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1. Introduction

Organisations are integrating their business processes seamlessly across the value chain using information systems (Gattiker and Goodhue, 2004; Annamalai and Ramayah, 2011) and are expecting to minimise information redundancy and improve information integrity and security through implementing information systems (Zhou, 2002; Olson, 2004). Enterprise Resource Planning (ERP) systems are information systems that are essential for organisations to improve business processes. Over the past two decades, ERP systems have become one of the most important and expensive implementations in the corporate use of information technology. Despite the benefits that can be achieved from a successful ERP system implementation, there is evidence of high failure in ERP implementation projects in numerous industries (Huang et al., 2004; Sun et al., 2015).

One of the main reasons for ERP failure has been identified as the lack of sufficient support from knowledge management approaches throughout the ERP project lifecycle (Sedera and Gable, 2010; Jayawickrama et al., 2013). Implementation of ERP systems in organisations requires a variety of complex and detailed knowledge in order to gain measurable business benefits (Mcadam and Galloway, 2005; Newell, 2015). Effectively managing a wide range of knowledge which resides in multiple stakeholders, including experienced implementation consultants and business users/representatives, has been identified as a crucial factor for ERP project success (Xu and Ma, 2008). Therefore, this study attempts to identify, categorise and prioritise the types of knowledge related to the successful implementation of ERP systems. This study aims to answer a specific research question: What are the most important knowledge varieties required for a successful ERP implementation in real industrial environment? The answer to the research question can be viewed as a sustainable, knowledge-based, decision making process which comprises various types of ERP-related knowledge, linked with organisational priorities to achieve ERP success in improving business performance.

2. Related work

This section reviews the literature on ERP knowledge types, ERP success variables and the use of the analytic hierarchy process (AHP) in IT/IS related studies.

2.1 Knowledge types related to ERP implementations

Knowledge types are essential to understand a particular subject in a great detail. The whole pool of knowledge pertaining to ERP implementation can be categorised into different knowledge types to investigate issues of KM for ERP implementation (Gable, 2005). This section evaluates how and why knowledge types have been used in past studies specifically into ERP knowledge management. Davenport (1998) identifies three types of knowledge which need to be managed during ERP implementation (1) software-specific knowledge, (2) business process knowledge (3) organisation-specific knowledge. Sedera et al. (2003) combine (2) and (3), and define them as "knowledge of the client organisation". They denote software-specific knowledge as "knowledge of the software". Gable et al. (2008) and Sedera and Gable (2010) have used the same two knowledge types to explain and categorise enterprise systems knowledge. Furthermore, both the studies state that knowledge of the software is low with clients, medium with consultants and high with vendors; whereas, knowledge of the client organisation is low with vendors, medium with consultants and high with clients. It is clear that knowledge of the software is mostly the knowledge external to the client organisation and knowledge of the client organisation is internal to the organization (Jayawickrama et al., 2014).

Parry and Graves (2008) also argue about two distinct types of knowledge required for ERP implementations, i.e. knowledge internal to the client organisation and knowledge external to the client organisation. Knowledge of ERP functionality, use of ERP, basic ERP system and IT infrastructure, programming and best business practices come under external knowledge, which are vital to improve business performance in the real industrial environment. Internal knowledge comprises of the knowledge of business processes and legacy systems in place in the client organisation, according to the knowledge centres of Parry and Graves (2008). Table 1 shows the different knowledge types used in past studies in order to represent the pool of all ERP-related knowledge.

Table 1: Summary of knowledge types used in past studies

Author	**Knowledge type**		
Davenport (1998)	Software-specific knowledge	Business process knowledge	Organisation-specific knowledge
Sedera et al. (2003), Gable et al. (2008), Sedera and Gable (2010)	Knowledge of the software	Knowledge of the client organisation	
Parry and Graves (2008)	Knowledge external to the client organisation	Knowledge internal to the client organisation	

The common pattern of external knowledge and internal knowledge to the client company is evident from the past literature. However, it can be argued whether this simplistic segmentation of knowledge types is adequate to evaluate the complex and detailed pool of ERP-related knowledge.

2.2 Prioritising knowledge using ERP success variables

In the ERP domain, there are several variables that have been used to measure the success of ERP implementations (Newell 2015). Sedera and Gable (2010) discovered the significant and positive relationship between knowledge management competence and enterprise system success. They proposed a model which demonstrates the equal importance of four KM lifecycle phases (i.e. creation, transfer, retention and application) to achieve ERP success. Delone and McLean (2003) measured information systems success through information quality, system quality and service quality. These three variables enhance the factors of intention to use and user satisfaction in order to increase the net benefits of implementing and using IS in organisations. By taking those IS success measurements into consideration, Sedera et al. (2003) and Gable et al. (2008) have defined enterprise system success measurements through their studies which are directly related to ERP systems. They revealed information quality, system quality, individual impact and organisational impact as variables which can be used to measure enterprise system success. Information quality is concerned with the quality of ERP system outputs: namely, the quality of the information the system produces in reports and on screen. This variable is also concerned with the availability of information; whether it is easy to understand and readily usable, along with the clarity and conciseness of information (Sedera et al., 2003; Sedera and Gable, 2010). The quality of the ERP system is concerned with how the system is designed to capture data from a technical and design perspective. Furthermore, it checks how easy it is to use and learn the system, whether the system meets business requirements through relevant functions and features, adaptation to user interfaces, whether data within the system is fully integrated and consistent and how easily the system can be modified, corrected or improved (Gable et al., 2008). Individual impact is concerned with how the ERP system has influenced users' individual capabilities and effectiveness on behalf of the organisation (Gable, 2005), how far the users can enhance their awareness and recall their job related information and how users can improve the effectiveness and productivity of their jobs through the system. Organisational impact refers to the impact of the ERP system at the organisational level, namely; improved business performance and organisational results and capabilities (Gable et al., 2008; Sedera and Gable, 2010). The system should result in cost savings such as reduced staff costs, inventory holding costs, administration expenses, etc. Thereby, overall productivity improvements must be visible. The system should also be able to facilitate increased capacity to manage a growing volume of activity (e.g. transactions, population growth, etc.). There should be opportunities to reengineer existing business processes through the system implementation. The higher the organisation's level of enterprise system related KM competence, the higher the level of success the enterprise system will have (Sedera and Gable, 2010). This explains almost half of the variance in enterprise system success; therefore, Sedera and Gable's (2010) study identifies knowledge management as possibly the most important antecedent of success. Recently, Jayawickrama et al. (2016) used the same four variables (i.e. information quality, system quality, individual impact and organisational impact) to measure the ERP success through the "knowledge competence wheel" that they developed for knowledge integration. In brief, this wheel demonstrates what, how and why ERP knowledge should be created, transferred, retained and re-used to achieve ERP implementation success.

2.3 AHP for knowledge prioritisation

Multi-criteria decision analysis (MCDA) techniques have generally been used in ERP related studies in order to select suitable ERP systems for organisations, measure the success possibility of implementing ERP systems and prioritise ERP customisation options. Efe (2016) attempts to ease group decision-making by using an integration of fuzzy AHP and fuzzy TOPSIS (technique for order preference by similarity to ideal solution) and its application to ERP system selection of an electronic firm. Results indicate that the proposed methodology decreases the uncertainty and the information loss in group decision making and thus, ensures a robust solution to the firm in selecting the suitable ERP package. In contrast, Kilic et al. (2015) have used two other multi-criteria decision making techniques, Analytic Network Process (ANP) and Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE) in combination to better address the ERP selection problem. An application case was carried out on the ERP selection problem for the Small and Medium-sized Enterprises (SMEs) in order to demonstrate the viability of the proposed methodology used in their study. On a separate note, Chang et al. (2012) applied an analytic hierarchical prediction model based on the multi-criteria decision making with Incomplete Linguistic Preference Relations (InLinPreRa) to help the organisations become aware of the essential factors affecting ERP implementation success. Pairwise comparisons were used to determine the priority weights of influential factors for ERP success, and the possible occurrence ratings of success or failure outcomes amongst decision makers. However, none of the above studies have attempted to prioritise ERP-related knowledge to achieve ERP implementation success.

The AHP method developed by Thomas L. Saaty is designed to help with complex multi-criteria decision problems. As Ho (2008) illustrates, the AHP method has been widely applied to various business decision problems such as investment decisions (portfolio selection, ERP package selection, etc.), forecasting (inter and intra-regional migration patterns, stock market fluctuations, etc.) and socio-economic planning issues (transportation planning, energy planning, etc.). To the authors' knowledge, however, there is no empirical research carried out to prioritise knowledge specifically related to ERP implementations. However, there are several ERP studies that have used the AHP method to select the best ERP product suites for the client organisation (Wei et al., 2005; Méxas et al., 2012; Gürbüz et al., 2012). In addition, AHP has been used to prioritise ERP risk factors and thereby assess the risk of the project and adopt risk mitigation strategies which are important for business performance improvement (Hu et al., 2013; Lee et al., 2014). However, it is important to ensure that the mathematical procedures in AHP can also produce accurate results for ERP knowledge prioritisation. Whitaker (2007) demonstrates that the AHP method has clear requirements that involve both the hierarchical structure and the priorities in the structure. Triantaphyllou and Mann (1995) addressed some challenges that occur when using AHP for decision making in engineering applications. They address the difficulties that arise when the criteria are expressed in different units, or when there are difficulties quantifying pertinent data. Saaty (2003) validates the pairwise comparison process and its fundamental scale used in the AHP. The Saaty compatibility index is used to show the closeness of the derived priorities in the validation examples to actual values, against which they wish to compare them, that have been standardised to a relative form by dividing by their sum. The main reason for using AHP for this study among the many other multi-criteria decision making techniques available is that AHP is the most commonly used technique in ERP related studies as discussed previously. In addition, as discussed above, AHP has the mathematical underpinning and validity in prioritising decision alternatives using specific criteria. Therefore, it confirms the suitability of AHP for studies in the nature of ERP implementations.

2.4 Research gaps

In summary, knowledge types, ERP success variables and AHP based knowledge prioritisation are the topics which relate to the research question being answered in this study. There are two key research gaps that can be identified through the related literature reviewed in this section;

(1) There is a lack of knowledge types to represent the entire pool of ERP-related knowledge. This requires the identification of various knowledge types and sub-types, and their categorisation into related segments for ERP success.

(2) There are no empirical studies which have prioritised ERP-related knowledge based on their importance to achieve ERP success for business performance improvement in real industrial environments.

Therefore, this study attempts to identify, categorise and prioritise the various ERP-related knowledge types and sub-types required to achieve ERP success. By bridging the research gaps identified, this empirical study can answer the research question of "what are the most important knowledge varieties required for a successful ERP implementation in real industrial environment?"

