERP is easy to learn	0.7700	
E3: Our ERP has good features	0.7772	
E4: Our ERP allows data integration	0.7526	
E5: Our ERP is efficient	0.7697	
E6: Our ERP has timely information	0.7871	
E7: The information on our ERP is important	0.7846	
E8: The information on our ERP is relevant	0.7830	
E9: The information on our ERP is usable	0.7928	
E10: The information on our ERP is available	0.7336	
E11: Our ERP vendor/consultant provides adequate technical support	0.6326	
E12: Our ERP vendor/consultant is credible and trustworthy	0.7308	
E13: Our ERP vendor/consultant has good relationships with my organisation	0.7053	
E14: Our ERP vendor/consultant is experienced and provides quality training and services	0.6840	
E15: Our ERP vendor/consultant communicates well with my organisation	0.8048	
E16: Our ERP enhances organisational learning and recall for individual worker	0.7144	
E17: Our ERP improves individual productivity	0.8039	
E18: Our ERP is beneficial for individual's tasks	0.7473	
E19: Our ERP enhances higher-quality of decision making	0.7197	
E20: Our ERP saves time for individual tasks and duties	0.7189	
E21: Our ERP helps to improve workers' participation in the organisation	0.8311	
E22: Our ERP improves organisational-wide communication	0.7905	
E23: Our ERP creates a sense of responsibility	0.7399	

Appendix 1: Questionnaire's measures, loadings and construct reliability (continued)

<i>Measures and constructs</i>	<i>Loading</i>	<i>Construct reliability</i>
<i>Industry climate</i>		
<i>ERP systems success</i>		
E24: Our ERP improves the efficiency of sub-units in the organisation	0.7470	
E25: Our ERP enhances solution effectiveness	0.7241	
E26: Our ERP provides us with competitive advantage	0.7286	
E27: Our ERP increases customer service/satisfaction	0.7034	
E28: Our ERP facilitates business process change	0.7725	
E29: Our ERP supports decision making	0.7887	
E30: Our ERP allows for better use of organisational data resource	0.7346	

The ERP systems success measures are assessed on a Likert scale (1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = neutral, 5 = somewhat agree, 6 = agree, and 7 = strongly agree).

'Our ERP' refers to the type(s) of ERP system in use in the participating firms.

Appendix 2: Questionnaire's measures by dimensions and their reliabilities

Systems Quality (Cronbach alpha = 0.73)

- Our ERP has accurate data.
- Our ERP is easy to learn.
- Our ERP has good features.
- Our ERP allows data integration.
- Our ERP is efficient.

Information Quality (IQ) (Cronbach alpha = 0.74)

- Our ERP has timely information.
- The information on our ERP is important.
- The information on our ERP is relevant.
- The information on our ERP is usable.
- The information on our ERP is available.

Vendor/Consultant Quality (Cronbach alpha = 0.88)

- Our ERP vendor/consultant provides adequate technical support.
- Our ERP vendor/consultant is credible and trustworthy.
- Our ERP vendor/consultant has good relationships with my organisation.
- Our ERP vendor/consultant is experienced and provides quality training and services.
- Our ERP vendor/consultant communicates well with my organisation.

Individual Impact (II) (Cronbach alpha = 0.75)

Our ERP enhances organisational learning and recall for individual worker.
 Our ERP improves individual productivity.
 Our ERP is beneficial for individual's tasks.
 Our ERP enhances higher-quality of decision making.
 Our ERP saves time for individual tasks and duties.

Workgroup Impact (Cronbach alpha = 0.75)

Our ERP helps to improve workers' participation in the organisation.
 Our ERP improves organisational-wide communication.
 Our ERP creates a sense of responsibility.
 Our ERP improves the efficiency of sub-units in the organisation.
 Our ERP enhances solution effectiveness.

