Applying the Delphi Method to Measure Enterprise Content Management Workflow System Performance

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Abstract. Organisations need to measure enterprise content management (ECM) workflow systems performance to achieve their mission and objectives. This requires an exploration of the business environment where ECM workflow systems operate using an appropriate decision-making method and business process management (BPM) values. This paper describes the Delphi method as an appropriate methodology and identifies CERT values as appropriate BPM values with the support from experts and experienced professionals to measure ECM workflow systems performance. CERT values are Customer orientation (C), Excellence (E), Responsibility (R) and Teamwork (T). The purpose of this paper is to explain how the Delphi method can be used to measure ECM workflow systems performance. Further, CERT values are described to drive the business processes through the Delphi method to measure workflow system performance. The paper examines the academic literature on Delphi studies, ECM and CERT values and the benefits of this combination of ideas are revealed. The Delphi method strengths are identified to measure ECM workflow systems performance. Overall, this study focuses on the Delphi rounds as decision-making criteria to formulate a methodology in combination with CERT values to evaluate ECM workflow systems performance.

Keywords: Enterprise Content Management, Business Process Management, Workflow Systems Performance, Delphi Method, Decision-Making Criteria.

1 Introduction

The Delphi method is known both theoretically and practically as a systematic technique to explore complex business practice and information system (IS) problems [1]–[3]. The Delphi method is also known for its usability in developing business decision-making criteria, key performance indicators (KPIs) and problem-solving objectives. Indeed, Delphi results can be used to improve business processes performance. In essence, the Delphi method is a structured communication technique, first developed as a systematic, interactive, forecasting process based on a panel of experts [4]–[6]. The experts respond to a set of questions in a series of rounds each providing their own response (controlled feedback). After each Delphi round, a facilitator delivers an anonymous summary of the experts' predictions from the

responses along with the reasons they provided for their judgments. As a result, experts are encouraged to review their answers in light of the replies of others. It is believed that during the Delphi rounds, the variation of the responses will decrease, and the group will converge towards a consensus response. The Delphi method as a process is stopped by pre-defined 'end' criteria (e.g., the number of rounds, achievement of consensus, or stability of results). Usually, the mean or median scores of the final round determine the final decision criteria and results [4], [5].

The Delphi method has been applied to detect critical issues, enable prediction and provide practitioners who are in leadership roles with important information relating to decision-making criteria development, policy construction or improvement in their practice [7]–[9]. Practically, Delphi has been used in many research areas to set goals and develop new roles for professionals. As a result, this study explores how the Delphi method can be used to measure workflow system performance using CERT values to achieve business objectives. The Delphi method along with business process management CERT values can be used to develop a set of actions (BPM Construct) in order to improve ECM workflow information system performance [10].

The business process management values of CERT (i.e., Customer orientation, Excellence, Responsibility, and Teamwork) are measurement concept values for an enterprise's processes, which can be applied to improve workflow system performance. CERT values are workflow information systems (WIS) and BPM values for managing an organisation workflows [2]. The Schmiedel et al. study [10, p. 298] has defined CERT values as ideals that influence behavioural and organisational patterns of a group and major business process objectives.

An enterprise content management system is a core strategic information management system for managing an enterprise's content and handling unstructured content (e.g., digital documents, emails, application forms). ECM systems have control over the creation and distribution of business information, characteristics and functionalities [11]. In this paper, ECM is used as a workflow information system that can be assessed using the Delphi method in conjunction with CERT values, which indicate sets of workflow measurement activities to optimise the system performance. ECM can be considered as an integrated approach to information system that covers and aligns established concepts (e.g., document management system (DMS), (web) content management and records management (RM) system) at an enterprise-wide scale [12]. ECM as a workflow information system improves an enterprise's customer services, streamlines processes, improves employee productivity, tracks information, provides assistance to comply with regulations, eliminates unnecessary digital and non-digital information and helps implement business continuity measures. Importantly, an organisation uses ECM system to clearly identify the required type of organisational culture, data type and other enterprise resource planning (ERP) system that ECM system would be integrated with to ensure effective workflow performance [13].

Workflow information systems are used to understand content actions, which are an important key condition for effective customisation of ECM systems [2], [12], [14]. WIS are information systems, which are used to solve problems for an enterprise's BPM [15]. WIS are the automation of processes involving combinations of human activities and IS applications [16]. The Delphi method can be applied to develop a deeper understanding of an enterprise's BPM (e.g., in examining which values support an organisation's workflow information systems).

Indeed, Delphi is usually chosen as its iterative approach enhances validity compared to other data gathering methods and processes (e.g., a single cross-sectional questionnaire). In practice, the Looy et al. study [17] have proven that Delphi results are higher in quantity and quality of ideas than other decision support methods. Also, Delphi examples are present in information system studies in general, and an enterprise's BPM and workflow information systems in particular. The following sections present a background to the Delphi method and introduce CERT values, ECM systems and workflow information systems. Consequently, the Delphi methodology and the concept of a Delphi study technique (framework) are discussed. Then, secondary results from published different Delphi studies are considered to describe and explain the impact of the Delphi method on workflow information systems performance, concluding with a discussion and conclusion as an outlook summary.