3. Research methodology adopted

Pragmatism states that the research question is the vital aspect of determining the research philosophy because pragmatism has the provision to work within both interpretivist and positivist paradigms (Saunders et al., 2009). It has the ability to practically integrate various perspectives to support data collection and interpretation. Therefore, pragmatism guides to study different phenomena in-depth that cannot be fully understood using only quantitative or qualitative methods (Venkatesh et al., 2013). Quantitative approaches are largely based on deduction, while qualitative approaches are based on induction. However, the pragmatic approach is based on abduction reasoning that moves back and forth between induction and deduction. This approach supports the use of both qualitative and quantitative methods in the same research inquiry (Howe, 1988; Maxcy, 2003). This study adopts abduction reasoning with two separate phases; a qualitative phase for inductive reasoning and a quantitative phase for deductive reasoning. There are three reasons to use two phases for this study;

(1) The qualitative phase aims to identify and categorise all ERP-related knowledge by in-depth interviews with ERP professionals who have ERP implementation experience in the industry.

(2) The quantitative phase aims to prioritise the various knowledge types and sub-types identified and categorised in the qualitative phase of the study. This is achieved by conducting an AHP based questionnaire among ERP professionals from both client and implementation partner organisations.

(3) The results of both phases are important to obtain the big picture of the problem domain and answer the research question in full.

The qualitative process of research involves identifying emerging patterns and procedures, normally with data collected in the participant's setting. Inductive data analysis builds theory from specifics and the researcher makes interpretations of the collected data (Creswell, 2009). Therefore, qualitative research largely relates to inductive reasoning. Quantitative research aims at validating theories by investigating relationships between variables and various instruments can be used to measure variables (Creswell, 2009). Typically, data collected can be analysed using statistical techniques. This type of research generally relates to deductive reasoning. A practical and applied research philosophy can be presented by the pragmatist approach and the use of mixed methods is best justifiable through the paradigm of pragmatism (Howe, 1988; Tashakkori and Teddlie, 2008). Moreover, it is evident that the mixed-methods movement has apparent pragmatist roots according to Maxcy (2003). Therefore, this study adopts philosophy of pragmatism using a mixed methods approach with both qualitative and quantitative research.

This explains what were the systematic qualitative and quantitative data collection and analysis methods adopted in this study. It is vital to carefully select appropriate research instruments when conducting scientific research (Morse, 2003; Tashakkori and Teddlie, 2008). The nature of the research question and purpose demanded the use of specific research methods for the qualitative and quantitative phases of this study. Figure 1 demonstrates the research instruments used in both qualitative and quantitative phases.

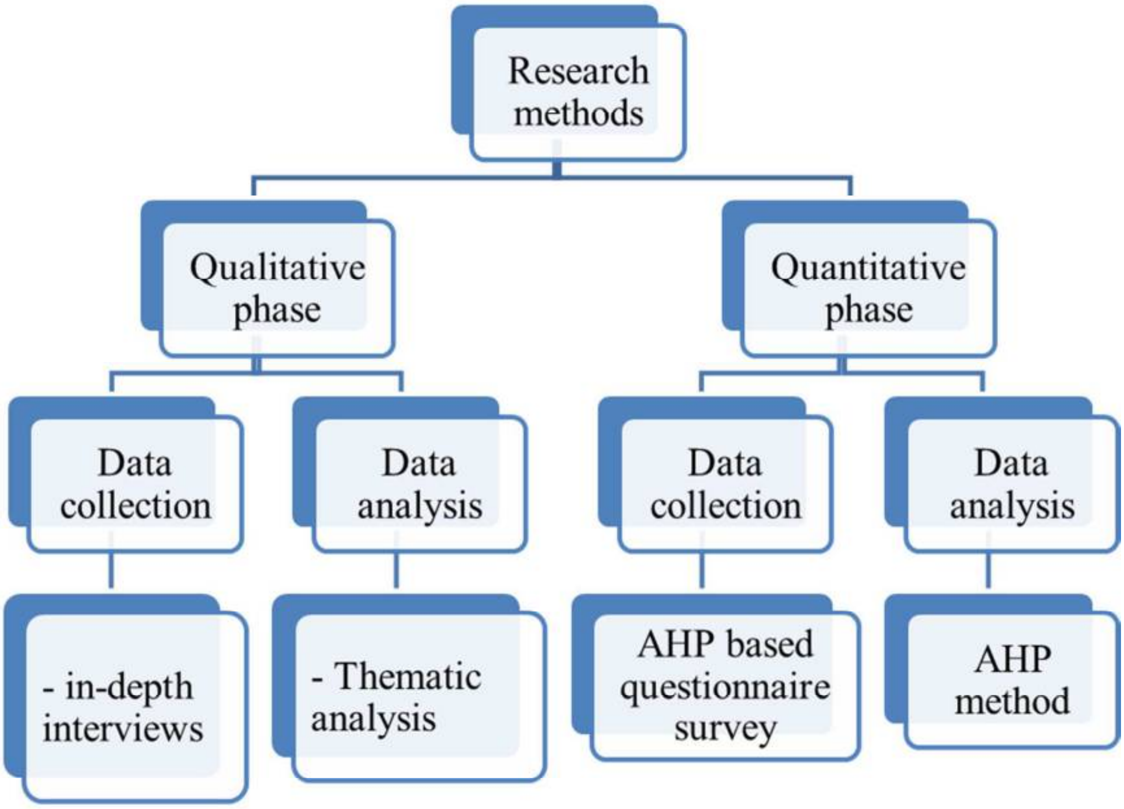

Figure 1: Research methods adopted

The qualitative phase attempts to obtain project experiences from the people who are directly involved in ERP implementations in order to identify and categorise the various types of knowledge. The qualitative data were collected using in-depth interviews. The in-depth interview method was selected for this study over alternative data collection methods such as observations, focus-group discussions and the Delphi technique, for five key reasons;

(1) In-depth interviews were helpful to confirm what was already known and reveal new themes by allowing interviewees the freedom to express their views in their own terms (King and Horrocks, 2010).

(2) Often, interview participants are not willing to share their personal project experiences in front of superiors, peers and subordinates; thus adopting one-to-one in-depth interviews is appropriate for this study (Olson, 2004).

(3) Having one-to-one interview provides the ability to obtain in-depth individual ERP implementation experience with respect to a particular project (McAdam and Galloway, 2005).

(4) It enables those being interviewed to ask questions from the interviewer to clarify a certain point or provide new ideas on the topic, thereby in-depth interviews encourage two-way communication (Creswell, 2009).

(5) There was always the option of asking leading questions to obtain answers to questions such as what, how and why different types of knowledge have been used during ERP implementation (Saunders et al., 2009).

The quantitative phase attempts to prioritise the knowledge types identified (in the qualitative phase) using AHP based online questionnaire (see Appendix A). The people factor needs to be managed properly in order to achieve ERP success through the knowledge that resides in individuals (Chan et al., 2009; Sedera and Gable, 2010). Moreover, this study focuses upon the variety of knowledge required for ERP implementation to achieve its success, and the researcher is part of what is being researched.

4. The nature of empirical data collected

This section largely discusses the analysis of descriptive data which were collected by client and implementation partner organisations, and the inconsistencies of 21 clusters/matrices in the AHP method.

4.1 Descriptive analysis

Initially, 14 in-depth interviews were conducted with ERP experts in order to identify what sort of knowledge is required to implement off-the-shelf ERP systems such as Oracle and SAP. Thematic analysis was used to analyse interview data. The findings from the interviews were then developed into an online survey which was distributed among ERP professionals in the UK in order to rank the identified types of knowledge and the elements. The AHP method has been used to prioritise the knowledge types and sub-types (knowledge elements) in achieving ERP implementation success, using specialist AHP software (Expert Choice Comparion Suite). The survey included 77 responses (effective response rate of 19%) from both clients (47%) and implementation partners (53%). Clients comprise all parties internal to the client organisation such as end users, super users, process champions, client's senior managers and the project manager from the client side. Implementation partners comprise all parties external to the client company such as implementation consultants, technical engineers, software developers, third party consultants and the project manager from the implementation partner/integrator side. The responses relate to specific UK implementations, of which 36% were Oracle implementations, 39% were SAP implementations and 25% were MS Dynamics implementations. All respondents were UK based. The results consist of 24% manufacturing sector organisations, 49% service sector organisations and 27% of organisations in both sectors.

4.2 Inconsistencies in clusters

The inconsistency ratios of all 21 clusters/matrices will be highlighted in this section. Table 2 demonstrates the cluster/matrix path and the respective inconsistency ratio of the cluster. In this study, for the textual convenience, knowledge type is referred to as “k-type” and knowledge element is referred to as “k-element” in short form. A k-element is a sub-knowledge type.

Table 2: Inconsistencies in clusters

Cluster no	**Cluster path**	**Inconsistency ratio**
1	Goal: Ranking k-types and k-elements	0.06
2	Goal: Ranking k-types and k-elements | Individual impact	0.06
3	Goal | Individual impact | Business process knowledge	0.05
4	Goal | Individual impact | ERP package knowledge	0.04
5	Goal | Individual impact | Organisational cultural knowledge	0.04
6	Goal | Individual impact | Project management knowledge	0.03
7	Goal: Ranking k-types and k-elements | Information quality	0.10
8	Goal | Information quality | Business process knowledge	0.06
9	Goal | Information quality | ERP package knowledge	0.06
10	Goal | Information quality | Organisational cultural knowledge	0.07
11	Goal | Information quality | Project management knowledge	0.08
12	Goal: Ranking k-types and k-elements | Organisational impact	0.07
13	Goal | Organisational impact | Business process knowledge	0.05
14	Goal | Organisational impact | ERP package knowledge	0.04
15	Goal | Organisational impact | Organisational cultural knowledge	0.05
16	Goal | Organisational impact | Project management knowledge	0.02
17	Goal: Ranking k-types and k-elements | System quality	0.08
18	Goal | System quality | Business process knowledge	0.05
19	Goal | System quality | ERP package knowledge	0.04
20	Goal | System quality | Organisational cultural knowledge	0.03
21	Goal | System quality | Project management knowledge	0.05

The inconsistency ratios of all 21 clusters is less than or equal to 0.1, therefore, all judgements can be accepted in the respective clusters and the priorities calculated using these judgements (Saaty and Vargas, 2012). The inconsistency ratio of cluster 7 is the cluster that has a maximum ratio of 0.1. All other ratios are below 0.1. The inconsistency ratio has been calculated by dividing the sum of inconsistency ratios of each cluster from 77 (total number of responses). Expert Choice Comparion Suite has an easy to use software feature in order to monitor and manage inconsistency ratios while providing responses to pairwise comparisons by the participants (not found in other software). Thus, this software feature can be used to obtain responses with acceptable inconsistency ratios. In this study, the reason for achieving acceptable inconsistency ratios is largely due to the use of this software feature by the participants while providing responses to the online questionnaire. When providing pairwise responses to the questionnaire, survey participants can see the inconsistency ratio of a particular matrix on the very next screen, thus he/she can revise the judgements if the inconsistency ratio is higher than the acceptable range.

