The Effect of Organisational Absorptive Capacity on Business Intelligence Systems Efficiency and Organisational Efficiency

Journal:	*Industrial Management & Data Systems*
Manuscript ID	IMDS-02-2020-0120.R2
Manuscript Type:	Research Paper
Keywords:	Absorptive Capacity (ACAP), Business Intelligence (BI), Structural Equation Modelling (SEM), Partial Least Squares (PLS), Organisational Efficiency, Measures

The Effect of Organisational Absorptive Capacity on Business Intelligence Systems Efficiency and Organisational Efficiency

Abstract

Purpose: BI systems (that is, technology and procedures that transform raw data into useful information for managers to enable them to make better and faster decisions) have enormous potential to improve organisational efficiency. However, given the high expenditure involved in the deployment of these systems, the factors that will enable their successful integration should be thoroughly considered and assessed before these systems are adopted. Absorptive Capacity (ACAP) is the ability of organisations to gather, absorb, and strategically influence new external information, and, as such, there is a strong theoretical connection between ACAP and BI systems. This research aims to empirically investigate the relationship between the dimensions underpinning ACAP (that is, acquisition, assimilation, transformation and exploitation) and whether and how they affect the efficiency of BI systems, which, in turn, can enhance organisational efficiency.

Design/methodology/approach: this study formulates five hypotheses addressing the effect of ACAP dimensions on BI systems efficiency, and the effect of BI systems efficiency on organisational efficiency. It synthesises previous qualitative work and current research to derive sets of measures for each of the key constructs of the study. It follows a quantitative methodology, which involves the collection of survey data from senior managers in the telecommunications industry and the analysis of the data using Partial Least Squares – Structural Equation Modelling (PLS-SEM).

Findings: the results of the analysis confirmed the validity of the constructs and proposed measures, and supported all five hypotheses suggesting a strong positive relationship between the ACAP dimensions, acquisition, assimilation, transformation and exploitation, and the efficiency of BI systems, and a strong effect of BI systems efficiency on organisational efficiency.

Practical implications: the study offers a comprehensive model of ACAP and BI systems efficiency. The set of measures that underpin these constructs could help researchers understand how ACAP dimensions are practically implemented and could contribute to their efforts to develop ACAP measurement instruments. At the same time, the model can help managers assess the readiness of their firms to adopt BI systems, and identify which areas should be further developed, before committing to the substantial financial investment associated with BI systems. It also provides a set of practical solutions that could be implemented to enable a more robust ACAP and support a better integration of BI systems.

Originality/value: following an empirical approach, this study refines our theoretical and practical understanding of ACAP as an organisational dynamic capability and its dimensions; it provides an account in how each dimension affects different aspects of BI systems efficiency, which, in turn, may contribute to the improvement of organisational efficiency. Moreover, the study reframes ACAP measures as a set of requirements that can be practically assessed and followed before attempting to purchase BI systems.

Keywords: Absorptive Capacity (ACAP), Business Intelligence (BI), Structural Equation Modelling (SEM), Partial Least Squares (PLS), Organisational Efficiency, Measures.

Article Classification: research paper.

1. Introduction

BI systems are a broad category of applications and technologies for gathering, storing, analysing, and providing access to data that aim to help the decision-making process (Liang and Liu, 2018) and, as such, BI systems have enormous potential to improve organisational efficiency (Wang and Byrd, 2017; Grezes, 2015). With increasingly more powerful computational algorithms and data storage capacity, BI solutions have been an area of continuous and growing interest. It is apparent, however, that the availability of any technology should not be the sole drive behind its adoption in an organisation. Rather, the ability of these systems to be successfully integrated and significantly contribute to organisational efficiency, and the factors that will support it, should be thoroughly considered and assessed before their adoption.

Absorptive Capacity (ACAP) is the ability of organisations to gather, absorb, and strategically influence new external information (Cohen and Levinthal, 1990), and as such there is a strong theoretical connection between ACAP and BI systems. This research aims to empirically investigate the relationship between the dimensions underpinning ACAP (that is, acquisition, assimilation, transformation and exploitation) and whether and how they affect the efficiency of BI systems, which, in turn, can enhance organisational efficiency. In particular, the research seeks to address the following research question:

Can ACAP influence the efficiency of BI systems and, consequently, influence overall organisational efficiency?

2. Background Review

Dissecting the research question, this section provides an overview of the core concepts and relations in it; in particular, it discusses literature to define ACAP and BI systems and to identify an association between ACAP and BI systems, and BI systems efficiency and organisational efficiency.

2.1 Absorptive Capacity: Concept and Dimensions

The concept of ACAP was developed by Cohen and Levinthal (1990), who defined it as: “the ability of organisations to identify, assimilate, and exploit knowledge coming from external sources." Since then, it has been investigated in various areas such as banking (Silva et al., 2004), technology (Nicholls-Nixon and Woo, 2003), strategic alliance (Cui, Wu and Tong, 2018), organizational learning (Cooper and Molla, 2016), product development (Stock et al., 2001), and organisational financial performance (Lin et al. 2016). Throughout the last two decades, the concept has been further developed such that now it is widely considered a dynamic organisational capability (Dabic et al., 2019). Central to this reconceptualisation was the work by Zahra and George (2002), who defined ACAP as a "dynamic capability embedded in a firm's routines and processes, making it possible to analyse the stocks and flows of a firm's knowledge and that contributes to the creation and sustainability of competitive advantage". Recent studies and systematic literature reviews on ACAP validated this reconceptualisation of ACAP as a dynamic capability, while also stressing its key role in knowledge transfer (Apriliyanti and Alon, 2017; Gao et al., 2017; Lin et al. 2016). Furthermore, Zahra and George (2002) offered an operationalisation of ACAP by decomposing it into four indicators or dimensions. These dimensions can be either characterised as 'potential' or 'realised':

1. **Acquisition** is concerned with Research and Development investment in organisations and describes the firm's ability in obtaining critical external data, information, and knowledge (Jordan et al., 2008).
2. **Assimilation** is concerned with the ability of an organisation to have structured and controlled set of procedures that enables the analysis and interpretation of the obtained external knowledge (Kumar and Palvia, 2001).
3. **Transformation** may involve new product designs and research projects, and describes the ability of a firm to combine prior knowledge with newly attained knowledge by having set of technical and non- technical processes that supports this combination and refinement of knowledge (Wang and Byrd, 2017).
4. **Exploitation** is related to the number of novel generated products, services, and patent declarations. Exploitation indicates the capacity of the firm to exploit the newly gained knowledge and efficiently apply it in services and product development that can lead to better performance and financial profit (Wolfswinkel et al, 2013).

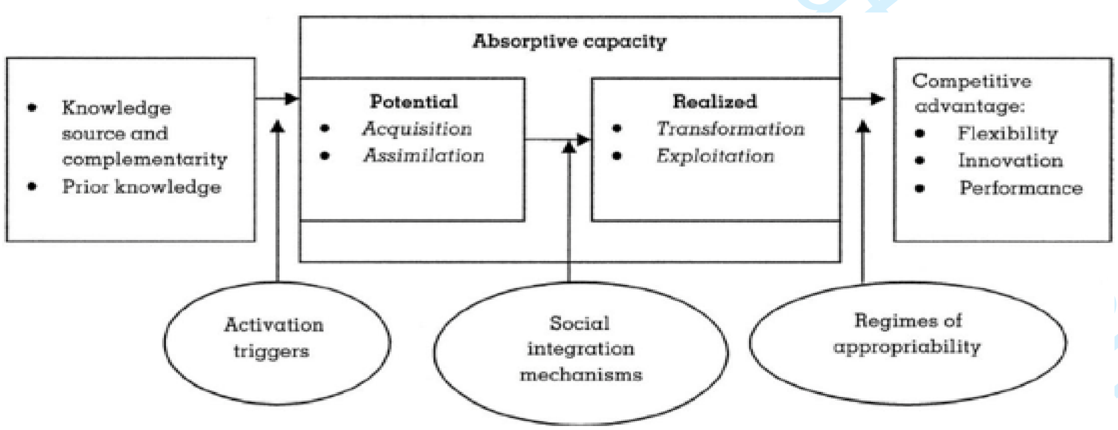

Figure 1. ACAP model developed by Zahra and George (2002)

A similar model was proposed by Todorova and Durisin (2007), which added interactions between the dimensions and power relationships as a factor affecting the acquisition of knowledge and its exploitation.

The model by Zahra and George (2002) had two critical contributions to the ACAP literature; first, it defined ACAP as a dynamic capability, that is, a key competency in generating strategic nature in an organisation, which is concerned with the element of 'change' in a certain organisation. Second, ACAP is operationalised through four dimensions, which are distinct and complementary (Floor, Cooper and Oltra, 2018). Naturally, there are practical limitations to this model, as well as other existing models, as pointed out by Duchek (2013), Lane et al (2006) and Gao et al. (2017). First, ACAP dimensions cannot be readily employed as empirical measures of an organisation's ACAP. Second, there is no direct link between each ACAP dimension and aspects or components relating to BI systems and technology. The research presented in this paper attempts to add to existing ACAP research by addressing these limitations. Relevant to the latter, the next section provides and overview of BI systems.

2.2 Business Intelligence (BI) Systems

BI systems are commonly used as an umbrella term for systems and procedures that transform raw data into useful information for managers to enable them to make better decisions (Wixom and Watson, 2010; Watson, 2009).

BI systems fall under the broader category of Information Systems (IS), but differ from other IS systems because of their explicit focus on data, data sources, and available analytical tools, and aim to directly support the decision-making process (Loon, 2019). Furthermore, BI systems differ in their use of sensing opportunities for organisational innovation and promoting business growth. The current research is very much influenced by the definition developed by Liang and Liu (2018), according to which, BI is a term covering technology-driven, and large combination of processes, politics, culture, and technologies for gathering, manipulating, storing, and analysing data for generating effective business and organisational performance, and discovering new business prospects. Moreover, a BI system includes a broad range of analytical software for diverse organisational provisions (Loon, 2019).

According to Laursen and Thorlund (2010), a BI system consists of three significant components: a technological component, a human component, and a business process to underlie the transformation of information to knowledge. BI systems rely on the organisation's IT infrastructure to operate (e.g., database services, shared resources, security systems, etc.) but should not be treated as merely part of the IT infrastructure (Liu et al., 2018). BI systems have enormous potential to directly improve organisational efficiency (Watson, 2009; Wang and Byrd, 2017; Grezes, 2015). However, the review conducted by McBride (2015) found that there is lack of empirical research that pinpoints how BI systems leads to organisational efficiency and identifies the required organisational capabilities that must pre-exist or must be developed to support the assimilation of BI systems. The next section focuses on research that has looked at ACAP as an organizational capability in relation to BI systems.

2.3 Theoretical Association between ACAP and BI Systems

Roberts et al. (2012) discussed the link between ACAP and Information Systems (IS), in general – not specifically BI systems – with the aim to refine current understanding of ACAP and direct its operative practice in IS studies. The study traced the evolution of ACAP literature, identified issues relevant to its conceptualisation and examined how ACAP has been measured, theorised, and then utilised in the IS research field. Similarly, Gao et al. (2017) analysed the use of ACAP in IS research and, while they found that ACAP was accurately and consistently conceptualised as a capability, their comprehensive literature review revealed that there is no common understanding of how it should be operationalised and measured. Focusing on BI systems, Elbashir et al. (2011) examined the role of organisational ACAP in the strategic use of BI systems to support integrated management control systems. The study argues that, organisational ACAP or the capability to collect, absorb and strategically control new information coming from external sources, depends on the creation of a proper technological set-up and the integration of BI systems. This view is echoed by Mashingaidze and Backhouse (2017), who argued that the ACAP of an organisation varies depending on the source of the information, and this source can be any type of data processing systems, including BI systems. While previous literature motivates a link between ACAP and BI systems, there is inadequate empirical investigation that focuses on characterising the potential relationship between ACAP and BI systems and specifying its direction.

The definitions in the literature of ACAP and BI systems reveal overlapping areas between the two constructs, which can be summarised as follows:

1. Both ACAP and BI systems receive data or information as inputs.
2. Both ACAP and BI systems generate knowledge as output.
3. Both ACAP and BI systems follow a systematic set of actions for processing their inputs.
4. The main objective of both ACAP and BI systems is to generate strategic value and better organisational performance.
5. Both ACAP and BI systems are key components in a modern, efficient, and successful organisation.

Therefore, the present study treats ACAP as being the managerial and organisational facilitator of BI systems. It suggests that ACAP when recognised in organisations can act positively to affect BI systems. In effect, ACAP is treated as being the conceptual form of BI, while BI is considered to be the technical facilitator of ACAP. This proposition will be developed and evaluated in the remaining of this paper.

2.4 Theoretical Association between BI systems Efficiency and Organisational Efficiency.

Organisational efficiency has been typically defined as an indication of the organisation's ability to optimally use its resources in response to its needs, and is measured as a function of inputs used to produce the required outputs (Cummings, 1983). BI systems must be business- and strategy-driven, and must have the ability to improve organisational efficiency (Watson, 2009; Wang and Byrd, 2017; Grezes, 2015). Chan et al. (1997) also pointed to a direct link between BI systems efficiency and organisational efficiency; their theoretical work focused on creating organisational schemes based on successful data processing systems assimilation and their effects. They found that the potential benefit of having a BI system inside an organisation is its ability to offer information to strategic managers to enable them to accelerate the decision making process, leading to better organisational performance and a more efficient data management environment. Organisational efficiency is also perceived to be improved by BI systems according to Turban et al. (2007). The existence of BI systems within organisations could provide members of the organisation, such as employees, partners, and suppliers, with easier access to information and the ability to practically analyse and share data. Naturally, this can have a positive impact on organisational efficiency, compared to competitors lacking such technology, and can also increase profit and productivity. The current research intends to provide experimental evidence to assess this theoretical standpoint.

3. Proposed Research Model and Hypotheses

This paper proposes that ACAP acts as a significant means of input and information facilitation within the organisation; therefore, the capability to absorb and acquire a given input, and transform and assimilate it into a unified required output as a sequence of refined knowledge results in an improved BI system efficiency; BI system efficiency, in turn, leads to better overall organisational efficiency. This proposition leads to the development of four hypotheses, which address the potential positive relationship between ACAP dimensions (as defined by Zahra and George, 2002) and BI systems. The last hypothesis addresses the positive relationship between BI systems efficiency and organisational efficiency. The proposed model and the underlying hypotheses are schematically shown in Figure 2. The proposed model involves one independent construct, ACAP, and two dependent constructs, BI systems efficiency and organisational efficiency. These constructs have been defined in subsections 2.1, 2.2, and 2.4 sections, respectively. In the next two subsections, the five hypotheses are formulated.