2 Background

The following sections provide discussions on the Delphi method, business process management, CERT values, enterprise content management performance and workflow information systems in order to illustrate the novelty and importance of the Delphi results, which can be applied to measure WIS performance using BPM values.

2.1 The Delphi Method and Business Process Management

Assessing the performance of an enterprise's workflow system requires the application of a methodology, which can be used for performance measurement. The Delphi method has been recognised as a means to compare workflow systems for producing empirical findings [18]. For example, a Delphi study could be implemented with BPM experts from different industries and geographic locations to define BPM job general profile and specifications. The Delphi method uses expert opinions to find a reliable consensus using a sequence of question rounds coupled with controlled feedback from the experts. The Delphi method has been used to specify BPM values for developing controlled decision-making criteria to find consensus regarding workflow system issues and other related problems. The Delphi study technique was named "Project DELPHI" at The RAND Corporation when the Delphi method was first developed to elicit experts' opinions for overall feedback [5]. Essentially, the Delphi method questions a group of chosen experts using questionnaires or interviews to improve the effectiveness and efficiency levels of an organisation's BPM [19].

Business process management is an approach that focuses on understanding and developing an enterprise's workflow information system based on two objectives. In the beginning, the identified two objectives are the effectiveness and efficiency levels of the business process (workflow system). In practice, the early BPM research studies have focused mainly on efficiency by focusing on the role of information systems and information technology (IT). Later, workflow information systems have been developed as a new approach for business technical prospects, mainly to develop business processes and workflow system design. Therefore, BPM studies are developed to focus on workflow information systems modelling and automation with the use of BPM approaches to implement effective information systems and IT solutions.

Nowadays, BPM approaches and workflow information systems use business practice and research studies to improve WIS in both effectiveness and efficiency levels in order to achieve an organisation's workflow objectives [19], [20].

Research studies on BPM values have suggested that together the Delphi method and BPM approaches can be used to conceptualise and analyse the elements of an organisation's BPM values. The Schmiedel et al. study [10] has recognised the use of CERT values as BPM (workflow system) values in achieving enterprise's workflow objectives, and they used the Delphi method to complete their study. Hence, CERT values as BPM construct have been recognised as success values when they are used along with the Delphi method to measure workflow information system performance.

2.2 The Delphi Method and CERT Values

Achieving expert consensus along with stability is a key objective of Delphi as it allows the participating experts to reach consensus on the significant aspects of a workflow system's issues [4], [6], [7]. Consensus is achieved when an arranged percentage of the participants come to an agreement. Usually, consensus is achieved when an assured percentage of the responses are within a given range (tolerance) for the predictable value. Also, the stability of views is an important indicator in Delphi together with its correlation to consensus. Certainly, stability is reached when no further changes in responses are obtained by the Delphi process. Although, consensus and stability are essential and need to be obtained, the purpose of a Delphi approach is in producing critical investigation and discussions, and not forcing a quick agreement. The Delphi method is also considered as a useful method for developing instruments to be used in information system studies [4], [6]. Hence, an instrument could be a physical questionnaire designed to collect demographic information or a survey form with questions to which the experts would respond based on their expertise. Such questions would usually be generated from problems facing an area of business process or a particular organisation's workflow information system.

The Schmiedel et al. BPM study [10] has recommended CERT values as a workflow system measurement concept (BPM construct) and the Delphi method as a study technique, work together well, in considering ECM workflow system performance. An approach would be to structure a series of rounds based on the Delphi method with the measured response (controlled feedback) using CERT values. In fact, CERT values have reached a high level of consensus rate on achieving workflow system objectives [10]. Also, CERT values have the commitment to develop workflow system objectives and the accountability to ensure stability in workflow system decision-making process.

2.3 CERT Values and Enterprise Content Management System Performance

Enterprise content management has the capability to promote efficient, effective and flexible workflow information system performance. Practically, ECM is a solution for most contemporary information management and business process management problems. ECM systems are the business tools, approaches, processes and skills an organisation needs to manage its information assets over its business lifecycle (workflow system) [12]. On the other hand, BPM workflows are the key engine driving ECM systems, because an understanding of business activities is a crucial precondition for setting up and customising a successful ECM system to an organisation's workflow.

ECM workflow system performance is the information system capabilities, achievements and speed to run BPM workflows. ECM systems ensure workflows are completed sufficiently as it has an impact on various performance aspects [10]. This raised questions such as what information should enterprises know? How do enterprises establish a workflow structure that enables them to understand their ECM workflow system? In fact, enterprises should look at their BPM values as one of the major factors for implementing an ECM system, because of its impact on WIS performance [12].