5. Empirical analysis and findings

There are two key types of empirical findings; research findings from interview data (knowledge identification and categorisation) and findings from the survey (knowledge prioritisation). The former is discussed first, then moving on to the latter.

5.1 Knowledge identification and categorisation

Specific types of knowledge were identified by analysing interview data using thematic analysis method (see Figure 2). Thematic analysis was used to allow new patterns to emerge from the interview transcripts in order to discover the various types of knowledge related to ERP implementation. Subsequently, the identified knowledge was categorised under specific titles. Thematic analysis is one of the approaches in analysing qualitative data; it concentrates on the themes or subjects and patterns, emphasising, pinpointing, examining, and recording patterns within the data (Braun and Clarke, 2006). Thematic analysis is normally concerned with experience focused methodologies. Throughout the analysis, the researcher identified a number of themes by considering the following three stages highlighted by King and Horrocks (2010):

Descriptive coding (***first-order codes***): the researcher identifies those parts of the transcript data that address the research questions and allocates descriptive codes throughout the whole transcript.

Interpretative coding (***second-order themes***): the researcher groups together descriptive codes that seem to share some common meaning and creates an interpretative code that captures this.

Defining overarching themes (***aggregate dimensions***): the researcher identifies a number of overarching themes that characterise key concepts in the analysis.

The second-order themes were identified using first-order codes, and they were categorised as aggregated dimensions to reveal knowledge types which result in achieving ERP success (see Figure 2). Based on the categorisation and theme analysis techniques suggested by Miles and Huberman (1994), the researcher read each interview transcript several times and coded each one separately on the basis of terms or phrases used by the participants.

Figure 2: Knowledge types and knowledge elements – data structure

The findings reveal 4 knowledge types that characterise all ERP implementation related knowledge as shown in Figure 3. These are primarily categorised as; ERP package knowledge, business process knowledge, organisational cultural knowledge and project management knowledge. These four knowledge types demonstrate the coverage of the entire pool of ERP knowledge with respect to Table 1 (Summary of knowledge types used in past studies). This covers both knowledge external to the client organisation and knowledge internal to the client organisation, in other words both internal and external knowledge in detail. ERP package knowledge and project management knowledge are considered as external knowledge. Business process knowledge and organisational cultural knowledge are considered as internal knowledge. ERP package related knowledge is knowledge pertaining to features and functions of the system; business process related knowledge refers to As-Is or existing process knowledge; Organisational cultural related knowledge explains the attitudes and behavioural aspects of the employees of an organisation; finally, project management related knowledge refers to use of methodologies and approaches to manage the ERP implementation.

In addition, the findings from the interview data show that there are sub-knowledge types, which have been labelled as "knowledge elements" (k-elements) under each knowledge type. ERP package knowledge has 7 knowledge elements to describe it in a more detailed manner, such as; knowledge of system functions and features, ERP concept, best business practices, system configurations, customisations, vendor managed KM systems and documentation templates. Figure 3 shows the categorisation of knowledge types and knowledge elements. More information about each knowledge element has been provided where appropriate while illustrating the findings in the next sub-section.

Business process knowledge also consists of 7 knowledge elements. They are as follows; knowledge of current business processes, client's industry, business requirements, current systems landscape, As-Is document templates, existing modules implemented and company big picture. Organisational cultural knowledge has 4 knowledge elements; knowledge of employee behaviour patterns, work culture, employee attitudes and governance structure. Project management knowledge comprises of 3 knowledge elements, they are; knowledge of implementation methodology, change management and project management techniques. There are 21 knowledge elements in total under the four knowledge types. It becomes easier to identify and transfer relevant knowledge between individuals by categorising the whole pool of ERP implementation related knowledge into specific areas. The next sub-section explains the prioritisation of the identified knowledge types and elements based on the survey responses.

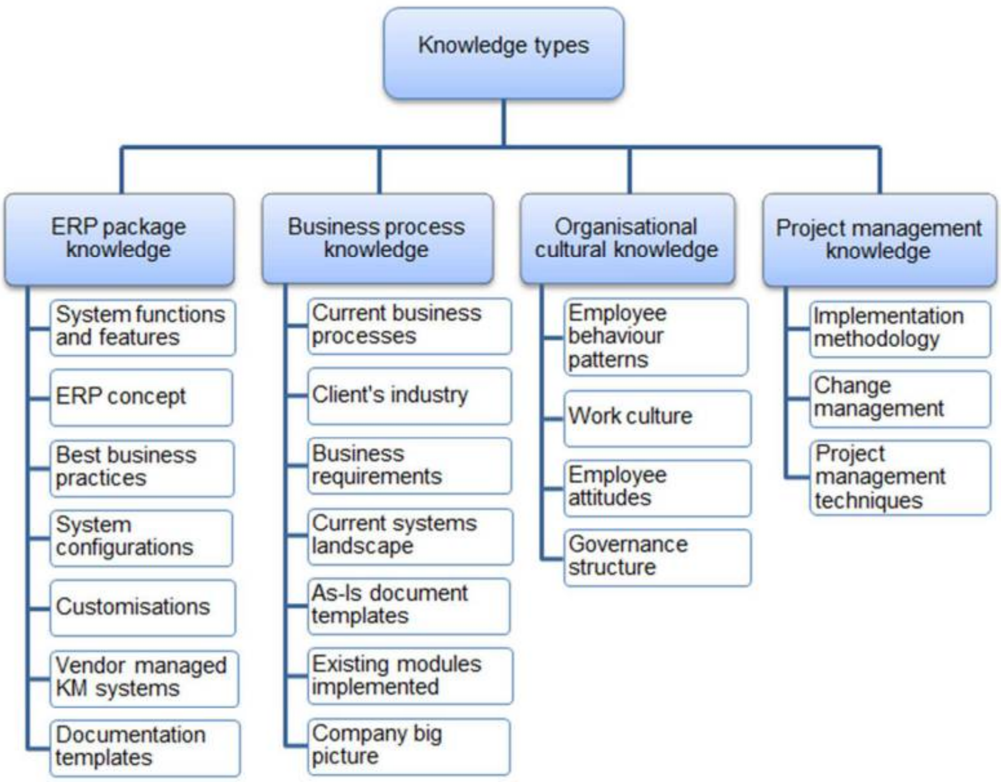

Figure 3: Knowledge categorisation

5.2 Knowledge prioritisation

The knowledge types and elements were ranked through an online survey based on the AHP method (see Appendix A). This method is all about pairwise comparing of one decision criterion with another, to identify a shared understanding of the most important criteria at a given time. In this study, the pairwise comparisons were between one knowledge type and another, with respect to ERP success variables. Each knowledge type/element was compared against every other knowledge type/element using Expert Choice Comparion Suite, which calculates the priorities and ranks knowledge types and elements based on the pairwise comparisons provided by the survey participants. An issue with AHP is that some of the comparisons may be inconsistent, so an inconsistency ratio is calculated to highlight where there is a problem. However, all the inconsistency ratios of the pairwise comparisons for this study were within the acceptable range (≤0.1) as discussed previously. Expert Choice Comparion Suite aggregates the results of all participants using aggregating individual judgements (AIJ) method. In this method, which is by far the most common, the individual judgments are combined by taking the geometric mean of the judgments to derive a 'recombined' set of priorities for each cluster of objectives in the hierarchy, as well as for alternatives with respect to each of the covering objectives (Saaty and Vargas, 2012). It has been shown that the geometric mean is the only aggregation method that will ensure that the reciprocal axiom of AHP holds for the combined judgments in a matrix of combined judgments (Ho, 2008). The percentage priority figures in tables 3-8 show the importance of one factor over other factors. Each table has a ranking based on client responses and implementation partner responses.

Organisational impact was ranked as the most important objective which needs to be fulfilled to achieve ERP success according to both clients and implementation partners as shown in

Table 3. Both parties commonly agree that positive organisation impact through the ERP system implementation is first priority. Business process improvements, reductions in organisational costs, handling customers more efficiently and managing enterprise resources effectively are expected from the ERP system; this has also been stressed by Carroll (2007) and Forslund (2010). The second important objective is information quality, in other words the quality of information that the system produces in terms of reports and on screen information based on the responses of clients. However, the implementation partner perspective is bit different, stating that system quality is the second most important criterion. The 2nd and 3rd places are swopped between the client and implementation partners. Clients give more preference to information quality rather than system quality, whereas it is exactly reversed with the implementation partners. The least important criterion is individual impact according to the responses from both client and implementation partner companies.

Table 3: Ranking of criteria

Rank	**Client**		**Implementation partner**	
	Criterion	*Priority %*	*Criterion*	*Priority %*
1	Organisational impact	38.32	Organisational impact	46.05
2	Information quality	30.81	System quality	20.73
3	System quality	17.42	Information quality	20.40
4	Individual impact	13.45	Individual impact	12.81

5.2.1 *Prioritisation of knowledge types*

The client perspective is different from implementation partner perspective as can be seen in Table 4. Clients rank ERP package knowledge as the most important knowledge type to achieve ERP implementation success. However, externals to the client's organisation i.e. implementation partners say business process knowledge is the most important knowledge type. If this result was closely observed, one can interpret that most of the time the client organisation steps into an ERP implementation lacking ERP package knowledge, but obviously very familiar with their own business process knowledge. Therefore, they see and value ERP package knowledge as most critical.

Table 4: Ranking of knowledge types

Rank	Client		Implementation partner	
	Knowledge type	*Priority %*	*Knowledge type*	*Priority %*
1	ERP package knowledge	46.55	Business process knowledge	37.17
2	Business process knowledge	26.42	ERP package knowledge	30.14
3	Project management knowledge	15.60	Organisational cultural knowledge	23.80
4	Organisational cultural knowledge	11.42	Project management knowledge	8.87

On the other hand, implementation partners rank exactly the opposite, because they have less knowledge of the business processes of the client company when compared with their knowledge of the ERP product and ERP in general. The 3rd and 4th ranks can be described in the same way: Project management knowledge is much higher with implementation partners than clients, but lack the knowledge of their client's organisational culture and give more priority for organisational cultural knowledge to achieve ERP project success. Clients rank exactly the opposite; they give more importance to project management knowledge over organisational cultural knowledge. In summary, it can be suggested that the thought process behind the ranking of knowledge types is largely based on the scarcity of knowledge of both parties. The higher the scarcity, higher the importance of that knowledge type to implement ERP system successfully. Therefore, if a client is getting ready for a new implementation, the company should start enhancing their existing knowledge-base, taking these ranks into consideration. They can either recruit people with relevant skills who have ERP implementation experience in the particular industry sector that the client company operates in or train existing staff. Otherwise they will have a very high dependency on the implementation partner during implementation and even after go-live. On the other hand, implementation partners can focus on their side of the ranking to get ready for the implementation during the pre-implementation stage and kick-off workshops by getting to know about the client company, their people, critical business processes and their working patterns. They can hire ERP consultants (contract or permanent basis) who have ERP implementation experience in the particular industry sector that the client company operates in.