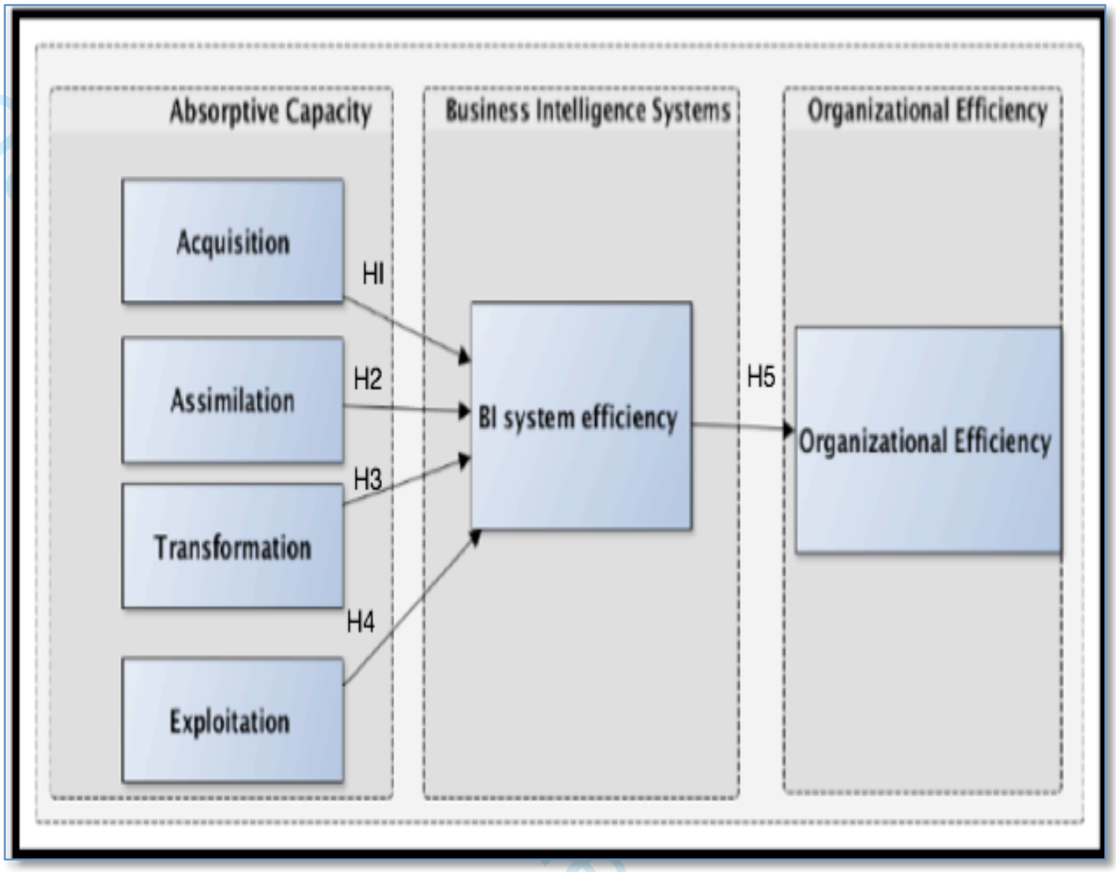

Figure 2. Proposed theoretical model and research hypotheses.

3.1 Proposed Effect of ACAP Dimensions on BI Systems Efficiency

Section 2.3 reviewed literature that motivated a relationship between organisational ACAP and BI systems. Building on this literature, the present study aims to identify the fine-grained effects of ACAP dimensions on BI systems efficiency. In particular, the following four hypotheses are framed:

*Hypothesis 1 (**H1**): There is a positive relationship between 'Acquisition' and BI systems efficiency.*

*Hypothesis 2 (**H2**): There is a positive relationship between 'Assimilation' and BI systems efficiency.*

*Hypothesis 3 (**H3**): There is a positive relationship between 'Transformation' and BI systems efficiency.*

*Hypothesis 4 (**H4**): There is a positive relationship between 'Exploitation' and BI systems efficiency.*

3.2 Proposed Effect of BI Systems Efficiency on Organisational Efficiency

The literature reviewed in Section 2.4 discussed the link between organisational efficiency and BI systems, leading to the following research hypothesis:

*Hypothesis 5 (**H5**): There is a positive relationship between BI systems efficiency and organisational efficiency in companies using BI systems.*

4. Research Methods

The study presented in this paper follows a quantitative methodology. Quantitative data was collected through online surveys that consisted of Likert-scale questions with a sample of (150) respondents, who were senior managers working in telecommunication companies. The data was analysed using Partial Least Squares – Structural Equation Modelling (PLS-SEM). The results of this analysis were used to test the five research hypotheses of this study. The quantitative work reported in this paper builds on previous qualitative research (Al-Eisawi and Serrano, 2019), as explained in subsection 4.1.

In order to test the research hypotheses, suitable items to measure the independent variable (ACAP dimensions) and two dependent variables (BI systems efficiency and Organisational efficiency) were extracted from the literature. PLS-SEM was used to test the validity of the measures and relevance of each to the corresponding construct/variable. These measurement items are discussed in the following sections.

4.1 ACAP Measurement Items

The dimensions of ACAP, acquisition, assimilation, transformation and exploitation are defined as distinct but complementary capabilities that compose a firm's ACAP setting; they represent a set of potentials that a particular organisation may obtain and use to serve its knowledge creation process (Watson, 1989, Zahra and George, 2002).

However, while this operationalisation is valuable and robust, there is much less clarity around how ACAP dimensions could be measured (Gao et al., 2017). With the aim to address this lack of clarity, a qualitative study was performed which involved 22 semi-structured interviews with senior managers in telecommunication companies. The Grounded Theory Methodology was used on the data; this analysis led to the development of a relational model that included the ACAP dimensions along with measurement items that corresponded to each dimension. Details of the process and outcomes of this study can be found in Al-Eisawi and Serrano (2019). The 19 measurement items that were extracted through this process are shown schematically in Figure 3.

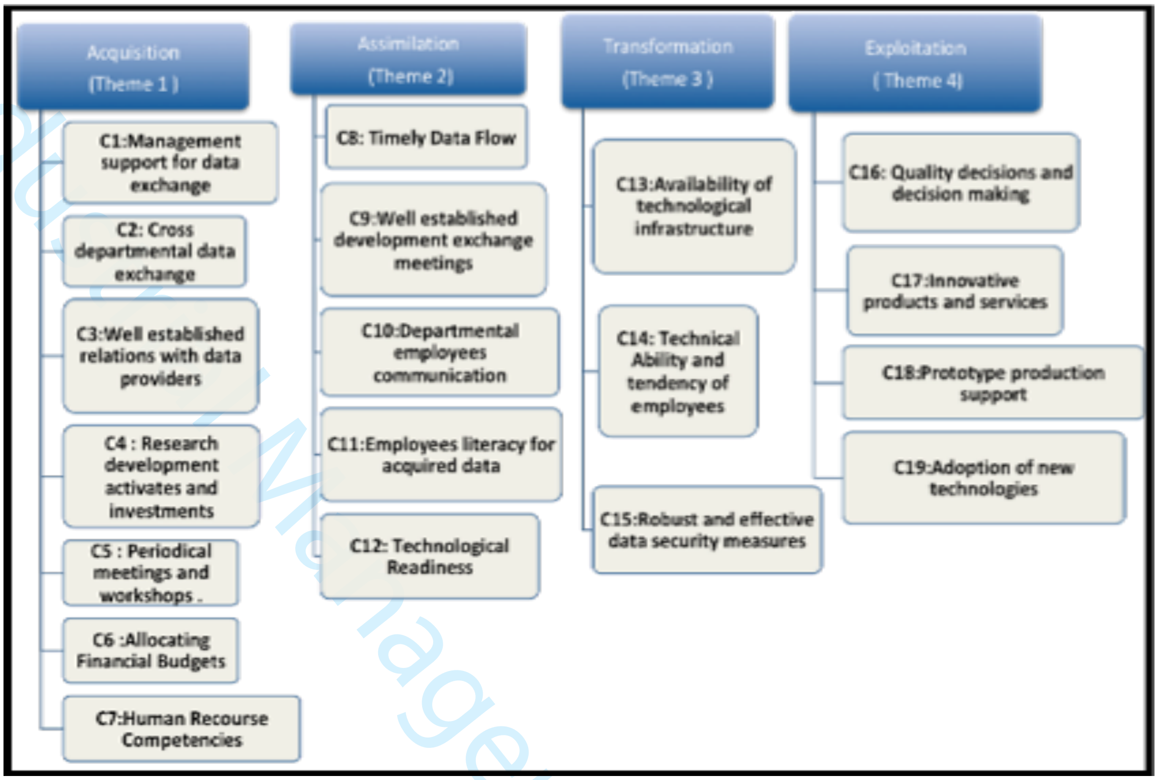

Figure 3. ACAP dimensions and measures (Al-Eisawi and Serrano, 2019).

Building on this work, a literature analysis was performed as part of the present study to determine whether these extracted measures align with previous research. This analysis provided theoretical support to the extracted measures. Table 1 summarises how these qualitatively extracted measures link with previous literature. The quantitative analysis presented in section 5 will serve as the final validation stage of the extracted measures.

Table 1. ACAP measurement items and source

4.2 BI Systems Efficiency Measurement Items

A BI system is treated in the proposed model as a dependent variable that relies on ACAP dimensions in order to operate effectively within organisations. Testing this set of hypotheses relied on measures extracted from previous research; these measures relate to BI systems' potential benefits in areas such as data collection and processing, internal and external communications, time/cost-to-market, decision making, operational costs etc. These measures and the study from which they originated are shown in Table 2.

Table 2. BI Systems Efficiency measurement items and source

4.3 Organisational Efficiency Measurement Items

The organisational efficiency construct relied on five measures extracted from literature, as shown in Table 3.

Table 3. Organisational efficiency measurement items and source

4.4 Data Collection and Sample

A total of 150 responses were received through the use of online surveys. Moreover, a screening question was enclosed within the online survey to confirm the use of BI systems within the interviewed organisations. The quantitative data for this study were collected through online surveys that included Likert-scale questions with senior managers working in telecommunication companies (the survey questions are included in the Appendix). The chosen companies implemented BI systems within their organisation and were bought from a BI systems vendor. Quantitative data was first analysed to ascertain a non-bias response by comparing early responses with later responses. The result for non-bias found no significant bias with the analysed data sample (as detailed in section 5.1). Next, data were analysed using PLS-SEM to determine the validity of the measures and constructs and to test the research hypotheses.

Different departments were engaged in the study. This decision was motivated by the aim to gather information from the perspectives and involvements of different BI systems users, which would lead to a comprehensive and accurate understanding of the usage of BI systems in different organisational performance aspects, and in the decision making process. The decision to engage different key departments was also influenced by the fact that, in technology-based industries, such as the telecommunications industry, many departments rely heavily on the use of BI systems, but at various levels in technical understanding and information detail. That is, the IT department consists of more technically-oriented individuals compared to other departments using BI; for example, the marketing department, finance department, and sales department require the use of the BI in higher management, and more non-technical people rely on dashboards in frequent basis for simple understanding of visual graphs and charts as compared to raw numbers (Liu et al., 2018) . Figure 4 shows the roles held by participants in the current study.

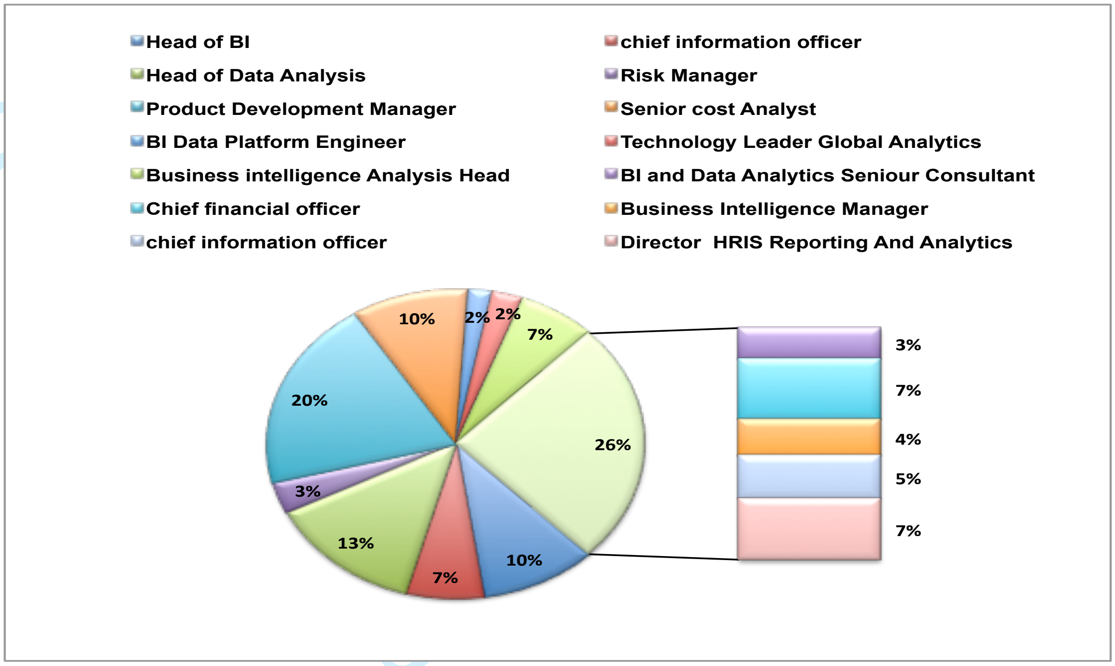

Figure 4. Pie chart of roles held by participants.

This descriptive analysis illustrated in Figure 4 indicates that all surveys targeted senior managers with most (20%) working as product development managers, 13% as head of data analysts, and the rest were chief information officers, directors of human recourses, senior consultants, heads of data acquisition, risk managers, technology leaders, and senior cost analysts. These participants were selected because of seniority and work experience, which would entail a good understanding of organisational features such as ACAP and business systems, and being able to represent different functions in the organisation. The size of the firms was large with an average of 600 employees.

4.6 Data Analysis with Partial Least Squares (PLS)

The initial data entry was undertaken using SPSS, and all data was then uploaded and analysed with SmartPLS software. PLS was used for (i) factor analysis for testing the reliability and validity of indicators and constructs (these results are in sections 5.1-5.2) and (ii) path analysis for testing the relationships and hypotheses (these results are in section 5.3). The analysis performed PLS-SEM. The chosen method was selected because of its ability to deal with relatively small sample sizes (Chin, 1997). In PLS, a measurement item is referred to as an indicator, and the constructs are called latent variables. All indicators in the current study are required to be reflective measures; a reflective measure implies that if that indicator was removed from the set of indicators representing a certain construct, the construct will remain the same, meaning that they are adequate and relevant indicators to measure the latent variable. The direction of interconnection in reflective indicators is always from construct to indicator. The measurement model of this study is schematically shown in Figure 5.

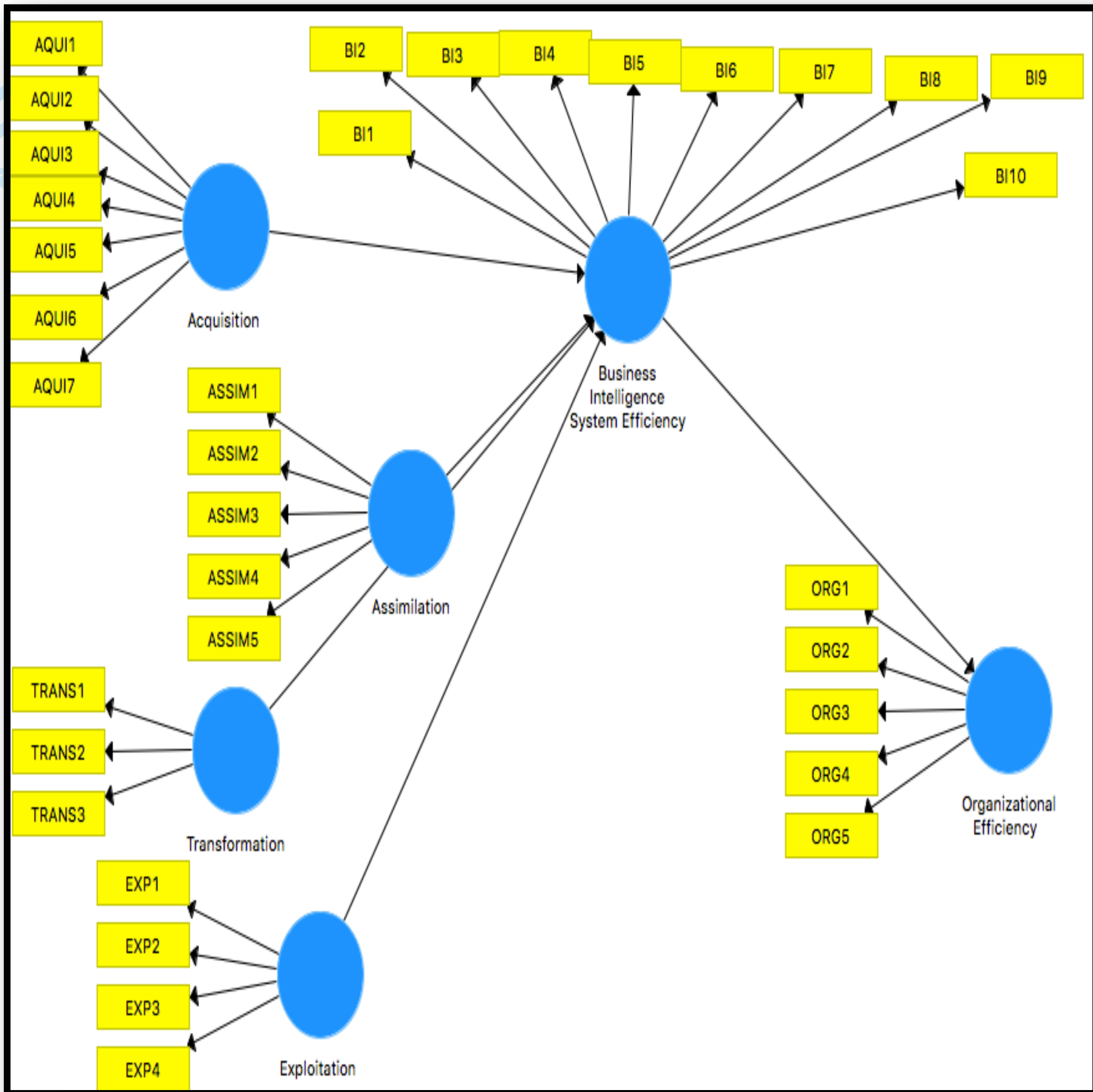

Figure 5. The measurement model using SmartPls 3.0.