Research studies on ECM systems established key capabilities related to business strategy development, process and deployment using workflow systems [21]–[23]. Also, many studies have argued that BPM analysis has provided a suitable basis for identifying content and its users along with the different systems in which content resides as ECM systems implementation affects an organisation's workflow activities. As a result, organisations should take CERT values as both the starting point and target for implementing ECM systems to achieve the required workflow objectives.

CERT values have been implemented to verify a BPM instrument to evaluate the extent to which an organisation adopts an information system for its BPM workflow system [2], [10], [20]. CERT values are a measurement concept, which can be applied for evaluating WIS performance. CERT values are BPM values that influence organisation structure, behaviour and patterns. Customer orientation (C) is the proactive and responsive attitude toward the needs of process output recipients; Excellence (E) is the workflow system continuous improvement and innovation required to achieve high performance; Responsibility (R) is the commitment to BPM workflow system objectives and the accountability for process decision-making; Teamwork (T) is the positive attitude toward cross-functional collaboration [24].

2.4 The Delphi Method and Workflow Information Systems

Workflow information systems need a decision-making approach to ensure that business processes have efficient and effective performance toward meeting the expected objectives. The Delphi method has been used in this context as a series of rounds (Table 1), which support experts' assessment by preparing a set of indicators to measure workflow system performance [4], [6], [24]. The Delphi method is an effective approach to explore ideas and structure group communication on framework development and rating, as well as weighing decision criteria by multiple criteria decision-making in order to develop a decision-making tool to prove a business process management workflow system concept (workflow model) or workflow-based process performance measurement system [17], [25].

Workflow is a set of activities to represent a business process, which involves the coordinated implementation of multitasks performed by multiple resources to achieve specific objectives [23], [26]–[28]. Workflow systems are used to guide organisations to standardise their business process management mechanism to meet their industry standards. The charter Workflow Management Coalition (WfMC) was established in 1993 for developing interoperability standards and common terminology for use by industry workflow vendors, which are sharing common themes for different workflow contexts [29]. WfMC has defined workflow as "The automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules." [29, p. 132].

Together, workflow automation in such systematic actions and the Delphi method are able to enhance understanding of the most efficient and effective workflow system performance. In fact, a workflow information system is used to manage workflow technologies for information systems development and management [14, p. 1]. WIS allows the BPM workflow to have the ability to generate the required performance levels to achieve the expected objectives. Also, workflow system needs BPM as a comprehensive approach to understand workflow effectiveness and efficiency levels by focusing on CERT values in the workflow information system implementation and performance. In contrast, the Delphi method is a research study technique, which is able to utilise CERT values as a comprehensive indicator to evaluate workflow system performance. The Delphi method is used to discover workflow system issues and indicators by weighing decision criteria using the Delphi multiple criteria decision-making rounds [4], [17], [20], [25]. In addition, the Delphi method can be used to explore ideas and structure group communication to develop systematic performance framework for rating and weighing decision-making criteria to measure workflow systems. Thus, the Delphi method is a multi-criteria framework and a decision-making tool, which can be used to prove a workflow model concept by measuring the system performance to improve workflow information system performance.

The Delphi method seeks to gain the most reliable consensus from experts and/or experienced professionals [4], [17], [25]. In common, the Delphi method is chosen as its iterative approach enhances validity compared to a single questionnaire. The purpose of Delphi is to produce critical investigation and discussions for the final agreement rather than forcing quick agreement. Indeed, the Delphi method has resulted in higher quantity and quality of ideas, than other group decision-making methods. In fact, examples of Delphi utilize are present in information systems studies in general and BPM workflow systems in particular [7], [10], [17].

3 The Delphi Method

Explanation and discussions about Delphi's framework, reliability and validity are provided in this section as follows.

3.1 The Delphi Method as a Research Study Framework

Implementing a study on business processes or workflow systems require a structured approach such as the Delphi method, which is used to collect expert opinions to find a consensus by a series of controlled questions. The Delphi method conventionally has three rounds each of which has different aims [4], [10], [17]. Round 1 is Brainstorming to identify and/or select key indicators or factors and set up an initial list of criteria. Round 2 is Narrowing Down to validate list of criteria or key indicators and rate (rank) those key indicators in importance or feasibility. Round 3 is Weighing to reach consensus or verify the decision and validate the study results. However, there are several ways to use Delphi; for example, some researchers depend on experts for finding issues and key indicators while others make use of a literature review to formulate a set of indicators or categories prior to the Delphi rounds. Table 1 summarises the conventional Delphi method rounds and its inputs and outputs.

Table 1. Delphi method rounds [17].