5.2.2 Prioritisation of knowledge elements

The most critical knowledge element under ERP package knowledge is knowledge of best business practices according to both clients and implementation partners. Both parties ranked knowledge of system functions and features and knowledge of system configurations for 2nd and 3rd places. Therefore, both parties can initially consider enhancing and transferring such specific knowledge in order to implement off-the-shelf ERP systems successfully in real industrial enviroments. The rest of the knowledge elements have been ranked slightly differently by clients and implementation partners as can be seen in Table 5.

Table 5: Ranking of knowledge elements – **ERP package knowledge**

Rank	**Client**		**Implementation partner**	
	Knowledge element	*Priority %*	*Knowledge element*	*Priority %*
1	Best business practices	14.35	Best business practices	8.59
2	System functions and features	12.20	System functions and features	6.96
3	System configurations	6.77	System configurations	5.37
4	Customisations	4.80	ERP concept	4.37
5	ERP concept	4.63	Customisations	3.38
6	Documentation templates	2.94	Vendor managed KM systems	3.27
7	Vendor managed KM systems	2.74	Documentation templates	2.67

ERP concept refers to knowledge of the general ERP concept, principles and benefits. Knowledge of customisations refers to the knowledge of custom interfaces, custom reports and custom forms. Examples for documentation templates are knowledge of the To-Be document templates, how to refer them and how to fetch information from them. Vendor managed KM systems talk about KM systems such as Oracle My Support (Metalink); knowledge of how to search resolutions for product issues, how to log a service request and so on.

There are 7 knowledge elements under business process knowledge. Both clients and implementation partners have ranked knowledge of business requirements and current business process in 1st and 2nd places respectively. The priorities confirm that the first two knowledge elements are far more important than rest of the knowledge elements. Therefore, it is essential to enhance and transfer an adequate amount of knowledge to the right individuals with respect to the first two knowledge elements. The rest of the ranks can be found in Table 6.

Table 6: Ranking of knowledge elements – **Business process knowledge**

Rank	Client		Implementation partner	
	Knowledge element	*Priority %*	*Knowledge element*	*Priority %*
1	Business requirements	8.03	Business requirements	10.99
2	Current business processes	6.73	Current business processes	8.02
3	Current systems landscape	3.53	Company big picture	4.91
4	Client's industry	3.38	Client's industry	4.39
5	Company big picture	3.28	Current systems landscape	3.62
6	Existing modules implemented	2.85	Existing modules implemented	2.27
7	As-Is document templates	1.95	As-Is document templates	2.15

Current system landscape refers to the knowledge of current legacy systems and other automated systems in place. This has been ranked 3rd by clients and 5th by implementation partners. Client's industry denotes knowledge of the client's industry specific business processes and activities. Both clients and implementation partners have ranked this as the 4th most important knowledge element for this knowledge type. Company big picture has been ranked as 5th and 3rd by clients and implementation partners respectively. This knowledge element refers to the knowledge of company hierarchy and business integration with the parent company. Knowledge of existing modules implemented and As-Is document templates are among the least important knowledge elements according to both parties. Existing modules implemented refers to knowledge of the modules already in place in the client/parent/subsidiary company of the same ERP package, and knowledge of the interaction between existing modules. Clients and implementation partners can use these rankings when planning and executing their knowledge transfer activities during implementation.

There are four knowledge elements under organisational cultural knowledge as can be seen in Table 7. Work culture has been ranked as the most important knowledge element to achieve ERP success by both clients and implementation partners. Work culture refers to the knowledge of work culture and sub-cultures, specifically within the client company. Governance structure refers to management hierarchy and company policies, and it has been ranked 2nd by clients and 3rd by implementation partners. Implementation partners have selected employee attitudes towards the ERP implementation as the 2nd most important knowledge element over governance structure. However, both parties agree upon the least important knowledge element which is employee behaviour patterns.

Table 7: Ranking of knowledge elements – **Organisational cultural knowledge**

Rank	**Client**		**Implementation partner**	
	Knowledge element	*Priority %*	*Knowledge element*	*Priority %*
1	Work culture	3.45	Work culture	7.04
2	Governance structure	2.80	Employee attitudes	6.52
3	Employee attitudes	2.37	Governance structure	5.25
4	Employee behaviour patterns	1.44	Employee behaviour patterns	4.58

The final set of knowledge elements are listed under project management knowledge in Table 8. At a glance, it can be observed that clients and implementation partners have ranked these three knowledge elements in same order. The use of effective change management strategies in the ERP implementation context is crucial during ERP implementation to improve business performance. The 2nd most important knowledge element is implementation methodology; the knowledge of ERP package specific implementation methodologies (such as Oracle AIM and Oracle Business Accelerators) and general methodologies. Least importance goes to project management techniques – knowledge of resource allocations, estimations, deliverables and project risk.

Table 8: Ranking of knowledge elements – **Project management knowledge**

Rank	Client		Implementation partner	
	Knowledge element	*Priority %*	*Knowledge element*	*Priority %*
1	Change management	4.83	Change management	2.62
2	Implementation methodology	3.82	Implementation methodology	1.69
3	Project management techniques	3.10	Project management techniques	1.33

The priority columns of the last four tables (5-8) clearly demonstrate that most of the time one set of priorities are higher than the other set. This is because clients and implementation partners ranked the knowledge types differently. Therefore, these rankings can be used in numerous ways depending whether it's a client company or implementation partner. For example, if a client steps into a new project, they can initially concentrate on advancing the first 3 knowledge elements under the ERP package knowledge type. On the other hand, if an implementation partner steps into a new project, they can initially focus on enhancing first 3 knowledge elements under the business process knowledge type.

The AHP results discussed above can be graphically represented in different ways (see Figure 4) to gain more insight; i.e. the performance of knowledge elements (k-elements) against each ERP success variable and overall performance. This displays the AHP ranks of all 21 k-elements at a glance and how each k-element performs against the four criteria and overall performance. If focuses on top three k-elements; according to clients, knowledge of best business practices (14.35%) and knowledge of system functions and features (12.20%) are among the two most important k-elements and they are listed under ERP package related k-elements. These two k-elements performed somewhat similarly against system quality criterion, and differently with other criteria. The 3rd most important k-element is knowledge of business requirements (8.03%). The clients should concentrate on creating, transferring, retaining and applying these critical k-elements using numerous approaches and techniques discovered in Jayawickrama et al. (2016).

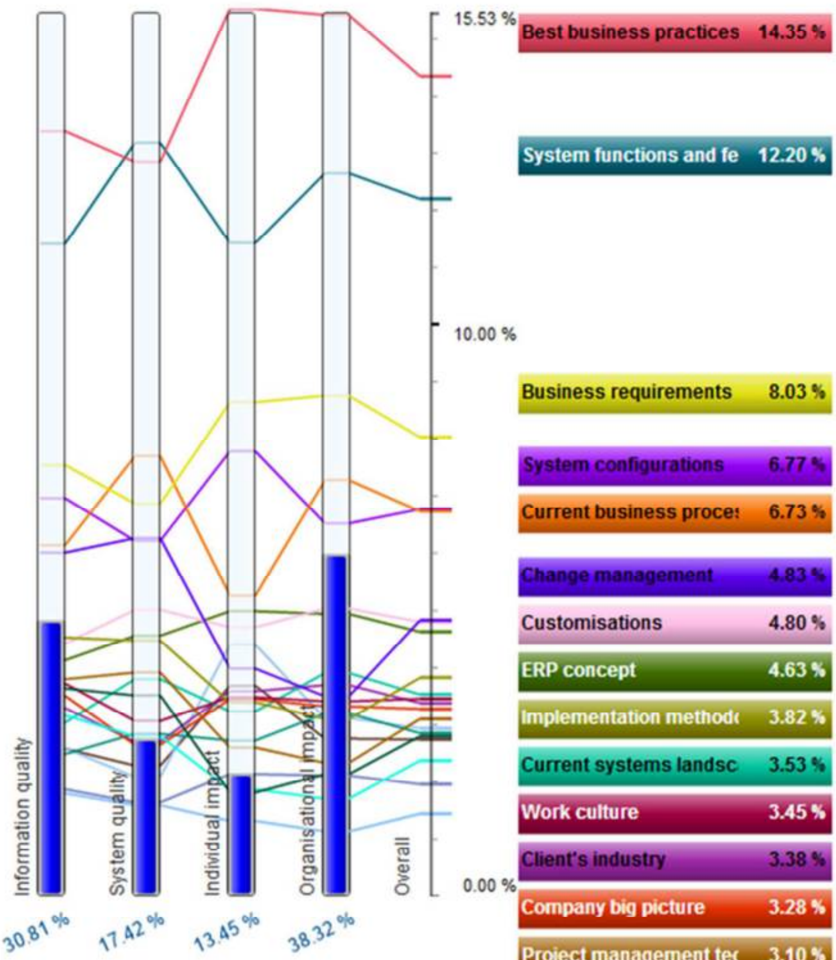

Figure 4: Client perspective – ERP success variables and knowledge elements

If focuses on top three k-elements; for implementation partners, knowledge of business requirements (10.99%) clearly stands ahead from other k-elements. It performed well against information quality, system quality and individual impact, as can be seen in Figure 5, but not against organisational impact. Although the organisation impact is the most important criterion in achieving ERP success according to implementation partners, the most vital k-element has not performed well against organisation impact. The second and third most important k-elements are knowledge of best business practices (8.59%) and current business processes (8.02%) in achieving ERP implementation success.