5 Results

This section presents the results of the statistical analysis performed to assess reliability and validity of constructs and measurement items (section 5.2), and the results of the research hypothesis testing (section 5.4). Section 5.1 provides the results of the non-response bias evaluation.

5.1 Testing for Non-response Bias

Non-response bias refers to differences occurring due to differences in the time when participants completed the survey (Cascio, 2012). Lambart and Harrington (1990) proposed a process for testing for non-response bias. The process mainly compares the data from respondents who completed the survey at an early stage to data of those who completed it later. In the current study testing for non-bias was conducted by comparing responses received immediately within the first two weeks of sending the online surveys to those who responded after a reminder email was sent to them. The early batch of responses reached a total number of 95 (including 85 valid responses), while the responses received after the reminder was 65 (included 55 valid responses). A number of 12 randomly selected survey questions were used as a measure to compare early and late response data. An independent samples t-test was used to compare the mean scores of each question, with the null hypothesis being that there are no significant differences between the two sets. The results (shown in Table 4.) failed to reject the null hypothesis, indicating that timing of the survey completion (early vs. late) did not produce significant differences in the responses.

Table 4: Nonresponse bias test.

5.2 Reliability and Validity of Measurement Model

Validity and reliability tests for each of the six constructs/variables and their indicators/measurement items were performed. Individual item reliability is indicated by the outer loadings of items on their designated construct. Correlations are measured using outer loadings, showing the extent an item loads onto a construct. Hulland (1999) suggested a minimum loading of 0.4. For this study, all items were above this threshold and were confirmed to be reliable for the measurement of the construct assigned to them (also see next sub-section on convergent validity). In addition, average variance (AVE) was used to indicate construct validity (also see next section on discriminant validity). All six constructs scored a value greater than the threshold of 0.5 (Yoo and Alavi, 2001). Finally, composite reliability (CR) values were calculated for each construct, which ranged from 0.70 to 1.000 for all constructs, suggesting high reliability (Gefen et al., 2011; Gefen et al., 2000, Nunnally and Bernstein, 1994). These results are shown in Table 5.

Table 5: Assessment of the Measurement Model.

Discriminant and convergent validity

Discriminant validity tests were performed to confirm whether a construct better explains the variance of its indicators compared with the other constructs (Fornell and Larcker, 1981). Simply put, the test shows that the indicators of a construct are not highly correlated with other indicators that were designed to measure the other constructs. The approach developed by Fornell and Larcker (1981) was used to evaluate discriminant validity, which involved the square root of the average variance (AVE) for each construct, such that it should be greater than all the other inter-construct correlations (Fornell and Larcker, 1981). As can be seen from Table 6, discriminant validity is confirmed for all constructs in the proposed model.

Table 6: Discriminant Validity.

In addition to discriminant validity, convergent validity was used to determine whether the indicators of a construct are, in fact, related. According to Chin et al., (2003), each indicator loading on its original construct must be above 0.70. Hair et al. (2011) suggested that any items with loading below 0.4 should be disregarded. Factor and cross-loadings were used to examine convergent validity. All measurement items loaded relatively high on their original constructs and low on the other constructs. Consequently, these results confirm that indicated measurement indicators precisely exemplify clear latent constructs. Likewise, the AVE for each construct must be above 0.50 (Bagozzi and Yi, 1988; Dillon at el, 1978). The results are shown in Table 7.

Table 7: Convergent Validity.

Predictive capacity of model

The model's predictive capacity was evaluated using R-square (R^2) values (Hair et al., 2017). The path coefficient significance levels were estimated using the bootstrapping method (Chin, 1998; Henseler et al., 2009) explained in detail in Section 5.3. R^2 is the variance in the endogenous constructs explained by all of the exogenous constructs connected with it (Hair et al., 2017). In the present study, there are two endogenous constructs, BI systems efficiency and organisational efficiency, and the exogenous construct is ACAP. As proposed by Falk and Miller (1992), R^2 should be greater than 0.1 for the c in the structural model, although a better interpretation of R^2 levels should also include the specific research focus and model (Falk and Miller, 1992). The effect of the exogenous construct on the endogenous constructs is considered substantial, moderate, and weak, if they have R^2 values of 0.75, 0.50, or 0.25, respectively (Hair et al., 2017). Table 8 shows the R^2 values associated with each endogenous construct.

Table 8. R-squared values for BI systems efficiency and Organisational efficiency constructs

Bootstrapping and Hypothesis Testing

Bootstrapping is a non-parametric resampling process that relies on evaluating the adaptability of the data by testing the variability of the collected sample without the use of parametric assumptions (Efron and Tibshirani, 1994), and it is critical to the process of building a robust theory or model. Running the PLS-SEM bootstrap test examined the scores of the significance of the path coefficients, and assessed the properties of the structural model. T-statistics were used to test the significance of the path coefficients. Conversely, the study followed the rule proposed by Hair et al. (2013) in which t-statistic

greater than 1.96 was considered significant for path coefficients at the 95% confidence level. To test the hypotheses presented in Section 3, regression weights were evaluated, and path coefficients between every two constructs related to each hypothesis were measured to allow inferences regarding the strength of the relationships of the model constructs.
As can be seen in Table 9., all hypotheses were supported, such that the relationships between the constructs were found to be significant.

Table 9. Hypothesis testing, path coefficient, T values, and P values

Based on these results, it is inferred that the ACAP dimensions, Acquisition, Assimilation, Transformation, and Exploitation, have a positive effect on BI systems efficiency as proposed in the research model. In turn, the analysis indicates a significant effect of BI systems efficiency on organisational efficiency. The final model in Figure 6 illustrates the confirmed relationships and effects between these constructs.

Figure 6. Confirmed model

6. Discussion

The research conducted PLS-SEM aiming to test the connection between ACAP extracted measures and their effect on BI systems efficiency, and testing another relation between the effect of BI systems efficiency on organisational efficiency. Recent studies have followed this approach to explore related research questions, such as Rehman et al. (2020). PLS-SEM tested the reliability of the indicators/measures of ACAP, BI systems efficiency, and organisational efficiency. Indicator reliability resulted in overall strong loading across all items. The three constructs (ACAP, BI systems efficiency, and organisational efficiency) were tested for consistency using both discriminant validity and convergent validity; convergent validity results confirm that the indicators clearly measure the constructs, while discriminant validity confirms that a construct's indicators do not relate to any other construct. The assessment of the model in PLS-SEM showed significant effects between the constructs, providing support to the five hypotheses of this study. These effects are discussed in the next two sections.

6.1 Effects of ACAP Dimensions on BI Systems Efficiency

The results of this study provide further support to the argument that ACAP as an organisational capability has a positive role in strengthening the value attained from implemented BI systems (Chen et al., 2012). Adopting BI systems requires large expenditure and investments in state of the art infrastructure and technology. Managerial decisions to assist firms in acquiring, assimilating, transforming, and exploiting knowledge are necessary for more efficient BI systems.

The acquisition dimension of ACAP revealed a positive effect on BI systems efficiency. Acquisition refers to the ability to recognise, obtain, and grasp the external knowledge required for organisational growth (Lane and Lubatkin, 1998). The tested indicators reflecting the acquisition dimension of ACAP (well-established relations with data providers, periodical meetings and workshops with experts, and allocating financial budgets for research development activities) were all found have a reasonable potential positive effect on enhancing data acquisition inside organisations. Also, key acquisition indicators such as extensive internal and external communication channels between employees, group meetings, and training can be encouraged by departmental efforts.

In line with the proposed ACAP indicators, BI systems efficiency can be highly influenced by the prior technical knowledge, and technological tendency available in managers. This is necessary as a defense tool used for successful organisational competitiveness. Consequently, this can encourage the degree of information sharing across business units and the ability of managerial teams to assimilate the given BI system requirements which, in turn, can lead to better and effective decision-making process generated through both ACAP dimensions and BI systems. Finally, the study added a final subordinate contribution by proposing that the existence of BI systems within organisations can provide significant members of organisations such as employees, partners, and suppliers with more efficient access to information, as well as providing a practical data analysis and sharing environment. This can be performed by always reflective and effective policies and organisational design structures that assist the process of knowledge transformation and protection, and, as such, achieving better organisational efficiency compared with other competitors (Lovitts, 2005).

6.2 Effect of BI Systems Efficiency on Organisational Efficiency

Building on the quantitative results, the proposition relating to (H5) was supported and suggested a positive effect from BI system efficiency on the overall organisational efficiency. The tested BI system efficiency indicators, and organisational efficiency indicators in the current research also confirmed this. When BI systems are reliable as a key data management system, they can effectively act as decision-making boosters leading to an overall organisational efficiency reflected in data-driven organisations (Kwon et al., 2014; Shin, 2015; Shin 2013, Esteves and Curto, 2013; Shin 2014). Subsequently, this proposition can begin with evaluating the measures of ACAP that are available within organisations. Decision makers in Telecommunication firms in many cases tend to rapidly adopt BI systems without any consideration for the ACAP indicators proposed and analysed thoroughly in the current study.

Building on the current research final results, the study proposes the following organisational aspects that can benefit when sustaining an adequate level of BI systems efficiency:

- Organisational success will be higher compared with key competitors in the same industry.
- Organisational ownership of market share compared with key competitors in the same industry.
- Organisational development is at a quicker pace compared with key competitors in the same industry.
- Increasing organisational profit compared with key competitors in the same industry.
- Organisational product and services innovation is better compared with key competitors in the same industry.

BI systems efficiency is essential as a strategic source of high value, particularly if an organisation seeks to fully exploit BI systems facilities and capabilities for its strategic improvement in different departments (Beath et al., 2012; Mayer-Schönberger and Cukier, 2013; Galbraith, 2014).

7.1 Theoretical Contributions

The study adds to our theoretical understanding of ACAP dimensions, BI systems efficiency and organisational efficiency, and their interactions. It does so by complementing the rich body of theoretical research with empirical data derived from the domain of telecommunications.

In particular, it offers additional support to research that treats ACAP as a ‘capability’ rather than an asset (Winter, 2000, Gao et al., 2017). Furthermore, it aligns well with studies that stress the dynamic nature of ACAP as a capability, reflecting the element of change within an organization (Apriliyanti and Alon, 2017; Gao et al., 2017; Lin et al. 2016). Our study proposes that the four organisational capabilities of knowledge acquisition, assimilation, transformation, and exploitation coherently interact to present ACAP as a dynamic capability that induces the firm's ability to generate and employ the knowledge required to shape broad organisational capabilities that foster organisational change and development (e.g., technological, technical, dissemination, marketing and innovation). These varied capabilities contribute in building well founded origins that can assist in attaining a competitive advantage that yields superior and efficient performance when operating advanced systems such as BI systems (Elbashir et al., 2011). It is thus very important to state that ACAP supports to open the black box that has controlled previous research on organisational and strategic change (Zahra and George, 2002).

The study also provides a finer-grained insight into ACAP dimensions, by, first, qualitatively extracting 19 indicators of ACAP (Al-Eisawi and Serrano, 2019), then, tracing their validity in past literature, and, finally, further validating these indicators using factor analysis. This set of indicators could help researchers in understanding how ACAP dimensions can be practically realised and inform their efforts to develop measurement instruments for ACAP and its dimensions (Flatten et al., 2011). Extending previous theory-driven research in the bi-directional link between ACAP and BI systems, it demonstrates how each ACAP dimension impacts the performance of BI systems within firms. It also provides evidence to support the proposition that ACAP and BI systems are highly related, and, arguably, the conceptual or technological manifestation of each other. Finally, refining our understanding of how BI systems can significantly contribute to organisational efficiency, this research identifies the particular elements of BI systems that are important in creating value for the company.

7.2 Practical Contributions to Industry

This study provides recommendations in how managers could practically determine and measure their firm's ability to realise the benefits of the behavioral and non-technical aspect of ACAP offered as a set of potential dynamic capabilities. It stresses the need for managers and executives to pay more attention to positive organisational outcomes that arise as a result of implementing the extracted proposed ACAP indicators presented in the model. It is advised that managers are aware of the ACAP dimensions, relating to acquisition, assimilation, transformation, and exploitation of data and knowledge. These dimensions can act as a set of requirements before committing to the substantial expenditure associated with deploying BI systems, or any state-of-the-art data processing software.

Setting up a successful and efficient BI systems-centered environment has been typically linked with the availability and amount of financial spending and on various technological-based factors, such as having the appropriate IT infrastructure, or having the right technology tools for determining how and when to analyse data (Liang and Liu, 2018). However, the present study attempts to shift this paradigm, showing that ACAP measures underlie the success and efficiency of BI systems. That is, it recommends that a thriving environment for BI systems should not only rely on the technical and technological tools and processes. The desired data-driven environmental success might be attained by the efforts of strategic managers in evaluating their ACAP initiatives and measures. The proposed model can guide such efforts. So, it is proposed that senior managers, particularly in technology-oriented industries, should have a reasonable set of assessed measures that are proposed to evaluate their organisational weakness and strengths from an ACAP perspective. The extracted measures in this model can offer foundations for shaping where and how further potential organisational assets can be leveraged. While viewing the extracted measures managers, strategic data acquisition managers, senior data analysts, and even human resource managers can consider what they already have from these sets, and what is missing or needs to be further discovered. Similarly, a secondary practical contribution lies in offering a validated and practical set of measures on BI systems efficiency and assimilation, which could be used to improve organisational efficiency.

The study provided insight into how managers can tackle their strategic challenges for generating profit and being able to respond to changing business environments by the joint and focused consideration of aspects that relate to IT, business practices and processes, analytical tools and skills needed.

8. Limitations and Future Work

A possible limitation of the current study is the use of a relatively small sample size for the quantitative data collection and analysis, as well as the fact that data came from a single industry. Future work will include a larger sample engaging senior managers across different technology-based industries. It is also important to determine the variations between knowledge-intensive industries such as the telecommunications and banking industries, and other less knowledge-intensive industries, as well the differences between companies at different stages of maturity. This could reveal the relative value and impact of ACAP. Additional future work will also include empirical research on the 'dynamic' nature of the four ACAP dimensions, such as analysing how they can change while the industry is evolving and changing.

References

Al-Eisawi, D and Serrano, A (2019). "Absorptive Capacity and its Potential Role in Supporting Organisational knowledge Creation: A Qualitative Approach". Proceeding of the 24th UK Academy for Information Systems UKAIS Annual Conference, Oxford University, Oxford, UK, and 9th April – 10th April.

Apriliyanti, Indri Dwi and Alon, Ilan, (2017). "Bibliometric analysis of absorptive capacity," International Business Review, Elsevier, vol. 26(5), pages 896-907.

Arthur H. Gilbert, Roger Alan Pick, Sidne Gail Ward(2000) ."Perennial management data systems issues in US manufacturing firms", Industrial Management & Data Systems, Vol. 100 Issue: 7, pp.325-329, https://doi.org/10.1108/02635570010304815

Bagozzi, R. P., and Yi, Y. (1988) "On the evaluation of structural equation models". Journal of the Academy of Marketing Science, 16(1), 74–94.