Organisational Impact (OI) (Cronbach alpha = 0.84)

Our ERP provides us with competitive advantage.
 Our ERP increases customer service/ satisfaction.
 Our ERP facilitates business process change.
 Our ERP supports decision making.
 Our ERP allows for better use of organisational data resource.

Note: The Cronbach alpha for the scale with all six dimensions is 0.932.

Appendix 3: Factor analysis

Measure	Factor							
	1	2	3	4	5	6	7	8
IND1	-0.104	-0.182	-0.074	0.092	0.084	-0.907	-0.199	0.051
IND2	0.104	0.182	0.074	-0.092	-0.084	0.907	0.199	-0.051
NAT1	-0.018	-0.116	-0.015	0.167	0.044	0.286	0.740	-0.157
NAT2	-0.081	0.006	0.047	0.121	-0.146	-0.116	-0.810	-0.192
E1	0.791	0.056	-0.011	0.054	0.099	0.091	-0.140	0.196
E2	0.464	0.540	0.156	-0.063	-0.133	0.232	0.138	-0.072
E3	0.468	0.089	0.751	-0.037	-0.002	-0.037	0.044	-0.156
E4	0.537	0.264	0.527	0.075	-0.066	-0.055	-0.084	0.191
E5	-0.069	0.212	0.680	0.201	0.049	-0.031	0.403	0.053
E6	0.854	0.022	0.022	0.142	0.161	0.071	0.051	0.144
E7	0.116	0.140	0.315	0.075	0.097	-0.164	0.063	0.627
E8	-0.029	0.157	0.750	0.237	0.268	0.015	-0.124	-0.009
E9	0.074	0.170	0.727	0.080	0.255	0.105	-0.156	0.347
E10	0.248	0.254	0.722	0.071	0.102	0.160	-0.046	0.216
E11	0.157	0.763	0.334	0.100	0.080	0.025	0.032	0.170
E12	-0.013	0.785	0.406	0.142	0.038	-0.003	-0.023	0.086
E13	0.092	0.789	0.319	0.082	0.129	0.186	0.047	0.049
E14	0.059	0.814	-0.120	0.203	0.062	0.146	-0.116	-0.023

Appendix 3: Factor analysis (continued)

<i>Measure</i>	<i>Factor</i>							
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>
E15	0.382	0.462	0.263	0.052	0.449	-0.133	-0.070	0.110
E16	0.252	0.436	-0.155	0.202	0.581	-0.076	-0.129	0.298
E17	0.114	0.013	0.098	0.080	0.753	-0.081	0.252	0.158
E18	0.444	0.347	0.336	0.228	0.354	-0.158	0.206	-0.035
E19	0.777	0.197	0.171	0.152	0.041	-0.004	0.115	0.081
E20	0.253	0.541	0.051	0.215	0.395	0.230	-0.154	-0.171
E21	0.718	0.141	-0.007	0.300	0.119	0.130	-0.097	-0.301
E22	0.701	0.022	0.326	0.196	0.262	-0.071	0.182	-0.125
E23	0.087	0.182	0.269	0.088	0.694	0.022	0.009	-0.375
E24	0.052	-0.023	0.181	0.643	0.347	-0.034	-0.290	0.057
E25	0.331	0.130	-0.006	0.693	0.159	0.165	-0.054	0.132
E26	0.325	-0.035	0.261	0.587	-0.039	-0.455	0.138	0.032
E27	0.101	0.289	0.180	0.788	-0.015	-0.165	0.050	-0.047
E28	0.117	0.216	-0.008	0.832	0.136	-0.145	0.136	-0.068
E29	0.146	0.000	0.231	0.402	0.669	-0.092	0.087	0.197
E30	0.165	0.071	0.266	0.584	0.282	0.140	0.079	0.472
Eigenvalue	4.621	4.183	4.129	3.645	2.930	2.374	1.908	1.495
Cumulative variance %	13.59	25.89	38.038	48.76	57.38	64.36	69.97	74.37

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalisation. Rotation converged in eight iterations (Please Appendix 1 for the symbols' notations).