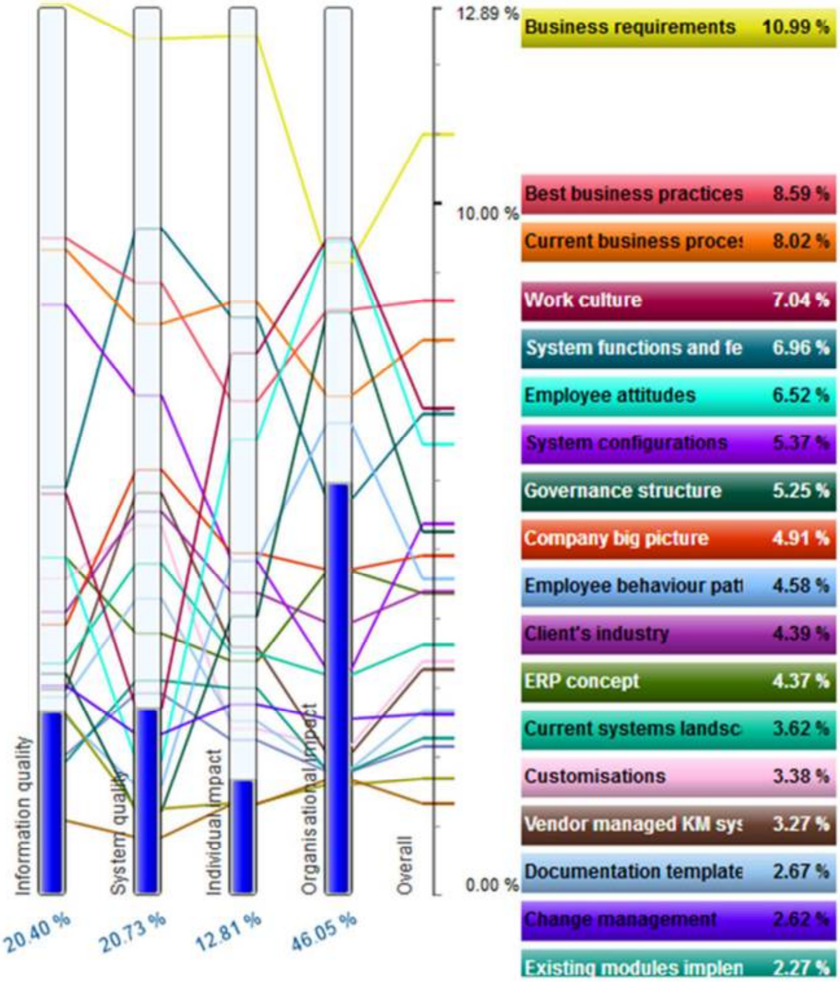

Figure 5: Implementation partner perspective – ERP success variables and knowledge elements

By observing Figure 4 and 5, clients and implementation partners can obtain many more insights on creating, transferring, retaining and re-using relevant specific knowledge during ERP projects.

5.2.3 Perform sensitivity analysis

Sensitivity analysis is an important step in the AHP method, as it ensures the consistency of the final decision/rank (Ho, 2008; Méxas et al., 2012). Various "what-if" scenarios can be visualised through sensitivity analysis that are helpful in observing the impact of changes in criteria to the final alternative rank (Saaty and Vargas, 2012). Figures 6 (client) and 7 (implementation partner) show the sensitivity analysis performed between the ERP success variables (four criteria) and the knowledge types (four key alternatives), allowing the decision maker to observe how the final evaluation is likely to change. It also helps in measuring changes made, based on deviations in the weights of criteria.

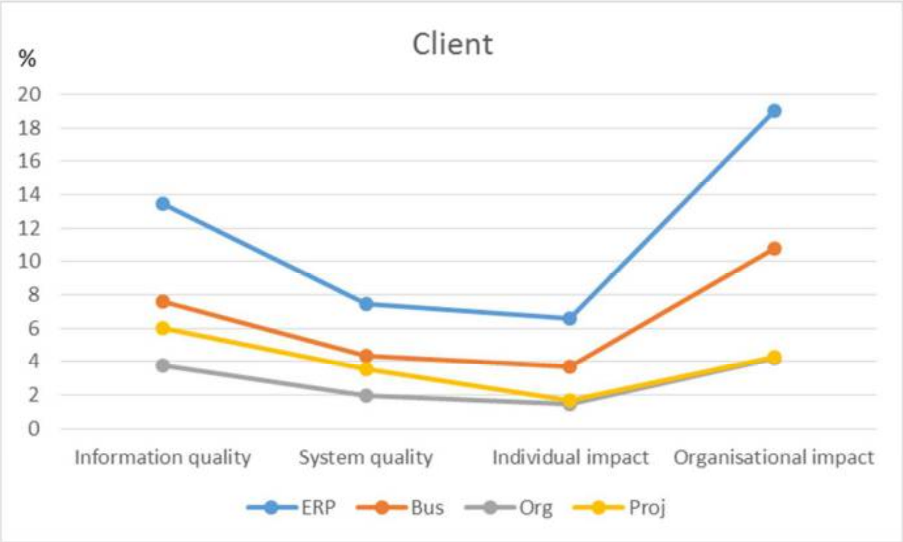

Figure 6: Sensitivity analysis – client

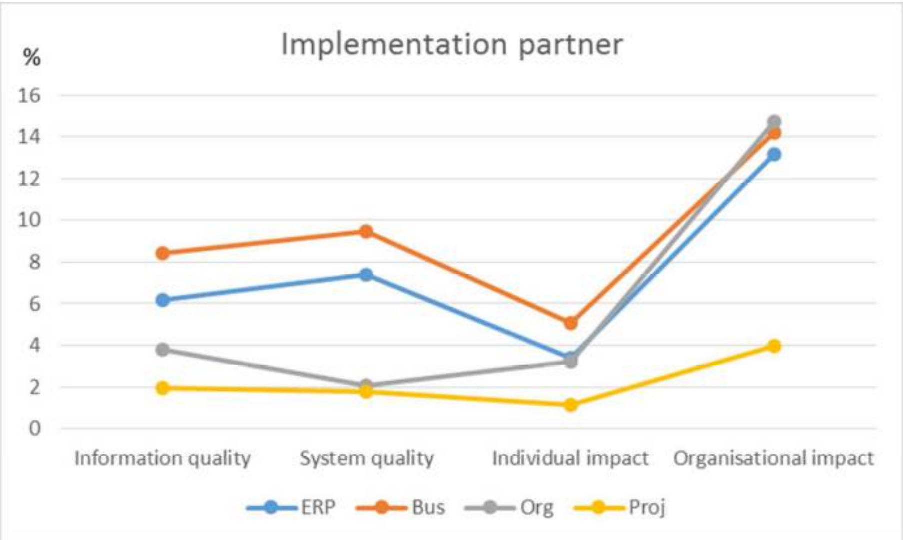

Figure 7: Sensitivity analysis – implementation partner

In this case, a simulation of the sensitivity analysis is carried out by making gradual changes to the values of each criterion, whether organisational impact, information quality, system quality or individual impact, and then observing the rank order due to such changes. Shifting the value of each criterion down to a zero point did not have any significant effect and therefore did not result in any changes to the first rank (ERP package knowledge as per client responses and business process knowledge as per implementation partner responses). Overall, based on the sensitivity analysis, it can be concluded that the final decision is consistent and reliable, therefore both client and implementation partner results can be generalised.

6. Discussion and conclusions

The knowledge types and elements revealed through the empirical findings of this study were prioritised using an AHP based online survey. The prioritisation of 4 k-types, 21 k-elements and 4 ERP success variables has extended the findings from the in-depth interviews. Although knowledge prioritisation is not a new concept for IT in general (Zimmermann et al., 2012; Lee et al., 2014), it is a new concept in the ERP field.

Nevertheless, there are several ERP studies that have used the AHP method to select the best ERP product suits for the client organisation (Wei et al., 2005; Méxas et al., 2012; Gürbüz et al., 2012). In addition, AHP has been used to prioritise ERP risk factors and thereby assess the risk of the project and adopt risk mitigation strategies (Hu et al., 2013; Lee et al., 2014).

This study was able to prioritise the knowledge types and knowledge elements using the 4 ERP success variables discussed previously. Therefore, clients and implementation partners know exactly what types of knowledge are more important than others in order to create, transfer, retain and apply during ERP implementation for its success. This study answered the research question: What are the most important knowledge varieties required for a successful

ERP implementation in real industrial environment? The answer to the research question can be viewed as a sustainable knowledge-based decision making process which comprises various types of ERP-related knowledge with their priorities to achieve ERP success in improving business performance. The results of this study can also be used to extend the usability of the "knowledge competence wheel" recently developed by Jayawickrama et al. (2016). Although Sedera et al. (2003) and Gable et al. (2008) revealed information quality, system quality, individual impact and organisational impact as variables in order to measure enterprise system success in their quantitative studies, they have not ranked ERP success variables. However, this study ranked the four ERP success variables based on the importance provided by both clients and implementation partners. Parthasarathy and Sharma (2014) prioritised ERP customisation choices using the AHP method in order to develop the most important customisations to the client organisation. Hence, clients can avoid unwanted custom developments and complexities, mitigate project risk, avoid budget overruns and use standard system functionalities for process improvements (Parthasarathy and Sharma, 2014). This study does the same to achieve ERP success, but by prioritising relevant knowledge types and sub-knowledge types. Thus, it eases the use of the knowledge categorisation model (see Figure 3) for knowledge management during ERP implementation. As in this study, Pyo (2012) identified and prioritised the various knowledge needed to perform particular tasks by industry practitioners. However, Pyo (2012) has not discussed any tasks or practitioners in the field of ERP. Lee et al. (2014) pointed out the prioritisation and verification of IT emerging technologies using the AHP method, which demonstrates that the AHP method is highly reliable as a method for selecting promising electronic device technologies. This section shows the use of the AHP method for the prioritisation of ERP customisation choices, risk factors and selection criteria. Moreover, it shows how AHP has been used for knowledge prioritisation in the ERP field as a newly emerging research area.

Although the empirical findings of this study are promising and valuable, a few limitations have been recognised which will be considered by the researchers in their future work. This study only covers off-the-shelf ERP systems implementation, not bespoke ERP systems implementation. The empirical data were collected from UK implementations without data from ERP implementations in the developing economies. Further research will address the above limitations in order to make this study more rigorous.