Round	Input of the codification panel	Output of the expert panel
1	**Brainstorming** • Propose initial list of criteria • Request missing criteria	• Per initial criterion: – rate its importance – give open comments • For all criteria: – rate overall importance – give open comments • Propose missing criteria
2	**Narrowing Down** • Consolidate criteria	• Per criterion: – rate its importance – give open comments • For all criteria: – rate overall importance – give open comments
3	**Weighing** • Determine final criteria • Request weightings	• For all criteria: – rate overall importance – give open comments • Weigh criteria and options

Brainstorming. This is the first stage of the Delphi method (Round 1), which can be considered as a pilot study for collecting a small sample of the study data to propose the initial list of criteria and indicate importance (e.g., workflow system im-portance levels). Based on the Brainstorming round, the initial decision criteria will be the subject of a Narrowing Down round [4], [17].

In practice, brainstorming is used to identify key measurement indicators for business processes and workflow systems. CERT values have the potential to structure the Brainstorming round in order to identify initial key performance indicators. Based on brainstorming round 1, the identified KPIs from key variables of CERT values can be used in the Narrowing Down round [10], [20].

Narrowing Down. This is the second stage of the Delphi method (Round 2), which validates the results from the Brainstorming round. Narrowing Down is used for seeking a complete rating or ranking of the recognised key indicators by measuring their importance or feasibility to obtain a degree of consensus. This gives a list of key indicators to use in the Weighing round [4], [17]. Narrowing Down is used to confirm the key indicators of the workflows in order to obtain the final rate of consensus for decision-making of workflow system and to get the key measurement indicators. This will recognise workflow system key variables of each CERT value and rate/rank each key variable. Based on Narrowing Down (round 2), both the recognised workflow system key variables of CERT values and the rate/rank of the consensus of each key variable can be used in the Weighting round [10], [20].

Weighing. This is the final stage of the Delphi method (Round 3) and it is used to conduct a final evaluation to reach, and then, reveal the Delphi results. Thus, the study round 3 will determine the final criteria, e.g., weighting system, workflow model diagram [4], [7]. The weighing round seeks the most reliable key indicator variables of CERT values to obtain the best workflow system performance. These key indicator variables are the workflow system running principles that determine the most appropriate information system behaviour and structure for the organisation to achieve its mission and goals [10], [20].

3.2 The Delphi Method Reliability

The Delphi method has a comprehensive set of indicators, because Delphi takes account of all important and different workflow information system aspects. The Delphi method discovers the workflow system issues and key performance indicators by weighing decision-making criteria using Delphi rounds as a multiple criteria decision-making process [4], [7], [17], [25]. This decision-making framework is used to identify and select the study experts who participate as highly skilled professionals to obtain a knowledgeable view, work experience or practise opinion. Knowledge in a professional field, business subject or expertise on the BPM issues that is being investigated can be used to explore ideas and structure group communication on a framework for the workflows rating or ranking.

In contrast, a key objective of the Delphi method is achieving consensus and stability by allowing participants to reach consensus on the significant aspects of the workflow system [7], [30]. Consensus is achieved when arranged percentage of the participants come to an agreement on such BPM issues. Stability is reached when no further unstable responses are obtained within the process of Delphi rounds. In fact, stability is the consistency of responses between successive Delphi rounds [7]. Hence, consensus and stability are essential for ensuring the Delphi results are obtained.

3.3 The Delphi Method Validity

Delphi is an expert analysis method, which has been proven to be appropriate and useful for studying business processes and workflow systems. Delphi has been used to construct, identify, select and validate key factors (KPIs) in a number of business studies [4], [7]. In practice, the Delphi method is used for examining the BPM workflow system validity in the weighing round by doing a quantitative assessment of the reliability and validity of the workflow model. A quantitative measurement instrument can be used to define a specific business operations workflow using CERT values multi-dimensional structure [19], [20]. This gives empirical insights on the descriptive and predictive rules of the new workflow model.

Schmiedel et al. in a global Delphi study [10] have verified and evaluated the codification results by expert participants to ensure the validity of the BPM study findings. Hence, the Delphi method has a key methodological role by ensuring the validity of its results as experts can be asked to validate their study results toward the final BPM workflow system findings and decision-making criteria. This gives consistent results from realistic quantitative evidence.

4 Delphi Results

Research studies have provided significant insights and findings using the Delphi method. Delphi has achieved various improvements in finding consensus and determining the effectiveness of the criteria for measuring BPM workflow system performance [7]. Delphi method has been used to define and examine the characteristics of the business processes, which enable better understanding of workflow system and the measurement of effectiveness and efficiency levels. In fact, previous Delphi studies have recognised CERT values (Table 2) as distinct key BPM values to measure an enterprise's workflow system [19], [20]. Therefore, CERT values and Delphi method can be used to make a criterion (framework) that supports decision-making in order to measure workflow information system performance.

Table 2. CERT values to measure workflow information systems [20].

Value / CERT Constructs	Definition
Customer orientation	The rules, policies, and attitude to obtain the required customer relationship results.
Excellence	Enterprise's workflow system performance continuity of improvement and innovation.
Responsibility	The courage and accountability to accomplish an enterprise's business process objectives.
Teamwork	The team members' ability to resolve business process issues through a positive attitude.