Beath, C., Becerra-Fernandez, I., Ross, J. Short, J.(2012)Finding value in the data explosion. MIT Sloan Management Review, 53, (4), 18-20.

Bollen, K. A. (1984). Multiple indicators: Internal consistency or no necessary relationship? Quality and Quantity 18, 377-385.

Bollen, K., and Lennox, R. (1991) "Conventional wisdom on measurement: A structural equation perspective". Psychological Bulletin, 110(2), 305-314.

Brown. T (2006). Confirmatory factor analysis for applied research. New York: Guilford.

Chen, W. and Hirschheim, R. (2004). A paradigmatic and methodological examination of information systems research from 1991 to 2001. *Information Systems Journal*, 14(3), pp.197-235.

Cooper, V., and Molla, A. (2017) "Information systems absorptive capacity for environmentally driven IS-enabled transformation: IS-environmental absorptive capacity. Information Systems Journal, 27(4), 379-425. doi:10.1111/isj.12109

Cummings, LL. 1983. "Organizational effectiveness and organizational behavior: A critical perspective". In Organizational Effectiveness: A Comparison of Multiple Models, Edited by: Cameron, KS and Whetten, ADavid. 187–203. USA: Academic Press Inc

Dillon, W., Goldstein, M. and Schiffman, L. (1978) "Appropriateness of Linear Discriminant and Multinomial Classification Analysis in Marketing Research ". Journal of Marketing Research, 15(1), p.103.

Efron, B. and Tibshirani, R.J. (1994) "An Introduction to the Bootstrap ". Chapman and Hall/CRCthe, UK.

Elbashir, M. Z., Collier, P. A., and Sutton, S. G. (2011) "The role of organisational absorptive capacity in strategic use of business intelligence to support integrated management control systems ". The Accounting Review, 86(1), 155-184. Doi: 10.2308/accr.00000010.

Elbashir, M. Z., P. A Collier, and M. J. Davern. (2008). " Measuring the effects of business intelligence systems: The relationship between business process and organisational performance ". International Journal of Accounting Information Systems 9: 135 – 153.

Fitriana, R., Eriyatno, and Djatna .(2011)," Progress in Business Intelligence System research a Literature Review", International Journal of Basic and Applied Sciences IJBAS-IJENS Vol: 11 No: 03.

Foley, E., Guillemette, M. G.(2010). What is Business Intelligence? International Journal of Business Intelligence Research, Vol. 1, No. 4, 2010, pp. 1–28.

Gao, Shijia, Yeoh, William, Wong, Siew Fan and Scheepers, Rens 2017, A literature analysis of the use of absorptive capacity construct in IS research, International journal of information management, vol. 37, no. 2, pp. 36-42, doi: 10.1016/j.ijinfomgt.2016.11.001.

Hair, J. F., Hollingsworth, C. L., Randolph, A. B., & Chong, A. Y. L. (2017). An updated and expanded assessment of PLS-SEM in information systems research. Industrial Management & Data Systems, 117(3), 442–458.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. Journal of Marketing Theory and Practice, 19(2), 139–151.

Hair, J.F., C.M. Ringle, and M. Sarstedt. (2013). Partial least squares structural equation modelling: Rigorous applications, better results and higher acceptance. Long Range Planning 46: 1 – 12.

Hair, J.F., C.M. Ringle, and M. Sarstedt.(2012). Partial least squares: The better approach to structural equation modeling. Long Range Planning 45: 312 – 319.

Harris, R., and Yan, J. (2018) The measurement of absorptive capacity from an economics perspective: Definition, measurement and importance: Measurement of absorptive capacity. Journal of Economic Surveys, doi:10.1111/joes.12296

Heath, H. and Cowley, S. (2004) 'developing a grounded theory approach: A comparison of Glaser and Strauss; 14725778', International journal of nursing studies, 41(2), pp. 141-150.

Hofstede, G. (2001). Culture's Consequences: Comparing Values, Behaviours, Institutions, and Organisations across Nations, 2nd ed. Sage, Thousand Oaks, CA.http://dx.doi.org/10.2307/20159255

Hotho, J.J, Becker- Ritterspach, F and Saka-Helmhout, A .(2011). Enriching Absorptive Capacity through Social Interaction, British Journal of Management, Vol. 23, 383-401.

Howson, C (2007). Successful Business Intelligence, McGraw-Hill Professional Publishing, Emeryville, USA. Available from: ProQuest EBook Central.

Hulland, J. (1999). Use of partial least squares (PLS), Strategic management research: A review of four recent studies. Strategic Management Journal, 20(4), 195–204.

Jordan Z., Rainer, R. K. and Marshall, T. E. (2008). ‘Business Intelligence: An Analysis of the Literature’, Information Systems Management, 25(2), pp. 121–131. doi: 10.1080/10580530801941512.

Kim, L. (1998). Crisis Construction and Organisational Learning: Capability Building in catching up at Hyundai Motors, Organisation Science, and Vol. 9. No 4.

Kim, L. (1999). Building Technological Capability for Industrialization: Analytical Framework and Korea’s Experience, Industrial and Corporate Change, Vol. 8. Nov.

Kostopoulos, K., Papalexandris, A., Papachroni, M. and Ioannou, G. (2011). Absorptive capacity, innovation, and financial performance. *Journal of Business Research*, 64(12), pp.1335-1343.

Kumar, A and Palvia, P (2001). "Key data management issues in a global executive information system", Industrial Management & Data Systems, Vol. 101 Issue: 4, pp. 153-164, https://doi.org/10.1108/02635570110390099

Kwon, O., Lee, N., & Shin, B. (2014). Data quality management, data usage experience and acquisition intention of big data analytics. International Journal of Information Management, 34(4), 1–22.

Lane, J.P. Koka, R.B and Pathak, S. (2006) .The Reification of Absorptive Capacity: A Critical Review and Rejuvenation of the Construct, Academy of Management Review, Vol. 31, No. 4, 833-863.

Lin, C , Tan, B and Changes’ (2002). "The critical factors for technology absorptive capacity", Industrial Management and Data Systems, Vol. 102 Issue: 6, pp. 300-308.

Lin, T.-C., Chang, C.L.-h. and Tsai, W.-C. (2016), "The influences of knowledge loss and knowledge retention mechanisms on the absorptive capacity and performance of a MIS department", Management Decision, Vol. 54 No. 7, pp. 1757-1787. https://doi.org/10.1108/MD-02-2016-0117.

Liu, X., Zhao, H. and Zhao, X. (2018). "Absorptive capacity and business performance: the mediating effects of innovation and mass customization", Industrial Management and Data Systems, Vol. 118 No. 9, pp. 1787-1803.

Lovitts, E. (2005). Being a good course taker is not enough: a theoretical perspective on the transition to independent research AU - Studies in Higher Education, 30(2), pp. 137-154.

McBride, N., (2015). Virtuous Business Intelligence. *International Journal of Business Intelligence Research*, 6(2), pp.1-17.

Nabeel Rehman, Sadaf Razaq, Ammara Farooq, Nayab Mufti Zohaib & Mohammad Nazri (2020), Information technology and firm performance: mediation role of absorptive capacity and corporate entrepreneurship in manufacturing SMEs, Technology Analysis & Strategic Management, DOI:

Pittz, T. G., Intindola, M. L., Adler, T., Rogers, S., and Gard, C. (2018). Collaborating smartly: The role of open strategy in absorptive capacity: Journal of Small Business Management, doi: 10.1111/jsbm.12430.

Popovič A, Puklavec B, Oliveira T (2019) ."Justifying business intelligence systems adoption in SMEs: Impact of systems use on firm performance ".Industrial Management & Data Systems, 119(1), 210-28.

Ringle CM, Wende S, Will A (2005). SmartPLS 2.0 M3. University of Hamburg, Hamburg, Germany. http://www.smartpls.de

Roberts, Galluch, Dinger and Grover (2012). Absorptive Capacity and Information Systems Research: Review, Synthesis, and Directions for Future Research. MIS Quarterly, 36(2), p.625.Rumelt RP. 1987. Theory, strategy, and entrepreneurship.

Stock, G., Greis, N. and Fischer, W., 2001. Absorptive capacity and new product development. The Journal of High Technology Management Research, 12(1), pp.77-91.

Turban, E., et al., (2007). Decision Support and Business Intelligence Systems, 8th edition, Prentice Hall, New Jersey

Wang Y, Byrd TA. (2017). Business analytics-enabled decision-making effectiveness through knowledge absorptive capacity in health care. J of Knowledge Management, 21(3), 517-39.

Watson, H. J. (2009). Tutorial: Business Intelligence – Past, Present, and Future. Communications of the Association for Information Systems, 25, pp-pp.

Winter, G. (2000). A Comparative Discussion of the Notion of 'Validity' in Qualitative and Quantitative Research. The Qualitative Report, 4(3), 1-14. Retrieved from https://nsuworks.nova.edu/tqr/vol4/iss3/4

Yoo, Y., and Alavi, M. (2001). Media and Group Cohesion: Relative Influences on Social Presence, Task Participation, and Group Consensus. MIS Quarterly, 25(3), 371-390. Doi: 10.2307/3250922

Zahra, S. and George, G. (2002). Absorptive Capacity: A Review, Reconceptualization, and Extension, Academy of Management Review, Vol. 27, No. 2.

Zhang, Y., and Wildemuth, B. M. (2009). "Qualitative analysis of content. In B. Wildemuth (Ed.), Applications of Social Research Methods to Questions in

Information and Library Science "(pp. 308-319). Westport, CT: Libraries Unlimited.

Zheng W, Wu YJ, Chen L (2018). Business intelligence for patient-centeredness: A systematic review. Telematics and Informatics, 35(4), 665-76.

Loon M . (2019) Knowledge management practice system: Theorising from an international meta-standard. Journal of Business Research, 94, 432-41.

Liang T, Liu Y (2018) Research Landscape of Business Intelligence and Big Data analytics: A bibliometric study. Expert Systems with Applications, 111, 2-10.

Appendix

Quantitative Survey

The surveys were analysed according to the number of points on each scale taken from the original scales, where applicable.

Question: To what extent you agree or disagree with the following statements?

ACAP Measures

ACAP Acquisition

- Q1) Management support for data exchange exists in my organisation.
- Q2) Departmental data management exists in my organisation.
- Q3) There is support for well-established relations with data providers.
- Q4) Research development activates, and investments exist in my organisation.
- Q5) Periodical Meetings and workshops with experts occur in my organisation.
- Q6) Human resource competencies are highly encouraged.
- Q7) My organisation does allocate financial budgets supporting different initiatives for data exchange purposes.

ACAP Assimilation

- Q8) Timely data flow is organised and noticeable in my organisation.
- Q9) Well-established development exchange meetings occur in my organisation.
- Q10) Departmental employee's communication occurs in my organization.
- Q11) In my organisation employees have a degree of literacy regarding acquired data from other resources
- Q12) Technological readiness is apparent in employees in terms of data processing competencies.

ACAP Transformation

- Q13) in my organisation, there is adequate availability of technological infrastructure.
- Q14) in my organisation technical ability and tendency of employees is highly present.

- Q15) Robust, and effective data security measures are implemented in my organisation.

ACAP Exploitation

- Q16) in my organisation, there is an acceptable degree of quality decisions and decision-making.
- Q17) in my organisation exists apparent innovative products and service.
- A1) we have prototype production support.
- Q19) My organisation always seek the adoption of new technologies.

BI systems Efficiency

Question: To what extent you agree or disagree with the following statements?

- Q20) BI systems improved data collection from different systems resources using BI technical tools.
- Q21) In my organisation using the BI system and BI technical tools increased employee productivity.
- Q22) BI system improved data collection from different systems resources.
- Q23) BI systems added enhanced coordination between partners, suppliers, and our organisation internally.
- Q24) BI systems lowered the cost of transactions with business partners/suppliers and data providers.
- Q25) BI system improved data processing and storage using data warehouse and OLAP online analytical processing tools.
- Q26) BI systems improved the efficiency of internal processes.
- Q27) BI systems in my organisation lowered operational cost.
- Q28) BI systems reduced the time and cost-to-market products/services.
- Q29) BI systems reduced the cost of effective decision-making.

Organisational Efficiency:

Question: To what extent you agree or disagree with the following statements?

- Q30) Organizational success in our organisational is higher compared with key competitors in the same industry.
- Q31) We have increased organisational ownership of market share compared with key competitors in the same industry.
- Q32) Organizational development in our organisations is at a quicker pace compared with key competitors in the same industry.
- Q33) We have Increasing organisational profit comparing with key competitors in the same industry.
- Q34) Organizational product and services innovation is better compared with key competitors in the same industry.

Table 1. ACAP measurement items and source.

Construct	Indicators	Item	Source/ *Results from qualitative Open Coding Categories and literature review*
Acquisition	AQUI1	Management support for data exchange exists in organisations	Elbashir et al. (2008)
	AQUI2	Departmental data management	(Silva et al., 2014)
	AQUI3	Well-established relations with data providers	(Pittz et al., 2018)
	AQUI4	Research development activates and investments	(Floor, Cooper and Oltra, 2018)
	AQUI5	Periodical Meetings and workshops with experts	(Cooper and Molla, 2016)
	AQUI6	Human Resource Competencies	(Silva et al., 2014)
	AQUI7	Allocating Financial Budgets	(Elbashir et al. 2008)
Assimilation	ASSIM1	Timely Data Flow	
	ASSIM2	Well-established development exchange meetings	(Popovič, Puklavec, and Oliveira, 2019)
	ASSIM3	Departmental employees communication	(Elbashir et al. 2008)
	ASSIM4	Employee’s literacy for acquired data	(Kostopoulos et al., 2011)
	ASSIM5	Technological Readiness	(Pittz et al., 2018)
Transformation	TRANS1	Availability of technological infrastructure	(Popovič, Puklavec, and Oliveira, 2019)
	TRANS2	Technical ability and the tendency of employees	(Pittz et al., 2018)
	TRANS3	Robust and effective data security measures	(Kostopoulos et al., 2011)
Exploitation	EXP1	Quality decisions and decision-making	(Elbashir et al. 2008)
	EXP2	Innovative products and service	(Liang and Liu, 2018)
	EXP3	Prototype production support	(Laursen and Salter, 2006)
	EXP4	Adoption of new technologies	(Elbashir et al. 2008)

Table 2. BI Systems Efficiency measurement items and source

Construct	Indicators	Items	Source
Business Intelligence System efficiency	BI1	BI system improved data collection from different systems resources using BI technical tools.	(Wixom and Watson, 2010)
	BI2	BI System increased employee's productivity	(Foley and Guillemette, 2010)
	BI3	BI systems added enhanced coordination between partners, suppliers, and our organisation.	(Liang and Liu, 2018)
	BI4	BI systems enhanced the coordination between employees and management	(Wang and Byrd, 2017)
	BI5	BI systems lowered the cost of transactions with business partners/suppliers, data providers	(Watson, 2009)
	BI6	BI system improved data processing and storage using data warehouse and OLAP online analytical processing tools	(Elbashir et al. (2008)
	BI7	BI system improved the efficiency of internal processes	(Olaru, 2014)
	BI8	BI system lowered operational cost	(Wang and Byrd, 2017)
	BI9	BI system reduced the time and cost-to-market products/services	(Watson, 2009)
	BI10	BI system reduced the cost of effective decision-making	(Wixom and Watson, 2010)

Table 3. Organisational efficiency measurement items and source

Construct	Construct	Items	Source
Organisational Efficiency	ORG1	Organisational success comparing with key competitors in the same industry.	(Watson, 2009)
	ORG2	Organisational ownership of market share compared with key competitors in the same industry	(Elbashir et al. 2008)
	ORG3	Organisational development at a quicker pace compared with key competitors in the same industry	(Foley&Guillemette, 2010)
	ORG4	Increasing Organisational profit comparing with key competitors in the same industry	(Turban et al. 2007)
	ORG5	Organisational products and services innovation comparing with key competitors in the same industry.	(Pittz et al., 2018)

Table 4: Nonresponse bias test.