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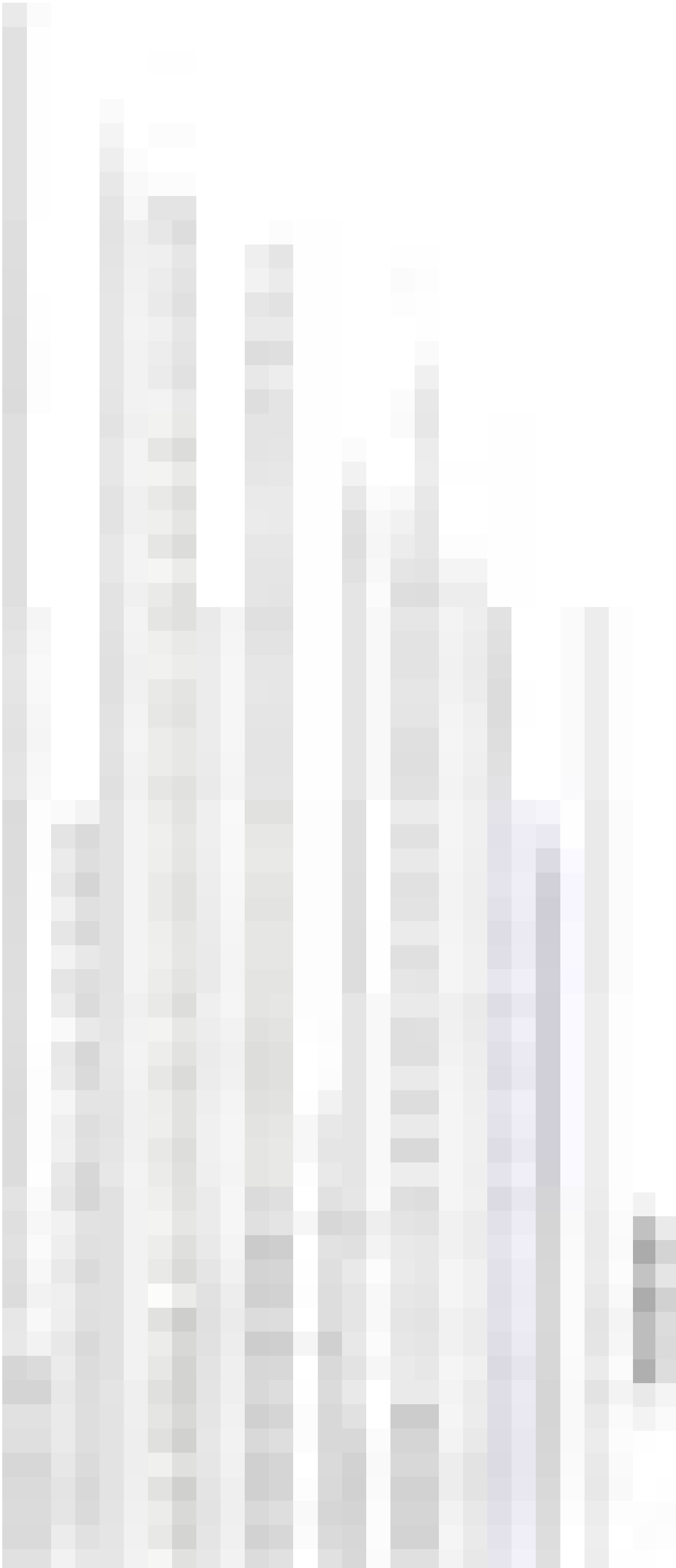
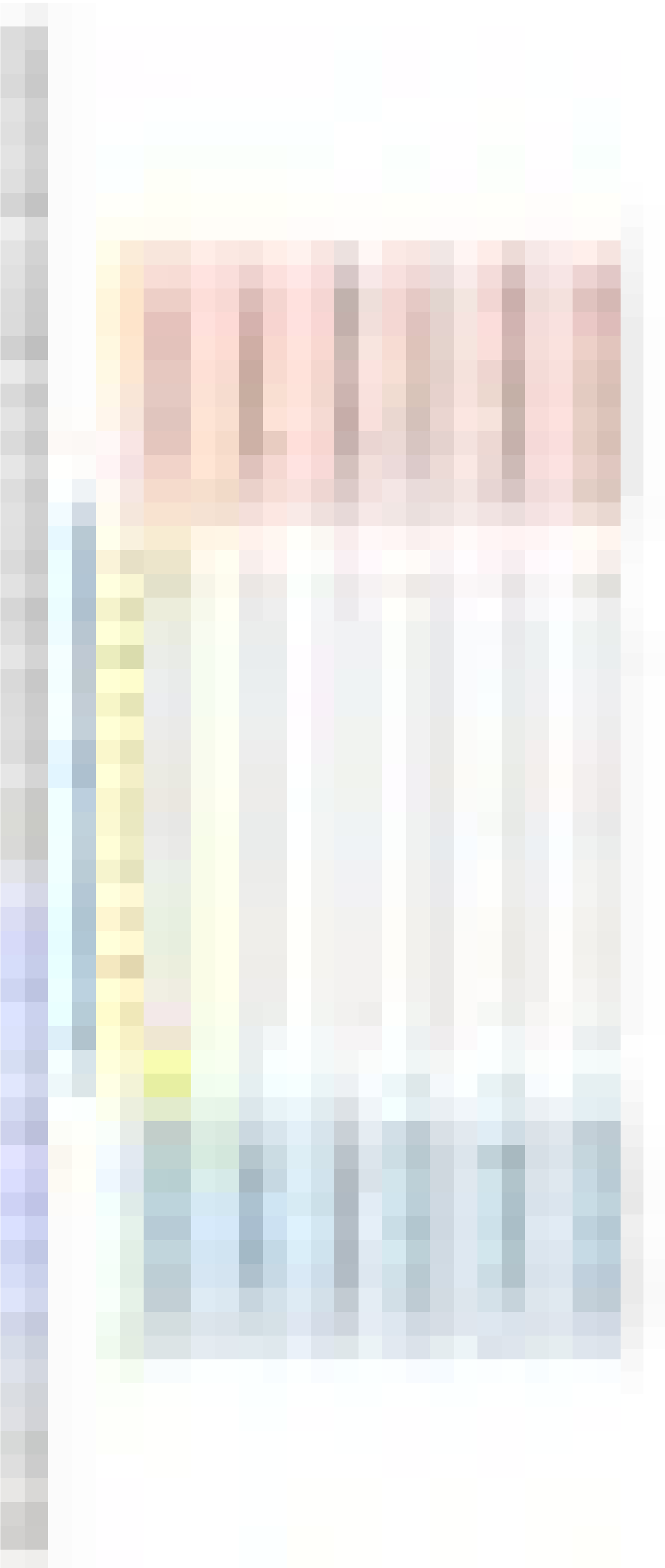
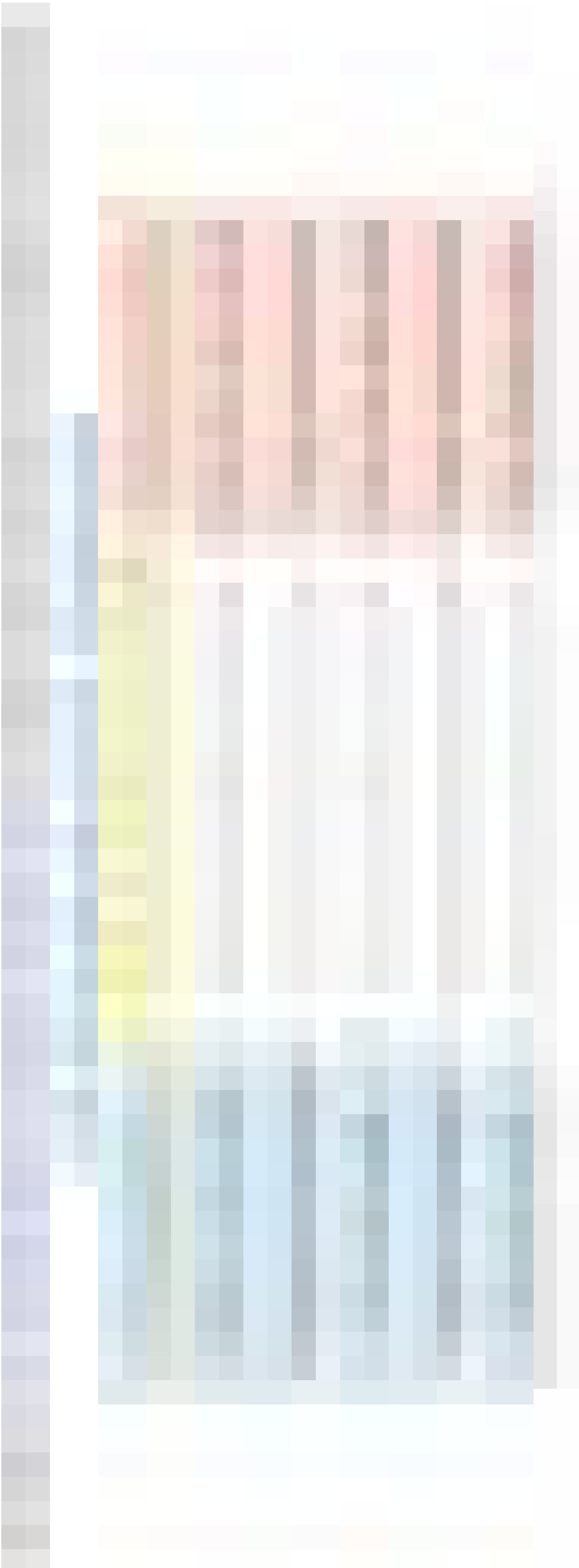
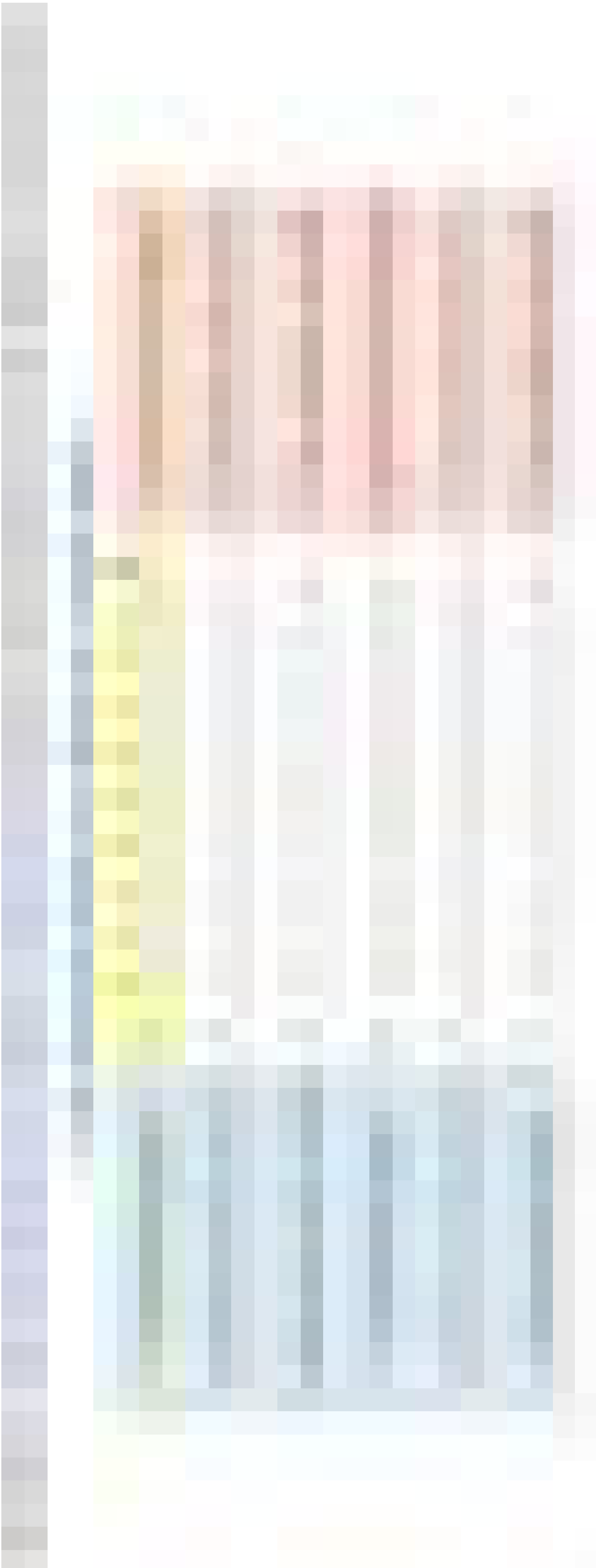
Appendices