CERT business process management values are an enterprise's decision-making principles that determine regular business behaviour and structures in the workflow system relational activities. Schmiedel et al. studies [10], [20], [24] have reported findings, which include identifying CERT values (Table 2) as important themes from the BPM study participants' feedback. Now, the results of further studies are considered to explore the relationship between the Delphi method and CERT values. This includes consideration of the Delphi method reliability, validity and results.

4.1 The Relationship Between the Delphi Method and CERT Values

CERT values have the ingredients to make a business environment accessible by workflow systems to improve their performance. The Delphi method can utilise CERT values as business process management core values to map the workflow procedures based on CERT classifications. Schmiedel et al. [10] have reported the results of a Delphi study finding that excellence (E) has the highest value ranking, and then, customer orientation (C) and responsibility (R), which are both ranked more highly

than teamwork (T). These values represent core business process management elements to improve workflow information system performance [20], [24]. Thus, the Delphi method with CERT values can be used to measure and improve WIS performance.

4.2 Delphi Results

The Delphi method is able to develop key performance indicators by following its three principal rounds (Table 1). These decision-making rounds can measure workflow information system performance in such a structural way (e.g., the first round to find or recognise the indicators, and then, the second round to validate those recognised indicators and rank them based on their business practicality and objectives achievement, and finally, a third round to verify the results in order to use them as KPIs). In general, the Delphi method uses its rounds as a ranking decision-making model, for instance: 1. Initial ranking (e.g., entity X greater than entity Y); 2. Rate the recognised entities (e.g., entity X = 9/10 while entity Y=4/10); 3. Compare X and Y entities based on their scale from 1 to 10 (e.g., entity X has five more identified elements than entity Y, which verify the scale of X to Y) [4], [17], [30]. In fact, Delphi' third round calculates the scale to confirm the rank of each entity [4], [17].

The completion of the Delphi method results in decision-making criteria that has consensus and rounds, which can be used as a concept (model) to develop business performance by improving workflow information system performance. However, Delphi method rounds can be distributed within more than three stages of the study framework. Looy et al. [17] have used Delphi within four rounds in a study relating to a business process maturity model (BPMM) to assess and improve business process maturity (Table 3).

Table 3. The Looy et al. study [17] toward a business process maturity model (BPMM).

BPMM Study Round	Delphi Round
First	Brainstorming
Second – Third	Narrowing down
Fourth	Weighing

The Looy et al. Delphi study [17] has concluded five stages to develop a proof-of-concept of a BPMM decision-making tool (model): First, evaluating scores of collected BPMMs based on calculations and according to the achieved weightings; Second, based on BPMMs practicality and achievement a questionnaire can be developed and tested by a pilot study; Third, the study questionnaire can be used to compare with a decision-making table of BPMM sample, the answers then delivered to the table, which will navigate systematically to the most suitable BPMMs based on the questionnaire final answers; Fourth, BPMMs proof-of-concept can be automated by the questionnaire and decision-making table; Fifth, BPMMs proof-of-concept is tested by case studies (e.g., Managers who wish to start with a BPMM are asked to evaluate the BPMM and its output, then assess the Managers satisfaction with the BPMM decision-making criteria and the selection process).

The Schmiedel et al. Delphi study [10] has proven that CERT values are supportive of business process management success. Indeed, the Delphi method controlled feedback have contained many positive responses to confirm CERT values success in developing workflow system performance (e.g., "I am committed to work with others to continually improve the performance of my business process to deliver excellent service/product to the customer and I take full responsibility for my actions"). The Schmiedel et al. Delphi study [19] on how business cultural values determine BPM success has confirmed that Delphi can support organisations to find unrecognised issues, which require feedback from experts and experienced professionals.

The Reliability of Delphi Results. The Delphi method has resulted many empirical evidence and insights in regard to workflow information systems. Indeed, impirical studies require reliable measurement techniques to be implemented as a comparison tool to deliver evaluation insights. The Delphi study technique together with business process management values such as CERT values can ensure reliability throughout the multi-stage process (Table 1), and through, CERT values an organisation can ensure workflow information system reliability to achieve its objectives [20], [24].

To measure ECM workflow system performance, CERT values can be applied to evaluate the system performance reliability through every Delphi study round (stage). For example, the Schmiedel et al. study [20] has measured the reliability using four sorting rounds based on the Delphi method, which has delivered an average for Kappa and Placement-Ratio measurement indexes (key indicators) in each round. This has provided a testing index on reliability, which in round four has shown that a Kappa value > 0.6 and a placement-ratio > 0.8 have been reached (see Table 4). Accordingly, the appropriate agreement levels have been achieved based on Kappa and Placement-Ratio key indicators to make the measurement mechanism to be applied in the application phase.

Table 4. The Schmiedel et al. [20] reliability levels in the testing index.