Arbitrarily survey question is chosen	MEAN Early patch N=85	MEAN The second patch answered after a reminder email N=65	Statistical Significance/Difference between two means/Alpha = >0.05 otherwise no difference
Q9) Well-established development exchange meetings occur in my organisation	1.73	1.66	0.98
Q3) There is support for well-established relations with data providers	2.00	2.44	0.92
Q13) In my organisation there is an acceptable availability of technological infrastructure	1.30	1.31	0.99
Q22) BI system improved data collection from different systems resources using BI technical tools.	2.11	2.78	0.88
Q21) In my organisation using BI System and BI technical tools increased employee productivity.	2.90	2.40	0.91
Q28) BI systems reduced the time and cost-to-market products/services.	1.51	1.78	0.95
Q33) We have Increasing organisational profit comparing with key competitors in the same industry.	2.66	2.71	0.99
Q32) Organisational development in our organisations is at a quicker pace compared with key competitors in the same industry.	1.54	1.00	0.90
Q27) BI systems in my organisation lowered operational costs .	1.48	2.43	0.83
Q17) In my organisation an apparent innovative products and services production exists .	2.00	2.89	0.84
Q19) my organisation always seeks the adoption of new technologies	1.32	1.31	0.99
Q26) BI systems improved the efficiency of internal operations.	4.00	4.33	0.94

Table 5: Assessment of the Measurement Model.

Constructs	Outer Loadings	AVE (Average Variance)	CR (Composite Reliability)
Acquisition	**0.8051**	**0.5679**	**0.9211**
	0.8746		
	0.8968		
	0.7263		
	0.6981		
	0.8728		
	0.7937		
Assimilation	**0.7961**	**0.7856**	**0.8903**
	0.7863		

	0.8677		
	0.7622		
	0.7161		
Transformation	0.7397	0.7649	0.8089
	0.7715		
	0.7837		
Exploitation	0.8227	0.8042	0.8806
	0.8107		
	0.8616		
	0.7218		
BI Systems Efficiency	0.7061	0.8422	0.9609
	0.8941		
	0.8164		
	0.8609		
	0.8903		
	0.8595		
	0.8404		
	0.8715		
	0.8627		
	0.8205		
Organisational Efficiency	0.8043	0.8257	0.9148
	0.8808		
	0.8112		
	0.8012		
	0.8313		

Table 6: Discriminant Validity.

Construct	Acquisition	Assimilation	Transformation	Exploitation	BI Systems efficiency	Organisational Efficiency
Acquisition	0.8274					
Assimilation	0.2483	0.7565				
Transformation	0.2775	0.3183	0.8714			
Exploitation	0.3483	0.2483	0.1483	0.8645		
Business Intelligence systems efficiency	0.1483	0.3183	0.1453	0.2483	0.8405	
Organisational Efficiency	0.2775	0.3048	0.2507	0.1569	0.1483	0.8600

Table 7: Convergent Validity

Item	Acquisition	Assimilation	Transformation	Exploitation	BI System Efficiency	Organisational Efficiency
AQUI1	**0.8051**	0.2857	0.5373	0.3699	0.4244	0.2973
AQUI2	**0.8746**	0.2480	0.322	0.015	0.4292	0.2561
AQUI3	**0.8968**	0.3309	0.4768	0.3192	0.3547	0.2415
AQUI4	**0.7263**	0.3655	0.2371	0.3320	0.3442	0.2962
AQUI5	**0.6981**	0.3646	0.4479	0.3475	0.2928	0.2594
AQUI6	**0.8728**	0.2732	0.3866	0.3179	0.3143	0.2921
AQUI7	**0.7937**	0.2839	0.4514	0.2337	0.3371	0.4371
ASSIM1	**0.3455**	**0.7960**	0.2179	0.2143	0.4234	0.4381
ASSIM2	**0.3188**	**0.7863**	0.3468	0.3224	0.3225	0.4324
ASSIM3	**0.3771**	**0.8677**	0.4263	0.3004	0.3416	0.2649
ASSIM4	**0.2727**	**0.7622**	0.125	0.2249	0.2299	0.3016
ASSIM5	**0.2677**	**0.7161**	0.3416	0.3263	0.3656	0.2416
TRANS1	0.3981	0.3270	**0.7397**	0.3719	0.3686	0.2744
TRANS2	0.3025	0.3293	**0.7715**	0.2492	0.3121	0.3057
TRANS3	0.2528	0.2839	**0.7837**	0.3839	0.2172	0.2984
EXP1	0.2212	0.2173	0.1632	**0.8227**	0.2540	0.2056
EXP2	0.3671	0.3391	0.5013	**0.8107**	0.4002	0.3692
EXP3	0.3092	0.3182	0.2933	**0.8616**	0.347	0.068
EXP4	0.3796	0.226	0.4995	**0.7218**	0.3545	0.2407
BI1	0.2180	0.1689	0.1973	0.1704	**0.7061**	0.3135

BI2	0.4712	0.2031	0.4514	0.3286	**0.8941**	0.5782
BI3	0.3436	0.2486	0.3182	0.3012	**0.8164**	0.3021
BI4	0.2661	0.2844	0.1676	0.2357	**0.8609**	0.2883
BI5	0.4024	0.3170	0.3689	0.2675	**0.8903**	0.2084
BI6	0.3355	0.8877	0.3617	0.2632	**0.8595**	0.3664
BI7	0.5325	0.024	0.4129	0.3335	**0.8404**	0.4570
BI8	0.3188	0.3112	0.3866	0.2741	**0.8715**	0.2888
BI9	0.3016	0.3135	0.3757	0.3621	**0.8627**	0.3788
BI10	0.2771	0.1832	0.3623	0.1960	**0.8205**	0.1287
ORG1	0.3207	0.3021	0.4356	0.3084	0.3122	**0.8043**
ORG2	0.2671	0.2728	0.3594	0.2181	0.2364	**0.8808**
ORG3	0.3065	0.2084	0.2968	0.2970	0.1948	**0.8112**
ORG4	0.3198	0.2022	0.3794	0.3843	0.2691	**0.8012**
ORG5	0.3689	0.3370	0.2924	0.3561	0.2272	**0.8313**

Table 8. R-squared values for BI systems efficiency and Organisational efficiency constructs

"Endogenous " Constructs	R Square	ACAP Impact on Constructs
Business Intelligence systems efficiency	0.753	Substantial
Organisational Efficiency	0.560	Moderate

Table 9. Hypothesis testing, path coefficient, T values, and P values

Hypothesis	Effect	Path Coefficient	T-Statistics	Supported /Not ‘Supported
H1	Acquisition -> BI systems efficiency	0.4188	4.8876	Supported
H2	Assimilation -> BI systems efficiency	0.1659	2.4963	Supported
H3	Transformation -> BI systems efficiency	0.1659	3.0721	Supported
H4	Exploitation BI systems efficiency	0.1559	3.1436	Supported
H5	BI systems efficiency -> Organisational efficiency	0.6310	7.5298	Supported

The Effect of Organisational Absorptive Capacity on Business Intelligence Systems Efficiency and Organisational Efficiency

Abstract

Purpose: BI systems (that is, technology and procedures that transform raw data into useful information for managers to enable them to make better and faster decisions) have enormous potential to improve organisational efficiency. However, given the high expenditure involved in the deployment of these systems, the factors that will enable their successful integration should be thoroughly considered and assessed before these systems are adopted. Absorptive Capacity (ACAP) is the ability of organisations to gather, absorb, and strategically influence new external information, and, as such, there is a strong theoretical connection between ACAP and BI systems. This research aims to empirically investigate the relationship between the dimensions underpinning ACAP (that is, acquisition, assimilation, transformation and exploitation) and whether and how they affect the efficiency of BI systems, which, in turn, can enhance organisational efficiency.

Design/methodology/approach: this study formulates five hypotheses addressing the effect of ACAP dimensions on BI systems efficiency, and the effect of BI systems efficiency on organisational efficiency. It synthesises previous qualitative work and current research to derive sets of measures for each of the key constructs of the study. It follows a quantitative methodology, which involves the collection of survey data from senior managers in the telecommunications industry and the analysis of the data using Partial Least Squares – Structural Equation Modelling (PLS-SEM).

Findings: the results of the analysis confirmed the validity of the constructs and proposed measures, and supported all five hypotheses suggesting a strong positive relationship between the ACAP dimensions, acquisition, assimilation, transformation and exploitation, and the efficiency of BI systems, and a strong effect of BI systems efficiency on organisational efficiency.

Practical implications: the study offers a comprehensive model of ACAP and BI systems efficiency. The set of measures that underpin these constructs could help researchers understand how ACAP dimensions are practically implemented and could contribute to their efforts to develop ACAP measurement instruments. At the same time, the model can help managers assess the readiness of their firms to adopt BI systems, and identify which areas should be further developed, before committing to the substantial financial investment associated with BI systems. It also provides a set of practical solutions that could be implemented to enable a more robust ACAP and support a better integration of BI systems.

Originality/value: following an empirical approach, this study refines our theoretical and practical understanding of ACAP as an organisational dynamic capability and its dimensions; it provides an account in how each dimension affects different aspects of BI

systems efficiency, which, in turn, may contribute to the improvement of organisational efficiency. Moreover, the study reframes ACAP measures as a set of requirements that can be practically assessed and followed before attempting to purchase BI systems.

Keywords: Absorptive Capacity (ACAP), Business Intelligence (BI), Structural Equation Modelling (SEM), Partial Least Squares (PLS), Organisational Efficiency, Measures.

Article Classification: research paper.

1. Introduction

BI systems are a broad category of applications and technologies for gathering, storing, analysing, and providing access to data that aim to help the decision-making process (Liang and Liu, 2018) and, as such, BI systems have enormous potential to improve organisational efficiency (Wang and Byrd, 2017; Grezes, 2015). With increasingly more powerful computational algorithms and data storage capacity, BI solutions have been an area of continuous and growing interest. It is apparent, however, that the availability of any technology should not be the sole drive behind its adoption in an organisation. Rather, the ability of these systems to be successfully integrated and significantly contribute to organisational efficiency, and the factors that will support it, should be thoroughly considered and assessed before their adoption.

Absorptive Capacity (ACAP) is the ability of organisations to gather, absorb, and strategically influence new external information (Cohen and Levinthal, 1990), and as such there is a strong theoretical connection between ACAP and BI systems. This research aims to empirically investigate the relationship between the dimensions underpinning ACAP (that is, acquisition, assimilation, transformation and exploitation) and whether and how they affect the efficiency of BI systems, which, in turn, can enhance organisational efficiency. In particular, the research seeks to address the following research question:

Can ACAP influence the efficiency of BI systems and, consequently, influence overall organisational efficiency?

2. Background Review

Dissecting the research question, this section provides an overview of the core concepts and relations in it; in particular, it discusses literature to define ACAP and BI systems and to identify an association between ACAP and BI systems, and BI systems efficiency and organisational efficiency.

2.1 Absorptive Capacity: Concept and Dimensions

The concept of ACAP was developed by Cohen and Levinthal (1990), who defined it as: "the ability of organisations to identify, assimilate, and exploit knowledge coming from external sources." Since then, it has been investigated in various areas such as banking (Silva et al., 2004), technology (Nicholls-Nixon and Woo, 2003), strategic alliance (Cui, Wu and Tong, 2018), organizational learning (Cooper and Molla, 2016), product development (Stock et al., 2001), and organisational financial performance (Lin et al. 2016). Throughout the last two decades, the concept has been further developed such that now it is widely considered a dynamic organisational capability (Dabic et al., 2019). Central to this reconceptualisation was the work by Zahra and George (2002), who defined ACAP as a "dynamic capability embedded in a firm's routines and processes, making it possible to analyse the stocks and flows of a firm's knowledge and that contributes to the creation and sustainability of competitive advantage". Recent studies and systematic literature reviews on ACAP validated this reconceptualisation of ACAP as a dynamic capability, while also stressing its key role in knowledge transfer (Apriliyanti and Alon, 2017; Gao et al., 2017; Lin et al. 2016). Furthermore, Zahra and George (2002) offered an operationalisation of ACAP by decomposing it into four indicators or dimensions. These dimensions can be either characterised as 'potential' or 'realised':

1. **Acquisition** is concerned with Research and Development investment in organisations and describes the firm's ability in obtaining critical external data, information, and knowledge (Jordan et al., 2008).
2. **Assimilation** is concerned with the ability of an organisation to have structured and controlled set of procedures that enables the analysis and interpretation of the obtained external knowledge (Kumar and Palvia, 2001).
3. **Transformation** may involve new product designs and research projects, and describes the ability of a firm to combine prior knowledge with newly attained knowledge by having set of technical and non- technical processes that supports this combination and refinement of knowledge (Wang and Byrd, 2017).
4. **Exploitation** is related to the number of novel generated products, services, and patent declarations. Exploitation indicates the capacity of the firm to exploit the newly gained knowledge and efficiently apply it in services and product development that can lead to better performance and financial profit (Wolfswinkel et al, 2013).

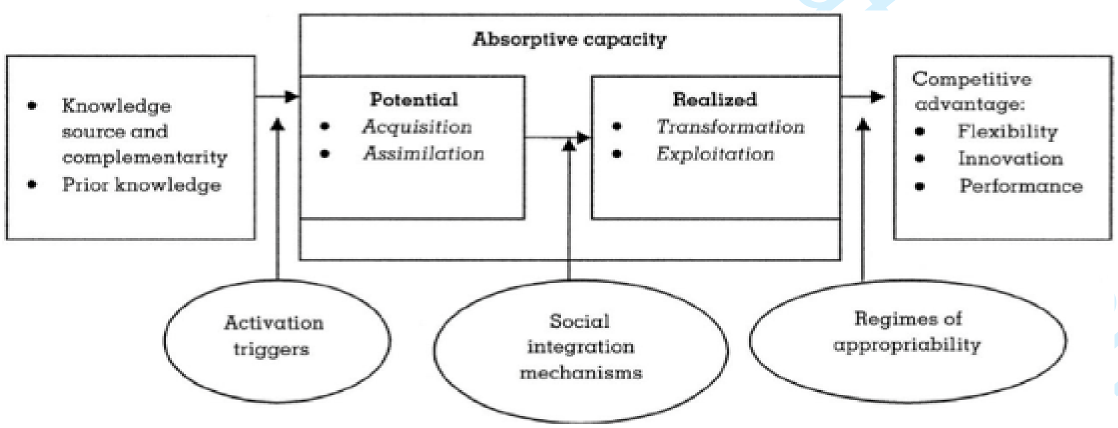

Figure 1. ACAP model developed by Zahra and George (2002)

A similar model was proposed by Todorova and Durisin (2007), which added interactions between the dimensions and power relationships as a factor affecting the acquisition of knowledge and its exploitation.

The model by Zahra and George (2002) had two critical contributions to the ACAP literature; first, it defined ACAP as a dynamic capability, that is, a key competency in generating strategic nature in an organisation, which is concerned with the element of 'change' in a certain organisation. Second, ACAP is operationalised through four dimensions, which are distinct and complementary (Floor, Cooper and Oltra, 2018). Naturally, there are practical limitations to this model, as well as other existing models, as pointed out by Duchek (2013), Lane et al (2006) and Gao et al. (2017). First, ACAP dimensions cannot be readily employed as empirical measures of an organisation's ACAP. Second, there is no direct link between each ACAP dimension and aspects or components relating to BI systems and technology. The research presented in this paper attempts to add to existing ACAP research by addressing these limitations. Relevant to the latter, the next section provides and overview of BI systems.

2.2 Business Intelligence (BI) Systems

BI systems are commonly used as an umbrella term for systems and procedures that transform raw data into useful information for managers to enable them to make better decisions (Wixom and Watson, 2010; Watson, 2009).
BI systems fall under the broader category of Information Systems (IS), but differ from other IS systems because of their explicit focus on data, data sources, and available analytical tools, and aim to directly support the decision-making process (Loon, 2019). Furthermore, BI systems differ in their use of sensing opportunities for organisational innovation and promoting business growth. The current research is very much influenced by the definition developed by Liang and Liu (2018), according to which, BI is a term covering technology-driven, and large combination of processes, politics, culture, and technologies for gathering, manipulating, storing, and analysing data for generating effective business and organisational performance, and discovering new business prospects. Moreover, a BI system includes a broad range of analytical software for diverse organisational provisions (Loon, 2019).
According to Laursen and Thorlund (2010), a BI system consists of three significant components: a technological component, a human component, and a business process to underlie the transformation of information to knowledge. BI systems rely on the organisation's IT infrastructure to operate (e.g., database services, shared resources, security systems, etc.) but should not be treated as merely part of the IT infrastructure (Liu et al., 2018). BI systems have enormous potential to directly improve organisational efficiency (Watson, 2009; Wang and Byrd, 2017; Grezes, 2015). However, the review conducted by McBride (2015) found that there is lack of empirical research that pinpoints how BI systems leads to organisational efficiency and identifies the required organisational capabilities that must pre-exist or must be developed to support the assimilation of BI systems. The next section focuses on research that has looked at ACAP as an organizational capability in relation to BI systems.