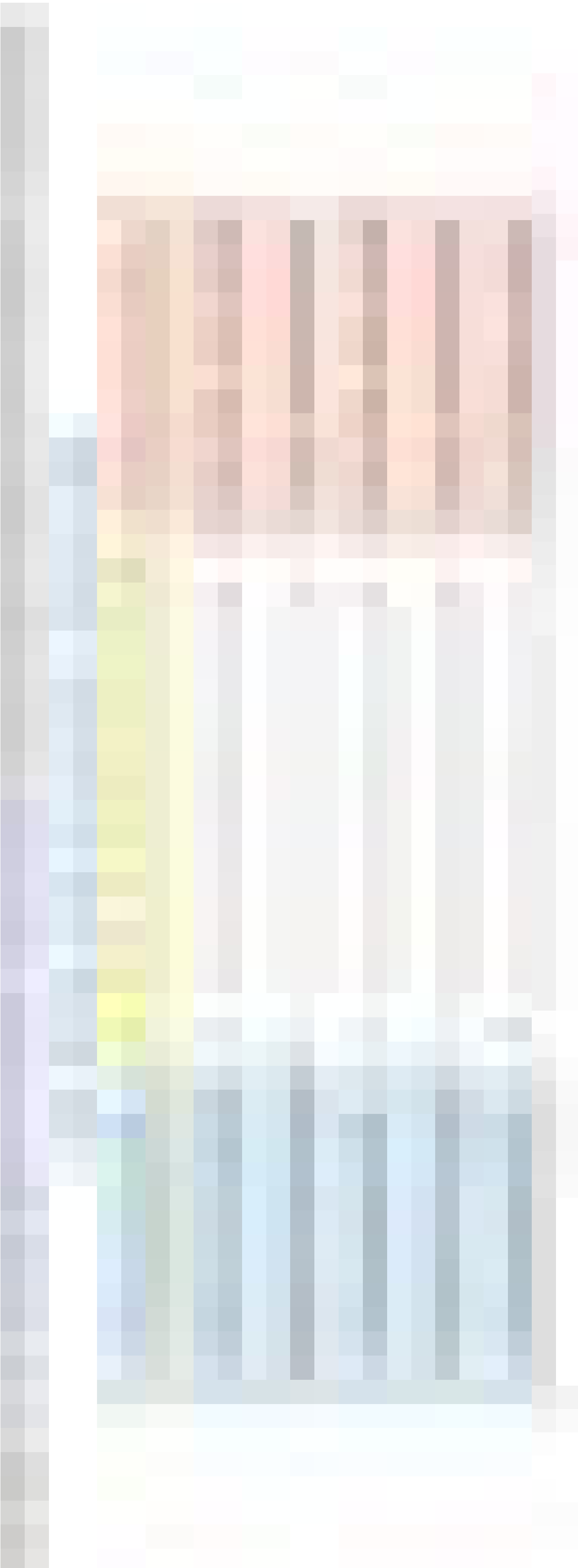
Appendix A: Screenshots of online AHP based questionnaire