Index	Round 1	Round 2	Round 3	Round 4
Kappa	0.29	0.42	0.26	0.67
Placement-Ratio	0.59	0.72	0.62	0.82

The Validity of Delphi Results. The Delphi method has been chosen to develop BPM workflow system studies, as a result of its iterative procedures, which enhance the validity of the study findings [17], [30]. The Delphi method focuses on expertise feedback as an appropriate framework to construct, recognise, find and validate workflow information system key indicators or valuable factors in several studies as described by Quyên study [4].

The most important advantage of the Delphi method is to ensure the validity of the study findings by asking the experts to validate the responses. In Delphi, examining the validity of the study findings is undertaken in the third round. The purpose of Delphi

rounds (Table 1) is to construct validated indicators and factors (e.g., CERT business process management values, which are used to examine the validity of the study measurement and develop confirmatory factors through factor analysis) [10], [17], [20], [24], [30]. Also, comparing Delphi study findings to other current studies in the same study area/subject allows an analysis of the validated Delphi results.

To measure ECM workflow system performance, CERT values can be applied to evaluate the workflow system performance validity in each Delphi round. For example, the Schmiedel et al. study [20] has validated BPM construct of CERT values by measuring the contribution of the formed indicators distinct construct (C.E.R.T) to the total BPM construct values (CERT) using three criteria (Table 5). First, the weight has shown CERT indicator weights are highly significant, which confirm the previous study stages of measurement procedures. Second, the relationship between BPM constructs have been evaluated using the adequacy coefficient R_a^2. This has shown the formed distinct indicators match with the aggregate BPM construct values. Third, the study has measured the BPM construct values for conceptual redundancy based on separating CERT influence from the BPM construct values using multicollinearity examination on the basis of the variance inflation factor (VIF). This has shown distinct indicators have less than the restrictive limit of 3.30, which means no multicollinearity. Conversely, BPM construct values (CERT) have VIF ranges between 3.66 and 5.27, which means the probability (p) of multicollinearity is increased. Overall, the study has used the Petter et al. [31] four options to assess p and developed independent samples t-tests between distinct indicators and BPM construct values, comparing key demographics (e.g., industry sector, and C. E. R. T. report). The t-tests produced insignificant p values that range between 0.45 to 0.71. Hence, multicollinearity has an insignificant effect, which means CERT values support BPM and workflow information systems to achieve the expected objectives.

Table 5. The Schmiedel et al. [20] validation of BPM construct values (CERT).

Indicator		**Weight**	**Significance**	**VIF**	**Adequacy coefficient R_a^2**
C		0.55	$p < 0.001$	1.74	0.83
E		0.54	$p < 0.001$	2.10	0.86
R		0.55	$p < 0.001$	1.89	0.84
T		0.54	$p < 0.001$	2.15	0.86
BPM construct					
values	**C**	0.26	$p < 0.001$	3.66	0.87
	E	0.27	$p < 0.001$	4.53	
	R	0.27	$p < 0.001$	4.55	
	T	0.27	$p < 0.001$	5.27	

4.3 Finding Key Performance Indicators

The Delphi method has higher quality and quantity of ideas than other BPM and workflow information systems measurement methods for developing decision-making criteria; the major advantage of Delphi method compared to other methods is the validation of the study findings as experts are asked to validate their feedback classification to reform the final decision-making criteria[10]. In fact, the Delphi method has analytical rounds, which facilitates strategic decisions in terms of which BPM dimensions an enterprise must improve (e.g., dimensions of CERT values that provide key indicators below the average compared to others should be considered as an area of performance development in a new BPM strategic plan) [20], [24].

Researchers have found that the Delphi method has been successfully applied to obtain expert opinions, structure a group communication process and build consensus to achieve the study aim and objectives. Hence, the Delphi method is a valuable research development framework for eliciting participants' experiences, views and ultimate their agreement [8].

Nowadays, it is necessary for enterprises to study their workflow information systems future requirements and they need to meet their expected objectives and required BPM workflow performances. Delphi has the capacity to capture the collective knowledge of an enterprise BPM workflow in order to find the key indicators to improve ECM workflow system performance [32].

5 Conclusion

The Delphi method and CERT business process management values can be applied to evaluate how an enterprise's workflow systems are performing. As a result, decision-makers, specialists and experts apply the Delphi method to measure workflow system in practice using CERT values to examine their BPM workflow performance [10], [24]. For example, Delphi has been applied in a study to develop organisational management information reports and a spider model diagram (Figure 1) in order to explain BPM workflow performance in relation to CERT values [20].