2.3 Theoretical Association between ACAP and BI Systems

Roberts et al. (2012) discussed the link between ACAP and Information Systems (IS), in general – not specifically BI systems – with the aim to refine current understanding of ACAP and direct its operative practice in IS studies. The study traced the evolution of ACAP literature, identified issues relevant to its conceptualisation and examined how ACAP has been measured, theorised, and then utilised in the IS research field. Similarly, Gao et al. (2017) analysed the use of ACAP in IS research and, while they found that ACAP was accurately and consistently conceptualised as a capability, their comprehensive literature review revealed that there is no common understanding of how it should be operationalised and measured. Focusing on BI systems, Elbashir et al. (2011) examined the role of organisational ACAP in the strategic use of BI systems to support integrated management control systems. The study argues that, organisational ACAP or the capability to collect, absorb and strategically control new information coming from external sources, depends on the creation of a proper technological set-up and the integration of BI systems. This view is echoed by Mashingaidze and Backhouse (2017), who argued that the ACAP of an organisation varies depending on the source of the information, and this source can be any type of data processing systems, including BI systems. While previous literature motivates a link between ACAP and BI systems, there is inadequate empirical investigation that focuses on characterising the potential relationship between ACAP and BI systems and specifying its direction.

The definitions in the literature of ACAP and BI systems reveal overlapping areas between the two constructs, which can be summarised as follows:

1. Both ACAP and BI systems receive data or information as inputs.
2. Both ACAP and BI systems generate knowledge as output.
3. Both ACAP and BI systems follow a systematic set of actions for processing their inputs.
4. The main objective of both ACAP and BI systems is to generate strategic value and better organisational performance.
5. Both ACAP and BI systems are key components in a modern, efficient, and successful organisation.

Therefore, the present study treats ACAP as being the managerial and organisational facilitator of BI systems. It suggests that ACAP when recognised in organisations can act positively to affect BI systems. In effect, ACAP is treated as being the conceptual form of BI, while BI is considered to be the technical facilitator of ACAP. This proposition will be developed and evaluated in the remaining of this paper.

2.4 Theoretical Association between BI systems Efficiency and Organisational Efficiency.

Organisational efficiency has been typically defined as an indication of the organisation's ability to optimally use its resources in response to its needs, and is measured as a function of inputs used to produce the required outputs (Cummings, 1983). BI systems must be business- and strategy-driven, and must have the ability to improve organisational efficiency (Watson, 2009; Wang and Byrd, 2017; Grezes, 2015). Chan et al. (1997) also pointed to a direct link between BI systems efficiency and organisational efficiency; their theoretical work focused on creating organisational schemes based on successful data processing systems assimilation and their effects. They found that the potential benefit of having a BI system inside an organisation is its ability to offer information to strategic managers to enable them to accelerate the decision making process, leading to better organisational performance and a more efficient data management environment. Organisational efficiency is also perceived to be improved by BI systems according to Turban et al. (2007). The existence of BI systems within organisations could provide members of the organisation, such as employees, partners, and suppliers, with easier access to information and the ability to practically analyse and share data. Naturally, this can have a positive impact on organisational efficiency, compared to competitors lacking such technology, and can also increase profit and productivity. The current research intends to provide experimental evidence to assess this theoretical standpoint.

3. Proposed Research Model and Hypotheses

This paper proposes that ACAP acts as a significant means of input and information facilitation within the organisation; therefore, the capability to absorb and acquire a given input, and transform and assimilate it into a unified required output as a sequence of refined knowledge results in an improved BI system efficiency; BI system efficiency, in turn, leads to better overall organisational efficiency. This proposition leads to the development of four hypotheses, which address the potential positive relationship between ACAP dimensions (as defined by Zahra and George, 2002) and BI systems. The last hypothesis addresses the positive relationship between BI systems efficiency and organisational efficiency. The proposed model and the underlying hypotheses are schematically shown in Figure 2. The proposed model involves one independent construct, ACAP, and two dependent constructs, BI systems efficiency and organisational efficiency. These constructs have been defined in subsections 2.1, 2.2, and 2.4 sections, respectively. In the next two subsections, the five hypotheses are formulated.

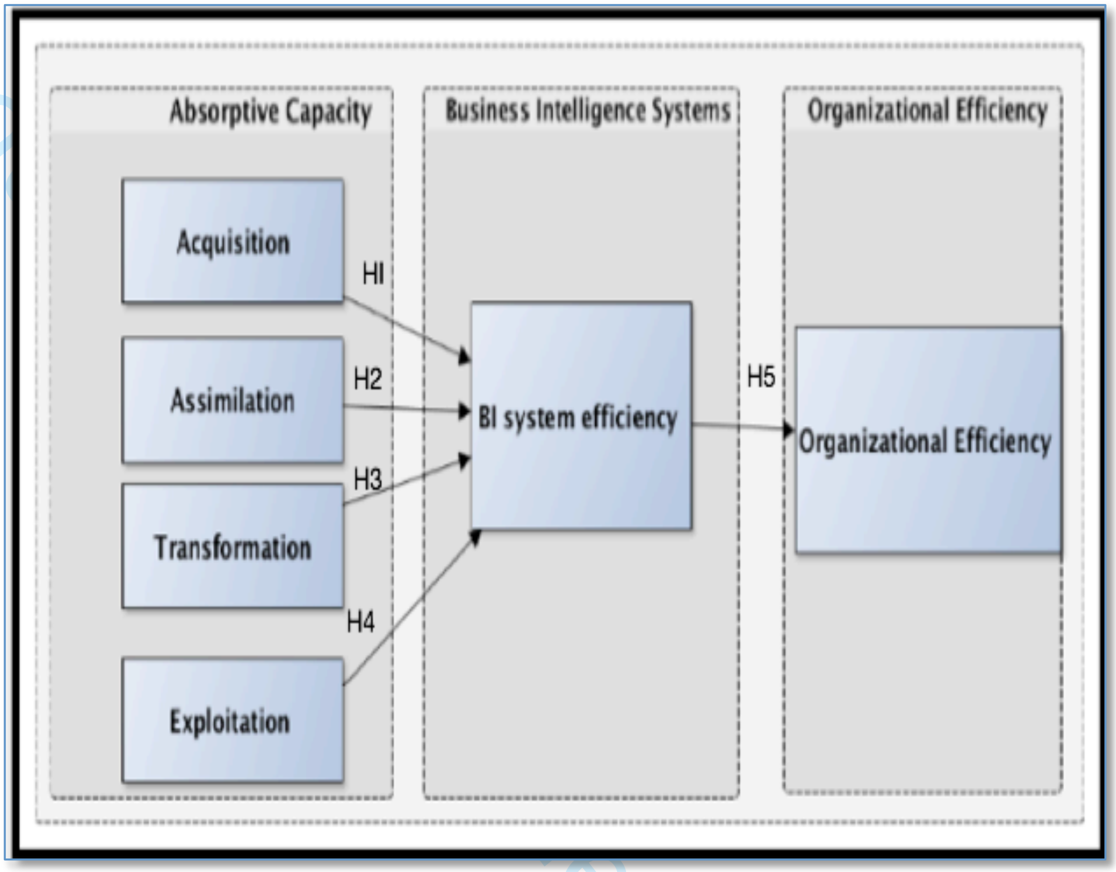

Figure 2. Proposed theoretical model and research hypotheses.

3.1 Proposed Effect of ACAP Dimensions on BI Systems Efficiency

Section 2.3 reviewed literature that motivated a relationship between organisational ACAP and BI systems. Building on this literature, the present study aims to identify the fine-grained effects of ACAP dimensions on BI systems efficiency. In particular, the following four hypotheses are framed:

*Hypothesis 1 (**H1**): There is a positive relationship between 'Acquisition' and BI systems efficiency.*

*Hypothesis 2 (**H2**): There is a positive relationship between 'Assimilation' and BI systems efficiency.*

*Hypothesis 3 (**H3**): There is a positive relationship between 'Transformation' and BI systems efficiency.*

*Hypothesis 4 (**H4**): There is a positive relationship between 'Exploitation' and BI systems efficiency.*

3.2 Proposed Effect of BI Systems Efficiency on Organisational Efficiency

The literature reviewed in Section 2.4 discussed the link between organisational efficiency and BI systems, leading to the following research hypothesis:

*Hypothesis 5 (**H5**): There is a positive relationship between BI systems efficiency and organisational efficiency in companies using BI systems.*

4. Research Methods

The study presented in this paper follows a quantitative methodology. Quantitative data was collected through online surveys that consisted of Likert-scale questions with a sample of (150) respondents, who were senior managers working in telecommunication companies. The data was analysed using Partial Least Squares – Structural Equation Modelling (PLS-SEM). The results of this analysis were used to test the five research hypotheses of this study. The quantitative work reported in this paper builds on previous qualitative research (Al-Eisawi and Serrano, 2019), as explained in subsection 4.1.

In order to test the research hypotheses, suitable items to measure the independent variable (ACAP dimensions) and two dependent variables (BI systems efficiency and Organisational efficiency) were extracted from the literature. PLS-SEM was used to test the validity of the measures and relevance of each to the corresponding construct/variable. These measurement items are discussed in the following sections.

4.1 ACAP Measurement Items

The dimensions of ACAP, acquisition, assimilation, transformation and exploitation are defined as distinct but complementary capabilities that compose a firm's ACAP setting; they represent a set of potentials that a particular organisation may obtain and use to serve its knowledge creation process (Watson, 1989, Zahra and George, 2002).

However, while this operationalisation is valuable and robust, there is much less clarity around how ACAP dimensions could be measured (Gao et al., 2017). With the aim to address this lack of clarity, a qualitative study was performed which involved 22 semi-structured interviews with senior managers in telecommunication companies. The Grounded Theory Methodology was used on the data; this analysis led to the development of a relational model that included the ACAP dimensions along with measurement items that corresponded to each dimension. Details of the process and outcomes of this study can be found in Al-Eisawi and Serrano (2019). The 19 measurement items that were extracted through this process are shown schematically in Figure 3.

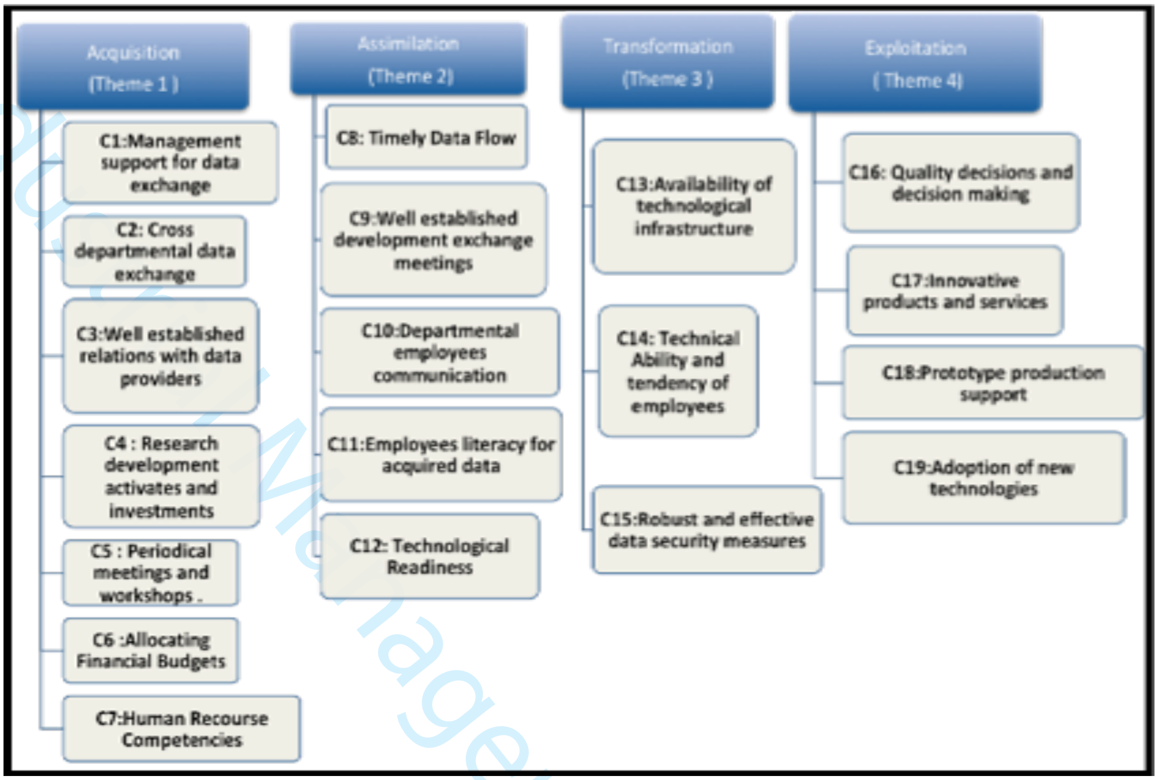

Figure 3. ACAP dimensions and measures (Al-Eisawi and Serrano, 2019).

Building on this work, a literature analysis was performed as part of the present study to determine whether these extracted measures align with previous research. This analysis provided theoretical support to the extracted measures. Table 1 summarises how these qualitatively extracted measures link with previous literature. The quantitative analysis presented in section 5 will serve as the final validation stage of the extracted measures.

Table 1. ACAP measurement items and source

4.2 BI Systems Efficiency Measurement Items

A BI system is treated in the proposed model as a dependent variable that relies on ACAP dimensions in order to operate effectively within organisations. Testing this set of hypotheses relied on measures extracted from previous research; these measures relate to BI systems' potential benefits in areas such as data collection and processing, internal and external communications, time/cost-to-market, decision making, operational costs etc. These measures and the study from which they originated are shown in Table 2.

Table 2. BI Systems Efficiency measurement items and source

4.3 Organisational Efficiency Measurement Items

The organisational efficiency construct relied on five measures extracted from literature, as shown in Table 3.

Table 3. Organisational efficiency measurement items and source

4.4 Data Collection and Sample

A total of 150 responses were received through the use of online surveys. Moreover, a screening question was enclosed within the online survey to confirm the use of BI systems within the interviewed organisations. The quantitative data for this study were collected through online surveys that included Likert-scale questions with senior managers working in telecommunication companies (the survey questions are included in the Appendix). The chosen companies implemented BI systems within their organisation and were bought from a BI systems vendor. Quantitative data was first analysed to ascertain a non-bias response by comparing early responses with later responses. The result for non-bias found no significant bias with the analysed data sample (as detailed in section 5.1). Next, data were analysed using PLS-SEM to determine the validity of the measures and constructs and to test the research hypotheses.

Different departments were engaged in the study. This decision was motivated by the aim to gather information from the perspectives and involvements of different BI systems users, which would lead to a comprehensive and accurate understanding of the usage of BI systems in different organisational performance aspects, and in the decision making process. The decision to engage different key departments was also influenced by the fact that, in technology-based industries, such as the telecommunications industry, many departments rely heavily on the use of BI systems, but at various levels in technical understanding and information detail. That is, the IT department consists of more technically-oriented individuals compared to other departments using BI; for example, the marketing department, finance department, and sales department require the use of the BI in higher management, and more non-technical people rely on dashboards in frequent basis for simple understanding of visual graphs and charts as compared to raw numbers (Liu et al., 2018) . Figure 4 shows the roles held by participants in the current study.