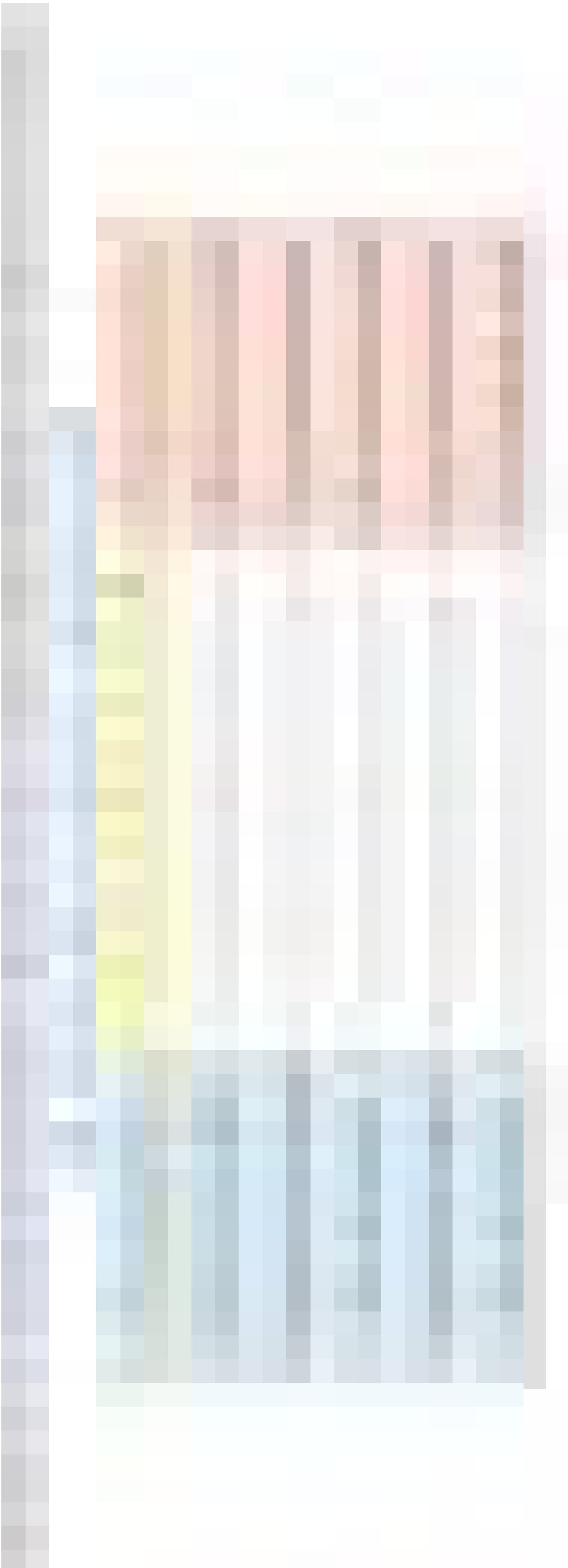


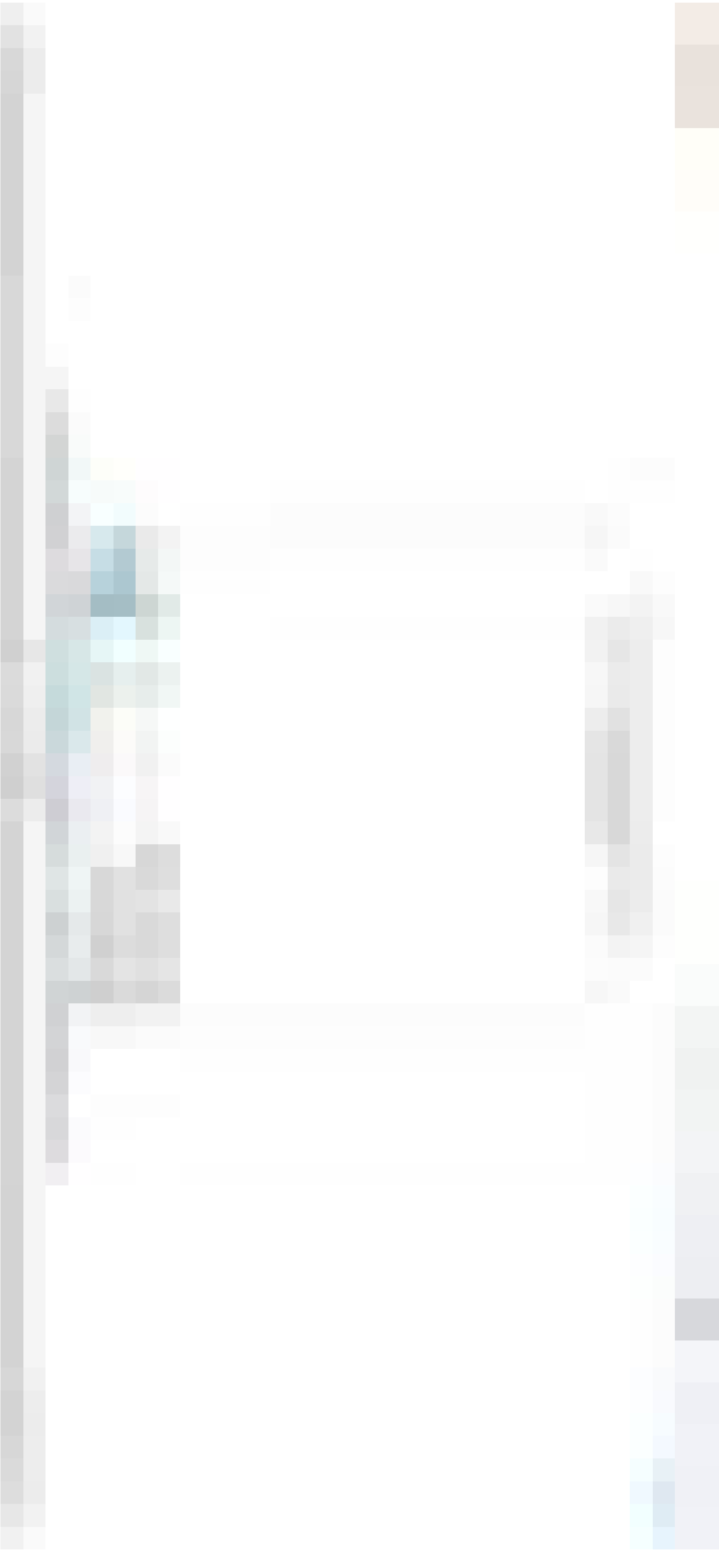


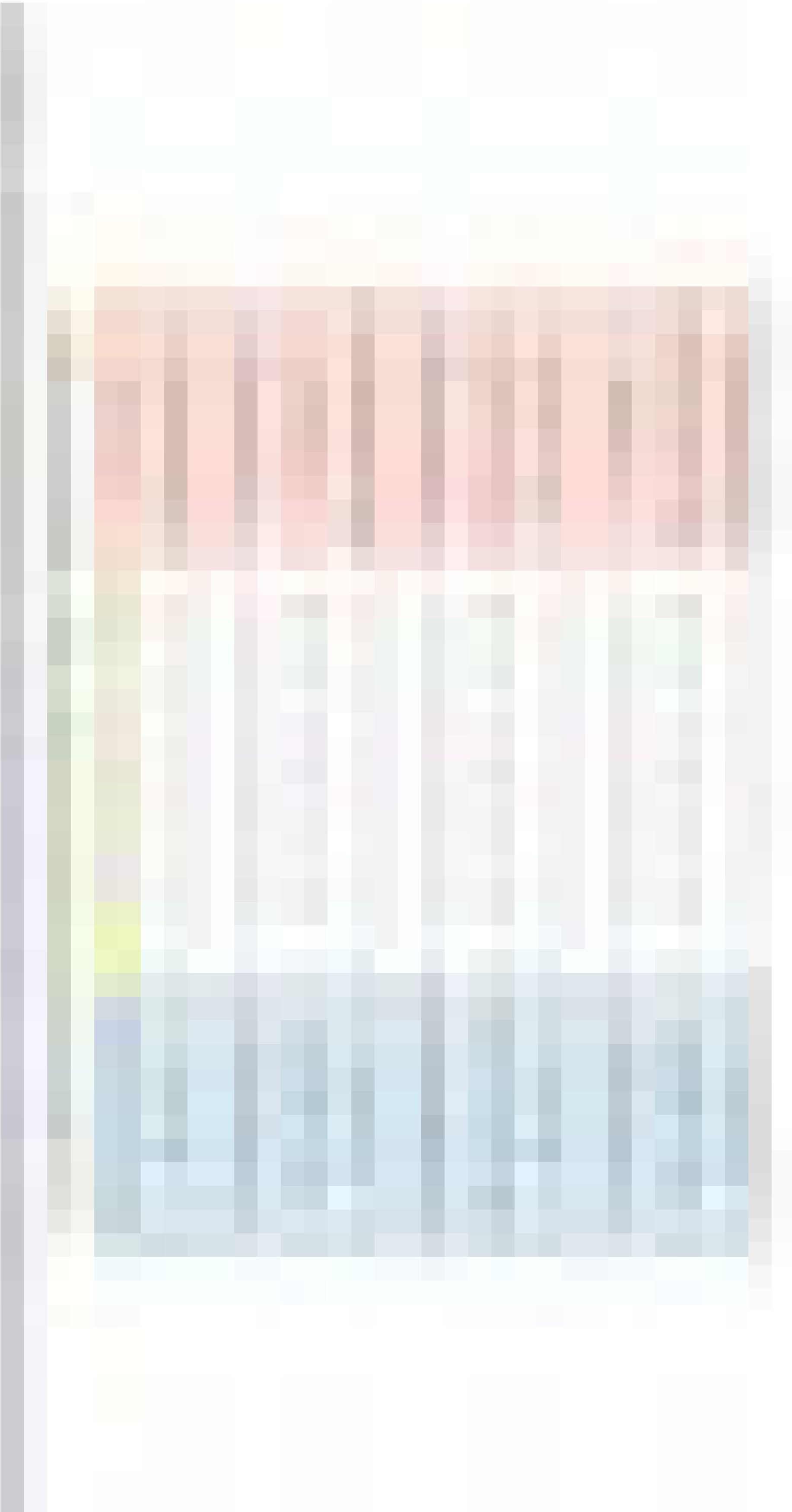


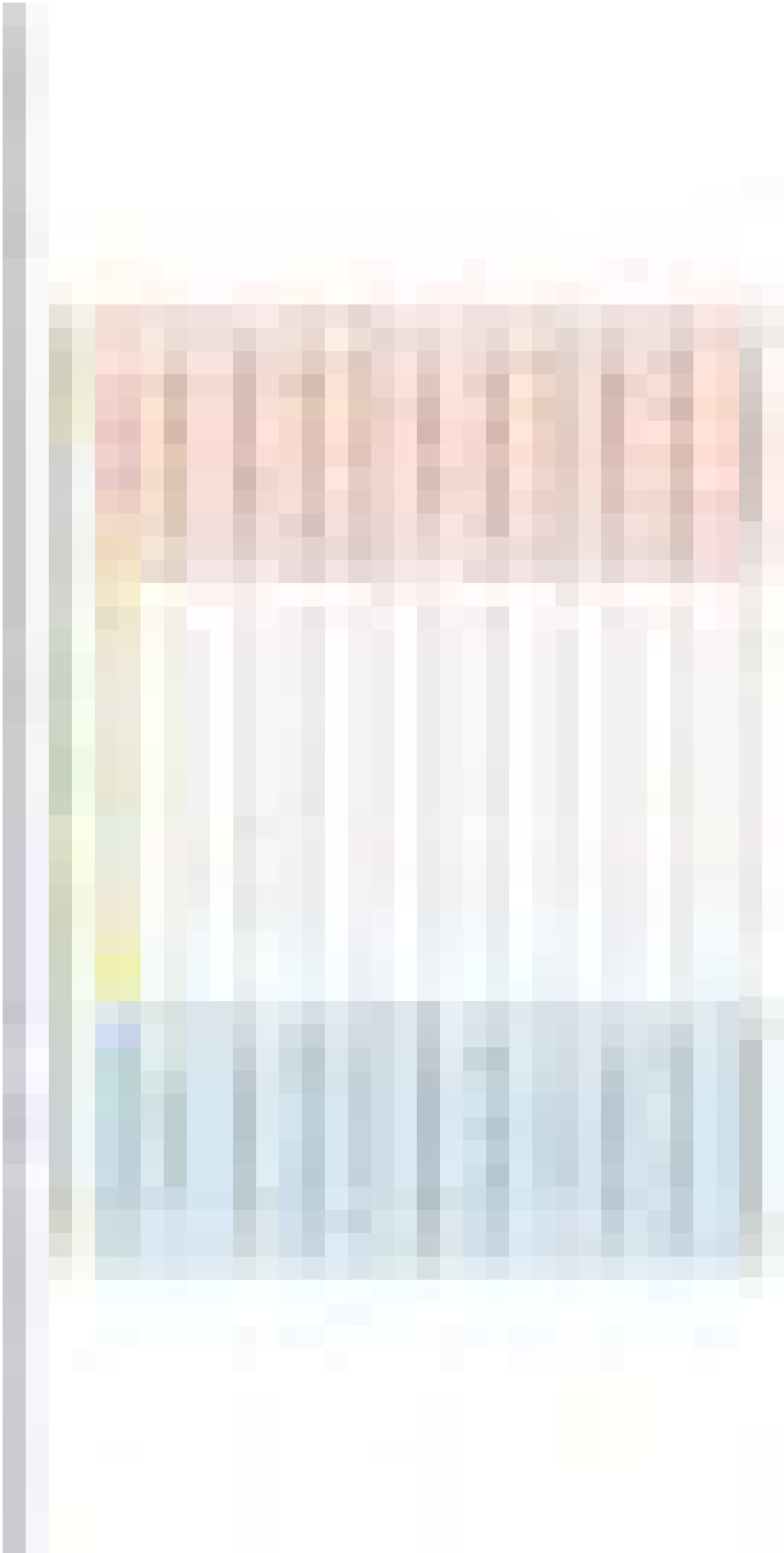


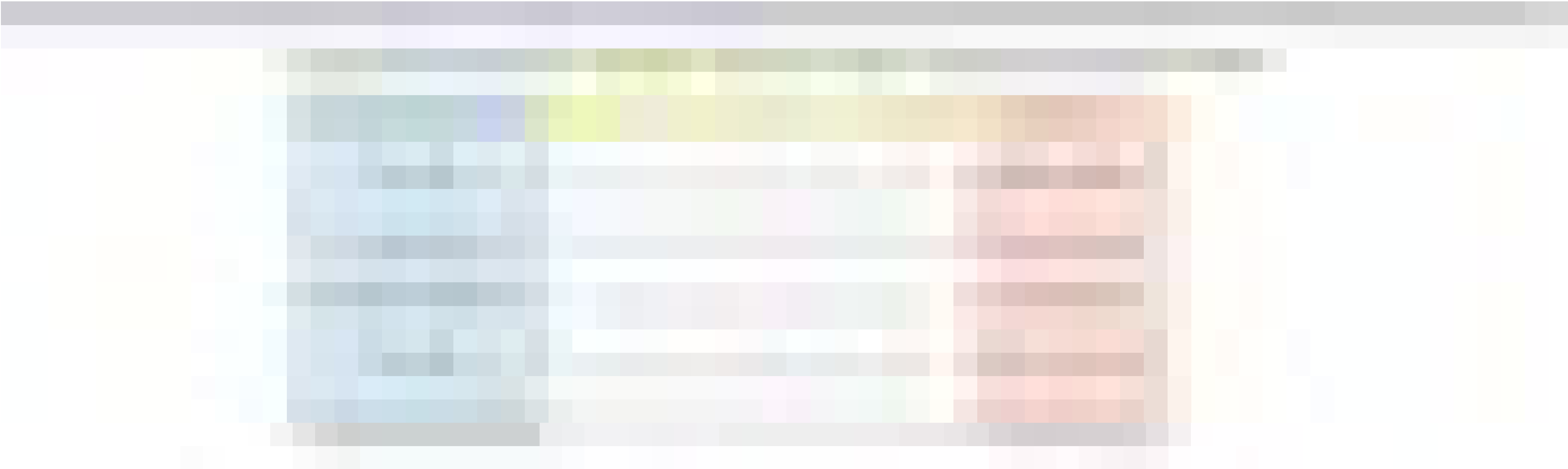


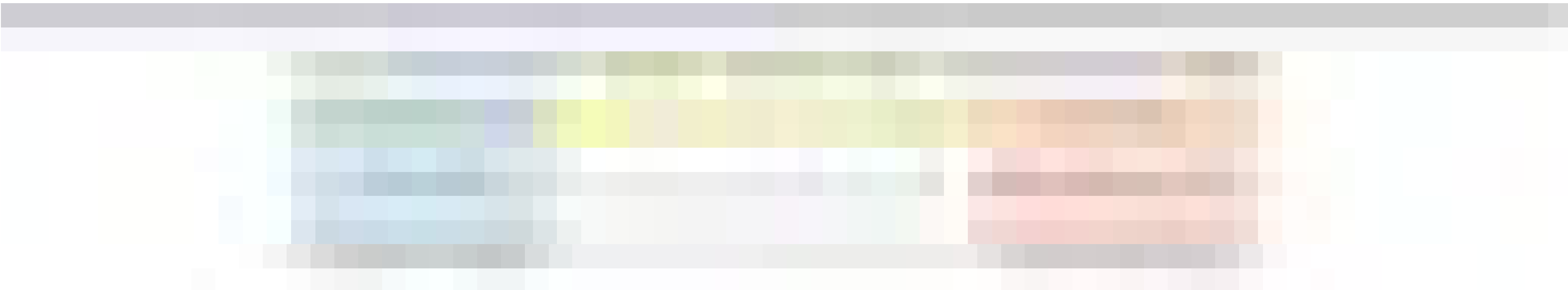












The questionnaire continues likewise to obtain pairwise comparisons for system quality, individual impact and organisational impact with respect to all knowledge elements.