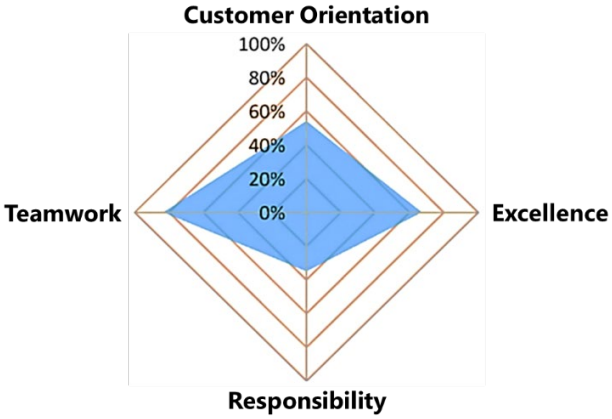

Fig. 1. The Schmiedel et al. [20] CERT insights spider model diagram.

In contrast, the Delphi method as a research study technique has been implemented to develop decision-making criteria and key performance indicators, which can be used to improve workflow information system performance. Accordingly, the concentration on the Delphi study technique to measure WIS performance using CERT values does present a limit on the Delphi method.

Practically, the Delphi method as a decision-making study technique should be used in other study areas, and therefore, it is recommended to implement Delphi for doing further information system studies in order to formulate decision-making criteria or key performance indicators to improve performance in order to successfully achieve specific objectives. However, further research can be achieved by Delphi using other organisational or BPM values. For example, the Delphi method can be used to measure other BPM dimensions such as financial performance in terms of efficacy and robustness. Also, further studies are possible on dimensions such as business relations and social responsibility in the measurement and improvement of professional practice.

The Delphi method has proven to be an appropriate framework for developing studies on BPM and workflow information systems. The Delphi method has been used to construct, identify, select and validate KPIs for business process management. Also, CERT values allow an enterprise to make an evaluation of its workflows by ranking business processes CERT classifications. Hence, the Delphi method and CERT values can be used to evaluate ECM workflow system in order to improve the system performance to ensure meeting the expected objectives [4], [10], [33].

The Delphi method is a study technique with unique characteristics including the weighting results, which have shown significant contribution to various professional practice and research studies. Methodologically, the Delphi method is a successful framework through which to construct BPM key performance indicators. The Delphi rounds do construct the initial BPM key indicators, and then, systematically structure them to be used as measurement values to evaluate workflow information system performance or any other enterprise systems performance.

In summary, the Delphi method is suitable for measuring workflow system performance, BPM workflow practice and research studies in a range of areas such as: defining roles of stockholders; identifying issues and problems; finding key performance indicators; exploring critical issues; selecting a project team; forecasting enterprise future and new strategies; answering research questions; developing service standards and/or policy construction; and delivering sufficient evidence (insights) for decision-making to improve organisational performance [7], [8], [17], [24], [30], [34].

References

1. Bouaynaya, W.: Characterization of Cloud Computing Reversibility as Explored by the Delphi Method. *Inf. Syst. Front.* 22(6), 1505–1518 (2020).
2. AbouGrad, H., Warwick, J., Desta, A.: Developing the Business Process Management Performance of an Information System Using the Delphi Study Technique. In *EAI International Conference on Technology, Innovation, Entrepreneurship and Education, Lecture Notes in Electrical Engineering (LNEE) book series, Vol 532,* pp. 195–210, A. Reyes-Munoz, P. Zheng, D. Crawford, and V. Callaghan, Springer, Cham (2019).