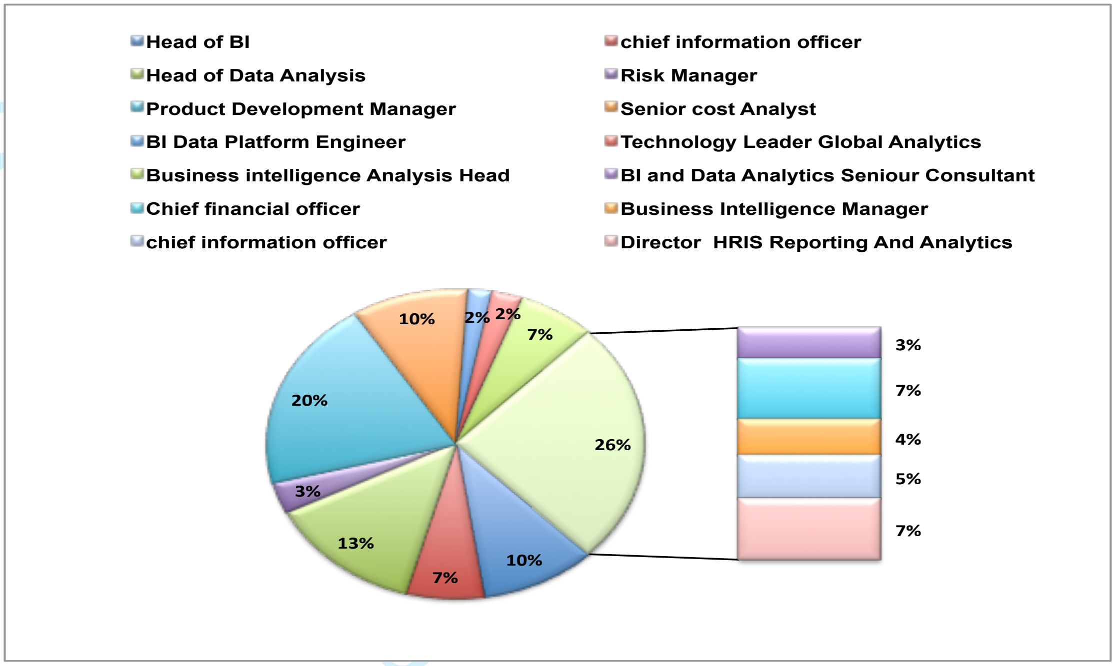

Figure 4. Pie chart of roles held by participants.

This descriptive analysis illustrated in Figure 4 indicates that all surveys targeted senior managers with most (20%) working as product development managers, 13% as head of data analysts, and the rest were chief information officers, directors of human recourses, senior consultants, heads of data acquisition, risk managers, technology leaders, and senior cost analysts. These participants were selected because of seniority and work experience, which would entail a good understanding of organisational features such as ACAP and business systems, and being able to represent different functions in the organisation. The size of the firms was large with an average of 600 employees.

4.6 Data Analysis with Partial Least Squares (PLS)

The initial data entry was undertaken using SPSS, and all data was then uploaded and analysed with SmartPLS software. PLS was used for (i) factor analysis for testing the reliability and validity of indicators and constructs (these results are in sections 5.1-5.2) and (ii) path analysis for testing the relationships and hypotheses (these results are in section 5.3). The analysis performed PLS-SEM. The chosen method was selected because of its ability to deal with relatively small sample sizes (Chin, 1997). In PLS, a measurement item is referred to as an indicator, and the constructs are called latent variables. All indicators in the current study are required to be reflective measures; a reflective measure implies that if that indicator was removed from the set of indicators representing a certain construct, the construct will remain the same, meaning that they are adequate and relevant indicators to measure the latent variable. The direction of interconnection in reflective indicators is always from construct to indicator. The measurement model of this study is schematically shown in Figure 5.

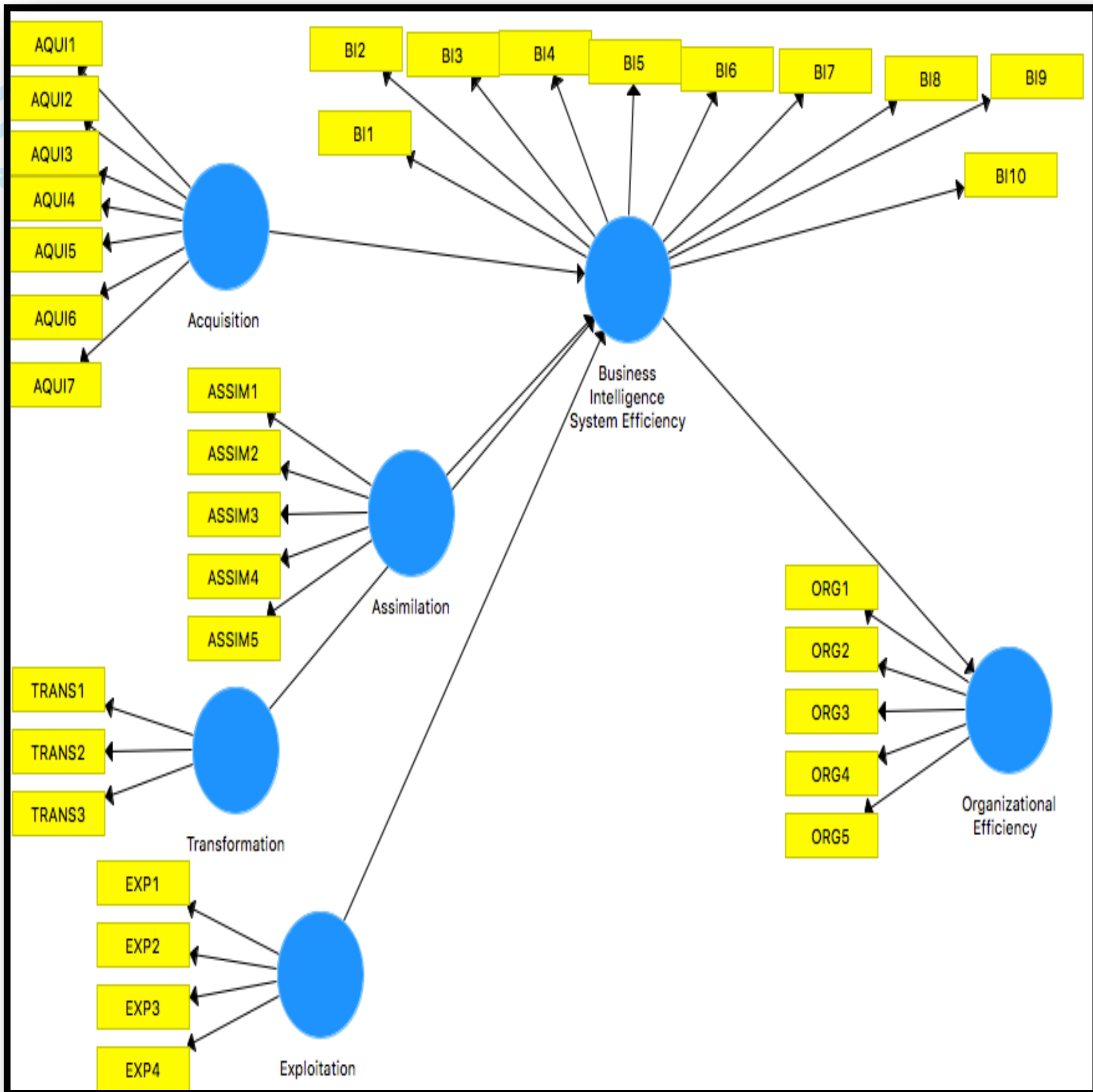

Figure 5. The measurement model using SmartPls 3.0.

5 Results

This section presents the results of the statistical analysis performed to assess reliability and validity of constructs and measurement items (section 5.2), and the results of the research hypothesis testing (section 5.4). Section 5.1 provides the results of the non-response bias evaluation.

5.1 Testing for Non-response Bias

Non-response bias refers to differences occurring due to differences in the time when participants completed the survey (Cascio, 2012). Lambart and Harrington (1990) proposed a process for testing for non-response bias. The process mainly compares the data from respondents who completed the survey at an early stage to data of those who completed it later. In the current study testing for non-bias was conducted by comparing responses received immediately within the first two weeks of sending the online surveys to those who responded after a reminder email was sent to them. The early batch of responses reached a total number of 95 (including 85 valid responses), while the responses received after the reminder was 65 (included 55 valid responses). A number of 12 randomly selected survey questions were used as a measure to compare early and late response data. An independent samples t-test was used to compare the mean scores of each question, with the null hypothesis being that there are no significant differences between the two sets. The results (shown in Table 4.) failed to reject the null hypothesis, indicating that timing of the survey completion (early vs. late) did not produce significant differences in the responses.

Table 4: Nonresponse bias test.

5.2 Reliability and Validity of Measurement Model

Validity and reliability tests for each of the six constructs/variables and their indicators/measurement items were performed. Individual item reliability is indicated by the outer loadings of items on their designated construct. Correlations are measured using outer loadings, showing the extent an item loads onto a construct. Hulland (1999) suggested a minimum loading of 0.4. For this study, all items were above this threshold and were confirmed to be reliable for the measurement of the construct assigned to them (also see next sub-section on convergent validity). In addition, average variance (AVE) was used to indicate construct validity (also see next section on discriminant validity). All six constructs scored a value greater than the threshold of 0.5 (Yoo and Alavi, 2001). Finally, composite reliability (CR) values were calculated for each construct, which ranged from 0.70 to 1.000 for all constructs, suggesting high reliability (Gefen et al., 2011; Gefen et al., 2000, Nunnally and Bernstein, 1994). These results are shown in Table 5.

Table 5: Assessment of the Measurement Model.

Discriminant and convergent validity

Discriminant validity tests were performed to confirm whether a construct better explains the variance of its indicators compared with the other constructs (Fornell and Larcker, 1981). Simply put, the test shows that the indicators of a construct are not highly correlated with other indicators that were designed to measure the other constructs. The approach developed by Fornell and Larcker (1981) was used to evaluate discriminant validity, which involved the square root of the average variance (AVE) for each construct, such that it should be greater than all the other inter-construct correlations (Fornell and Larcker, 1981). As can be seen from Table 6, discriminant validity is confirmed for all constructs in the proposed model.

Table 6: Discriminant Validity.

In addition to discriminant validity, convergent validity was used to determine whether the indicators of a construct are, in fact, related. According to Chin et al., (2003), each indicator loading on its original construct must be above 0.70. Hair et al. (2011) suggested that any items with loading below 0.4 should be disregarded. Factor and cross-loadings were used to examine convergent validity. All measurement items loaded relatively high on their original constructs and low on the other constructs. Consequently, these results confirm that indicated measurement indicators precisely exemplify clear latent constructs. Likewise, the AVE for each construct must be above 0.50 (Bagozzi and Yi, 1988; Dillon at el, 1978). The results are shown in Table 7.

Table 7: Convergent Validity.

Predictive capacity of model

The model's predictive capacity was evaluated using R-square (R^2) values (Hair et al., 2017). The path coefficient significance levels were estimated using the bootstrapping method (Chin, 1998; Henseler et al., 2009) explained in detail in Section 5.3. R^2 is the variance in the endogenous constructs explained by all of the exogenous constructs connected with it (Hair et al., 2017). In the present study, there are two endogenous constructs, BI systems efficiency and organisational efficiency, and the exogenous construct is ACAP. As proposed by Falk and Miller (1992), R^2 should be greater than 0.1 for the c in the structural model, although a better interpretation of R^2 levels should also include the specific research focus and model (Falk and Miller, 1992). The effect of the exogenous construct on the endogenous constructs is considered substantial, moderate, and weak, if they have R^2 values of 0.75, 0.50, or 0.25, respectively (Hair et al., 2017). Table 8 shows the R^2 values associated with each endogenous construct.

Table 8. R-squared values for BI systems efficiency and Organisational efficiency constructs

Bootstrapping and Hypothesis Testing

Bootstrapping is a non-parametric resampling process that relies on evaluating the adaptability of the data by testing the variability of the collected sample without the use of parametric assumptions (Efron and Tibshirani, 1994), and it is critical to the process of building a robust theory or model. Running the PLS-SEM bootstrap test examined the scores of the significance of the path coefficients, and assessed the properties of the structural model. T-statistics were used to test the significance of the path coefficients. Conversely, the study followed the rule proposed by Hair et al. (2013) in which t-statistic greater than 1.96 was considered significant for path coefficients at the 95% confidence level. To test the hypotheses presented in Section 3, regression weights were evaluated, and path coefficients between every two constructs related to each hypothesis were measured to allow inferences regarding the strength of the relationships of the model constructs.

As can be seen in Table 9., all hypotheses were supported, such that the relationships between the constructs were found to be significant.

Table 9. Hypothesis testing, path coefficient, T values, and P values

Based on these results, it is inferred that the ACAP dimensions, Acquisition, Assimilation, Transformation, and Exploitation, have a positive effect on BI systems efficiency as proposed in the research model. In turn, the analysis indicates a significant effect of BI systems efficiency on organisational efficiency. The final model in Figure 6 illustrates the confirmed relationships and effects between these constructs.

Figure 6. Confirmed model

6. Discussion

The research conducted PLS-SEM aiming to test the connection between ACAP extracted measures and their effect on BI systems efficiency, and testing another relation between the effect of BI systems efficiency on organisational efficiency. Recent studies have followed this approach to explore related research questions, such as Rehman et al. (2020). PLS-SEM tested the reliability of the indicators/measures of ACAP, BI systems efficiency, and organisational efficiency. Indicator reliability resulted in overall strong loading across all items. The three constructs (ACAP, BI systems efficiency, and organisational efficiency) were tested for consistency using both discriminant validity and convergent validity; convergent validity results confirm that the indicators clearly measure the constructs, while discriminant validity confirms that a construct's indicators do not relate to any other construct. The assessment of the model in PLS-SEM showed significant effects between the constructs, providing support to the five hypotheses of this study. These effects are discussed in the next two sections.

6.1 Effects of ACAP Dimensions on BI Systems Efficiency

The results of this study provide further support to the argument that ACAP as an organisational capability has a positive role in strengthening the value attained from implemented BI systems (Chen et al., 2012). Adopting BI systems requires large expenditure and investments in state of the art infrastructure and technology. Managerial decisions to assist firms in acquiring, assimilating, transforming, and exploiting knowledge are necessary for more efficient BI systems.

The acquisition dimension of ACAP revealed a positive effect on BI systems efficiency. Acquisition refers to the ability to recognise, obtain, and grasp the external knowledge required for organisational growth (Lane and Lubatkin, 1998). The tested indicators reflecting the acquisition dimension of ACAP (well-established relations with data providers, periodical meetings and workshops with experts, and allocating financial budgets for research development activities) were all found have a reasonable potential positive effect on enhancing data acquisition inside organisations. Also, key acquisition indicators such as extensive internal and external communication channels between employees, group meetings, and training can be encouraged by departmental efforts.

In line with the proposed ACAP indicators, BI systems efficiency can be highly influenced by the prior technical knowledge, and technological tendency available in managers. This is necessary as a defense tool used for successful organisational competitiveness. Consequently, this can encourage the degree of information sharing across business units and the ability of managerial teams to assimilate the given BI system requirements which, in turn, can lead to better and effective decision-making process generated through both ACAP dimensions and BI systems. Finally, the study added a final subordinate contribution by proposing that the existence of BI systems within organisations can provide significant members of organisations such as employees, partners, and suppliers with more efficient access to information, as well as providing a practical data analysis and sharing environment. This can be performed by always reflective and effective policies and organisational design structures that assist the process of knowledge transformation and protection, and, as such, achieving better organisational efficiency compared with other competitors (Lovitts, 2005).

6.2 Effect of BI Systems Efficiency on Organisational Efficiency

Building on the quantitative results, the proposition relating to (H5) was supported and suggested a positive effect from BI system efficiency on the overall organisational efficiency. The tested BI system efficiency indicators, and organisational efficiency indicators in the current research also confirmed this. When BI systems are reliable as a key data management system, they can effectively act as decision-making boosters leading to an overall organisational efficiency reflected in data-driven organisations (Kwon et al., 2014; Shin, 2015; Shin 2013, Esteves and Curto, 2013; Shin 2014). Subsequently, this proposition can begin with evaluating the measures of ACAP that are available within organisations. Decision makers in Telecommunication firms in many cases tend to rapidly adopt BI systems without any consideration for the ACAP indicators proposed and analysed thoroughly in the current study.