3. Ameyaw, E. E., Hu, Y., Shan, M., Chan, A. P. C., Le, Y.: Application of Delphi method in construction engineering and management research: A quantitative perspective. *J. Civ. Eng. Manag.*, 22(8), 991–1000 (2016).
4. Quyên, Đ. T. N.: Developing University Governance Indicators and their Weighting System Using a Modified Delphi Method. *Procedia - Soc. Behav. Sci.*, vol. 141, pp. 828–833, (2014).
5. Dalkey, N., Helmer, O.: An Experimental Application of the Delphi Method to the Use of Experts. *Manage. Sci.* 9(3), 458–467 (1963).
6. Alarabiat, A., Ramos, I.: The Delphi Method in Information Systems Research (2004-2017). *Electron. J. Bus. Res. Methods* 17(2), 261–268 (2019).
7. Nworie, J.: Using the Delphi Technique in Educational Technology Research. *TechTrends Link. Res. Pract. to Improv. Learn.* 55(5), 24–30 (2011).
8. Sitlington, H., Coetzer, A.: Using the Delphi technique to support curriculum development. *Educ. + Train.* 57(3), 306–321 (2015).
9. Gallego, D., Bueno, S.: Exploring the application of the Delphi method as a forecasting tool in Information Systems and Technologies research. *Technol. Anal. Strateg. Manag.* (2014).
10. Schmiedel, T., vom Brocke, J., Recker, J.: Which cultural values matter to business process management?. *Bus. Process Manag. J.* 19(2), 292–317 (2013).
11. Olusola, M., Sunday, I.: Evaluation of Content Management Systems Performance. *IOSR J. Comput. Eng.* 9(4), 62–69 (2013).
12. vom Brocke, J., Simons, A., Herbst, A., Derungs, R., Novotny, S.: The business drivers behind ECM initiatives: a process perspective. *Bus. Process Manag. J.*, 17(6), 965–985 (2011).
13. Hullavarad, S., O'Hare, R., Roy, A. K.: Enterprise Content Management solutions - Roadmap strategy and implementation challenges. *Int. J. Inf. Manage.* (2015).
14. Guerrero-García, J.: A Methodology for Developing User Interfaces to Workflow Information Systems. Université Catholique de Louvain (UCL), (2010).
15. García, J. G., Vanderdonckt, J., González Calleros, J. M.: Developing User Interfaces for Community-Oriented Workflow Information Systems. in *Ubiquitous and Pervasive Computing*, IGI Global, pp. 253–275, (2010).
16. Guerrero-García, J., Vanderdonckt, J., Lemaige, C., Calleros, J. M. G.: How to Describe Workflow Information Systems to Support Business Process. in *2008 10th IEEE Conference on E-Commerce Technology and the Fifth IEEE Conference on Enterprise Computing, E-Commerce and E-Services*, Jul., pp. 404–411, (2008).
17. Van Looy, A., De Backer, M., Poels, G.: Towards a Decision Tool for Choosing a Business Process Maturity Model. In *Proceedings of the 7th International Conference on Design Science Research in Information Systems: Advances in Theory and Practice*, pp. 78–87, (2012).
18. Müller, O., Schmiedel, T., Gorbacheva, E., vom Brocke, J.: Towards a Typology of Business Process Management Professionals: Identifying Patterns of Competences Through Latent Semantic Analysis. *Enterp. Inf. Syst.* 10(1), 50–80 (2016).
19. Schmiedel, T., vom Brocke, J., Recker, J., Culture in Business Process Management: How Cultural Values Determine BPM Success. In *Handbook on Business Process Management 2*, J. vom Brocke and M. Rosemann, pp. 649–663, Springer, Berlin (2015).

20. Schmiedel, T., vom Brocke, J., Recker, J.: Development and validation of an instrument to measure organizational cultures' support of Business Process Management. *Inf. Manag.* 51(1), 43–56 (2014).
21. vom Brocke, J., Simons, A., Cleven, A.: Towards a business process-oriented approach to enterprise content management: the ECM-blueprinting framework. *Inf. Syst. E-bus. Manag.* 9(4), 475–496 (2011).
22. Harr, A., vom Brocke, J., Urbach, N.: Evaluating the individual and organizational impact of enterprise content management systems. *Bus. Process Manag. J.* 25(7), 1413–1440 (2019).
23. Jaakonmäki, R., Simons, A., Müller, O., vom Brocke, J.: ECM implementations in practice: objectives, processes, and technologies. *J. Enterp. Inf. Manag.* 31(5), 704–723 (2018).
24. Schmiedel, T., Recker, J., vom Brocke, J.: The relation between BPM culture, BPM methods, and process performance: Evidence from quantitative field studies. *Inf. Manag.* 57(2), 103–175 (2020).
25. Van Looy, A., Shafagatova, A.: Business process performance measurement: a structured literature review of indicators, measures and metrics. *Springerplus*, 5(1), 1–24 (2016).
26. Marutha, N. S., Ngulube, P.: Enterprise content management system implementation readiness to improve medical records management in Limpopo Province, South Africa. *Libr. Philos. Pract.*, vol. 2018.
27. Yousfi, A., Saidi, R., Dey, A. K.: Variability patterns for business processes in BPMN. *Inf. Syst. E-bus. Manag.* 14(3), 443–467 (2016).
28. Vasilecas, O., Kalibatiene, D., Lavbič, D.: Rule- and context-based dynamic business process modelling and simulation. *J. Syst. Softw.*, vol. 122, pp. 1–15, (2016).
29. Chang, J. F.: *Business Process Management Systems: Strategy and Implementation*. Auerbach Publications, Boca Raton, FL (2006).
30. Looy, A. Van, Poels, G., Snoeck, M.: Evaluating Business Process Maturity Models. *J. Assoc. Inf. Syst.* 18(6), 461–486 (2017).
31. Petter, S., Straub, D., Rai, A.: Specifying Formative Constructs in Information Systems Research, *MIS Q.* 31(4), 623–656 (2007).
32. Stitt-Gohdes, W. L., Crews, T. B.: The Delphi technique: A research strategy for career and technical education. *J. Career Tech. Educ.*, 20(2), 55–67 (2004).
33. Hullavarad, S., O'Hare, R., Roy, A. K.: Enterprise Content Management solutions—Roadmap strategy and implementation challenges. *Int. J. Inf. Manage.* 35(2), 260–265 (2015).
34. Schmiedel, T., Müller, O., Debortoli, S., vom Brocke, J.: Identifying and quantifying cultural factors that matter to the IT workforce: An approach based on automated content analysis. *ECIS 2016 - Proc. 24th Eur. Conf. Inf. Syst.*, pp. 1–16, Istanbul, Turkey (2016).