Building on the current research final results, the study proposes the following organisational aspects that can benefit when sustaining an adequate level of BI systems efficiency:

- Organisational success will be higher compared with key competitors in the same industry.
- Organisational ownership of market share compared with key competitors in the same industry.
- Organisational development is at a quicker pace compared with key competitors in the same industry.
- Increasing organisational profit compared with key competitors in the same industry.
- Organisational product and services innovation is better compared with key competitors in the same industry.

BI systems efficiency is essential as a strategic source of high value, particularly if an organisation seeks to fully exploit BI systems facilities and capabilities for its strategic improvement in different departments (Beath et al., 2012; Mayer-Schönberger and Cukier, 2013; Galbraith, 2014).

7.1 Theoretical Contributions

The study adds to our theoretical understanding of ACAP dimensions, BI systems efficiency and organisational efficiency, and their interactions. It does so by complementing the rich body of theoretical research with empirical data derived from the domain of telecommunications.

In particular, it offers additional support to research that treats ACAP as a 'capability' rather than an asset (Winter, 2000, Gao et al., 2017). Furthermore, it aligns well with studies that stress the dynamic nature of ACAP as a capability, reflecting the element of change within an organization (Apriliyanti and Alon, 2017; Gao et al., 2017; Lin et al. 2016). Our study proposes that the four organisational capabilities of knowledge acquisition, assimilation, transformation, and exploitation coherently interact to present ACAP as a dynamic capability that induces the firm's ability to generate and employ the knowledge required to shape broad organisational capabilities that foster organisational change and development (e.g., technological, technical, dissemination, marketing and innovation). These varied capabilities contribute in building well founded origins that can assist in attaining a competitive advantage that yields superior and efficient performance when operating advanced systems such as BI systems (Elbashir et al., 2011). It is thus very important to state that ACAP supports to open the black box that has controlled previous research on organisational and strategic change (Zahra and George, 2002).

The study also provides a finer-grained insight into ACAP dimensions, by, first, qualitatively extracting 19 indicators of ACAP (Al-Eisawi and Serrano, 2019), then, tracing their validity in past literature, and, finally, further validating these indicators using factor analysis. This set of indicators could help researchers in understanding how ACAP dimensions can be practically realised and inform their efforts to develop measurement instruments for ACAP and its dimensions (Flatten et al., 2011). Extending previous theory-driven research in the bi-directional link between ACAP and BI systems, it demonstrates how each ACAP dimension impacts the performance of BI systems within firms. It also provides evidence to support the proposition that ACAP and BI systems are highly related, and, arguably, the conceptual or technological manifestation of each other. Finally, refining our understanding of how BI systems can significantly contribute to organisational efficiency, this research identifies the particular elements of BI systems that are important in creating value for the company.

7.2 Practical Contributions to Industry

This study provides recommendations in how managers could practically determine and measure their firm's ability to realise the benefits of the behavioral and non-technical aspect of ACAP offered as a set of potential dynamic capabilities. It stresses the need for managers and executives to pay more attention to positive organisational outcomes that arise as a result of implementing the extracted proposed ACAP indicators presented in the model. It is advised that managers are aware of the ACAP dimensions, relating to acquisition, assimilation, transformation, and exploitation of data and knowledge. These dimensions can act as a set of requirements before committing to the substantial expenditure associated with deploying BI systems, or any state-of-the-art data processing software.

Setting up a successful and efficient BI systems-centered environment has been typically linked with the availability and amount of financial spending and on various technological-based factors, such as having the appropriate IT infrastructure, or having the right technology tools for determining how and when to analyse data (Liang and Liu, 2018). However, the present study attempts to shift this paradigm, showing that ACAP measures underlie the success and efficiency of BI systems. That is, it recommends that a thriving environment for BI systems should not only rely on the technical and technological tools and processes. The desired data-driven environmental success might be attained by the efforts of strategic managers in evaluating their ACAP initiatives and measures. The proposed model can guide such efforts. So, it is proposed that senior managers, particularly in technology-oriented industries, should have a reasonable set of assessed measures that are proposed to evaluate their organisational weakness and strengths from an ACAP perspective. The extracted measures in this model can offer foundations for shaping where and how further potential organisational assets can be leveraged. While viewing the extracted measures managers, strategic data acquisition managers, senior data analysts, and even human resource managers can consider what they already have from these sets, and what is missing or needs to be further discovered. Similarly, a secondary practical contribution lies in offering a validated and practical set of measures on BI systems efficiency and assimilation, which could be used to improve organisational efficiency.

The study provided insight into how managers can tackle their strategic challenges for generating profit and being able to respond to changing business environments by the joint and focused consideration of aspects that relate to IT, business practices and processes, analytical tools and skills needed.

8. Limitations and Future Work

A possible limitation of the current study is the use of a relatively small sample size for the quantitative data collection and analysis, as well as the fact that data came from a single industry. Future work will include a larger sample engaging senior managers across different technology-based industries. It is also important to determine the variations between knowledge-intensive industries such as the telecommunications and banking industries, and other less knowledge-intensive industries, as well the differences between companies at different stages of maturity. This could reveal the relative value and impact of ACAP. Additional future work will also include empirical research on the 'dynamic' nature of the four ACAP dimensions, such as analysing how they can change while the industry is evolving and changing.

References

Al-Eisawi, D and Serrano, A (2019). "Absorptive Capacity and its Potential Role in Supporting Organisational knowledge Creation: A Qualitative Approach". Proceeding of the 24th UK Academy for Information Systems UKAIS Annual Conference, Oxford University, Oxford, UK, and 9th April – 10th April.

Apriliyanti, Indri Dwi and Alon, Ilan, (2017). "Bibliometric analysis of absorptive capacity," International Business Review, Elsevier, vol. 26(5), pages 896-907.

Arthur H. Gilbert, Roger Alan Pick, Sidne Gail Ward(2000) ."Perennial management data systems issues in US manufacturing firms", Industrial Management & Data Systems, Vol. 100 Issue: 7, pp.325-329, https://doi.org/10.1108/02635570010304815

Bagozzi, R. P., and Yi, Y. (1988) "On the evaluation of structural equation models". Journal of the Academy of Marketing Science, 16(1), 74–94.

Beath, C., Becerra-Fernandez, I., Ross, J. Short, J.(2012)Finding value in the data explosion. MIT Sloan Management Review, 53, (4), 18-20.

Bollen, K. A. (1984). Multiple indicators: Internal consistency or no necessary relationship? Quality and Quantity 18, 377-385.

Bollen, K., and Lennox, R. (1991) "Conventional wisdom on measurement: A structural equation perspective". Psychological Bulletin, 110(2), 305-314.

Brown. T (2006). Confirmatory factor analysis for applied research. New York: Guilford.

Chen, W. and Hirschheim, R. (2004). A paradigmatic and methodological examination of information systems research from 1991 to 2001. *Information Systems Journal*, 14(3), pp.197-235.

Cooper, V., and Molla, A. (2017) "Information systems absorptive capacity for environmentally driven IS-enabled transformation: IS-environmental absorptive capacity. Information Systems Journal, 27(4), 379-425. doi:10.1111/isj.12109

Cummings, LL. 1983. "Organizational effectiveness and organizational behavior: A critical perspective". In Organizational Effectiveness: A Comparison of Multiple Models, Edited by: Cameron, KS and Whetten, ADavid. 187–203. USA: Academic Press Inc

Dillon, W., Goldstein, M. and Schiffman, L. (1978) "Appropriateness of Linear Discriminant and Multinomial Classification Analysis in Marketing Research ". Journal of Marketing Research, 15(1), p.103.

Efron, B. and Tibshirani, R.J. (1994) "An Introduction to the Bootstrap ". Chapman and Hall/CRCthe, UK.

Elbashir, M. Z., Collier, P. A., and Sutton, S. G. (2011) "The role of organisational absorptive capacity in strategic use of business intelligence to support integrated management control systems ". The Accounting Review, 86(1), 155-184. Doi: 10.2308/accr.00000010.

Elbashir, M. Z., P. A Collier, and M. J. Davern. (2008). " Measuring the effects of business intelligence systems: The relationship between business process and organisational performance ". International Journal of Accounting Information Systems 9: 135 – 153.

Fitriana, R., Eriyatno, and Djatna .(2011)," Progress in Business Intelligence System research a Literature Review", International Journal of Basic and Applied Sciences IJBAS-IJENS Vol: 11 No: 03.

Foley, E., Guillemette, M. G.(2010). What is Business Intelligence? International Journal of Business Intelligence Research, Vol. 1, No. 4, 2010, pp. 1–28.

Gao, Shijia, Yeoh, William, Wong, Siew Fan and Scheepers, Rens 2017, A literature analysis of the use of absorptive capacity construct in IS research, International journal of information management, vol. 37, no. 2, pp. 36-42, doi: 10.1016/j.ijinfomgt.2016.11.001.

Hair, J. F., Hollingsworth, C. L., Randolph, A. B., & Chong, A. Y. L. (2017). An updated and expanded assessment of PLS-SEM in information systems research. Industrial Management & Data Systems, 117(3), 442–458.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. Journal of Marketing Theory and Practice, 19(2), 139–151.

Hair, J.F., C.M. Ringle, and M. Sarstedt. (2013). Partial least squares structural equation modelling: Rigorous applications, better results and higher acceptance. Long Range Planning 46: 1 – 12.

Hair, J.F., C.M. Ringle, and M. Sarstedt.(2012). Partial least squares: The better approach to structural equation modeling. Long Range Planning 45: 312 – 319.

Harris, R., and Yan, J. (2018) The measurement of absorptive capacity from an economics perspective: Definition, measurement and importance: Measurement of absorptive capacity. Journal of Economic Surveys, doi:10.1111/joes.12296

Heath, H. and Cowley, S. (2004) 'developing a grounded theory approach: A comparison of Glaser and Strauss; 14725778', International journal of nursing studies, 41(2), pp. 141-150.

Hofstede, G. (2001). Culture's Consequences: Comparing Values, Behaviours, Institutions, and Organisations across Nations, 2nd ed. Sage, Thousand Oaks, CA.http://dx.doi.org/10.2307/20159255

Hotho, J.J, Becker- Ritterspach, F and Saka-Helmhout, A .(2011). Enriching Absorptive Capacity through Social Interaction, British Journal of Management, Vol. 23, 383-401.

Howson, C (2007). Successful Business Intelligence, McGraw-Hill Professional Publishing, Emeryville, USA. Available from: ProQuest EBook Central.

Hulland, J. (1999). Use of partial least squares (PLS), Strategic management research: A review of four recent studies. Strategic Management Journal, 20(4), 195–204.

Jordan Z., Rainer, R. K. and Marshall, T. E. (2008). ‘Business Intelligence: An Analysis of the Literature’, Information Systems Management, 25(2), pp. 121–131. doi: 10.1080/10580530801941512.

Kim, L. (1998). Crisis Construction and Organisational Learning: Capability Building in catching up at Hyundai Motors, Organisation Science, and Vol. 9. No 4.

Kim, L. (1999). Building Technological Capability for Industrialization: Analytical Framework and Korea’s Experience, Industrial and Corporate Change, Vol. 8. Nov.

Kostopoulos, K., Papalexandris, A., Papachroni, M. and Ioannou, G. (2011). Absorptive capacity, innovation, and financial performance. *Journal of Business Research*, 64(12), pp.1335-1343.

Kumar, A and Palvia, P (2001). "Key data management issues in a global executive information system", Industrial Management & Data Systems, Vol. 101 Issue: 4, pp. 153-164, https://doi.org/10.1108/02635570110390099

Kwon, O., Lee, N., & Shin, B. (2014). Data quality management, data usage experience and acquisition intention of big data analytics. International Journal of Information Management, 34(4), 1–22.

Lane, J.P. Koka, R.B and Pathak, S. (2006) .The Reification of Absorptive Capacity: A Critical Review and Rejuvenation of the Construct, Academy of Management Review, Vol. 31, No. 4, 833-863.

Lin, C , Tan, B and Changes’ (2002). "The critical factors for technology absorptive capacity", Industrial Management and Data Systems, Vol. 102 Issue: 6, pp. 300-308.

Lin, T.-C., Chang, C.L.-h. and Tsai, W.-C. (2016), "The influences of knowledge loss and knowledge retention mechanisms on the absorptive capacity and performance of a MIS department", Management Decision, Vol. 54 No. 7, pp. 1757-1787. https://doi.org/10.1108/MD-02-2016-0117.

Liu, X., Zhao, H. and Zhao, X. (2018). "Absorptive capacity and business performance: the mediating effects of innovation and mass customization", Industrial Management and Data Systems, Vol. 118 No. 9, pp. 1787-1803.

Lovitts, E. (2005). Being a good course taker is not enough: a theoretical perspective on the transition to independent research AU - Studies in Higher Education, 30(2), pp. 137-154.

McBride, N., (2015). Virtuous Business Intelligence. *International Journal of Business Intelligence Research*, 6(2), pp.1-17.

Nabeel Rehman, Sadaf Razaq, Ammara Farooq, Nayab Mufti Zohaib & Mohammad Nazri (2020), Information technology and firm performance: mediation role of absorptive capacity and corporate entrepreneurship in manufacturing SMEs, Technology Analysis & Strategic Management, DOI:

Pittz, T. G., Intindola, M. L., Adler, T., Rogers, S., and Gard, C. (2018). Collaborating smartly: The role of open strategy in absorptive capacity: Journal of Small Business Management, doi: 10.1111/jsbm.12430.

Popovič A, Puklavec B, Oliveira T (2019) ."Justifying business intelligence systems adoption in SMEs: Impact of systems use on firm performance ".Industrial Management & Data Systems, 119(1), 210-28.

Ringle CM, Wende S, Will A (2005). SmartPLS 2.0 M3. University of Hamburg, Hamburg, Germany. http://www.smartpls.de

Roberts, Galluch, Dinger and Grover (2012). Absorptive Capacity and Information Systems Research: Review, Synthesis, and Directions for Future Research. MIS Quarterly, 36(2), p.625.Rumelt RP. 1987. Theory, strategy, and entrepreneurship.

Stock, G., Greis, N. and Fischer, W., 2001. Absorptive capacity and new product development. The Journal of High Technology Management Research, 12(1), pp.77-91.

Turban, E., et al., (2007). Decision Support and Business Intelligence Systems, 8th edition, Prentice Hall, New Jersey

Wang Y, Byrd TA. (2017). Business analytics-enabled decision-making effectiveness through knowledge absorptive capacity in health care. J of Knowledge Management, 21(3), 517-39.

Watson, H. J. (2009). Tutorial: Business Intelligence – Past, Present, and Future. Communications of the Association for Information Systems, 25, pp-pp.

Winter, G. (2000). A Comparative Discussion of the Notion of 'Validity' in Qualitative and Quantitative Research. The Qualitative Report, 4(3), 1-14. Retrieved from https://nsuworks.nova.edu/tqr/vol4/iss3/4

Yoo, Y., and Alavi, M. (2001). Media and Group Cohesion: Relative Influences on Social Presence, Task Participation, and Group Consensus. MIS Quarterly, 25(3), 371-390. Doi: 10.2307/3250922

Zahra, S. and George, G. (2002). Absorptive Capacity: A Review, Reconceptualization, and Extension, Academy of Management Review, Vol. 27, No. 2.

Zhang, Y., and Wildemuth, B. M. (2009). "Qualitative analysis of content. In B. Wildemuth (Ed.), Applications of Social Research Methods to Questions in

Information and Library Science "(pp. 308-319). Westport, CT: Libraries Unlimited.

Zheng W, Wu YJ, Chen L (2018). Business intelligence for patient-centeredness: A systematic review. Telematics and Informatics, 35(4), 665-76.

Loon M . (2019) Knowledge management practice system: Theorising from an international meta-standard. Journal of Business Research, 94, 432-41.

Liang T, Liu Y (2018) Research Landscape of Business Intelligence and Big Data analytics: A bibliometric study. Expert Systems with Applications, 111, 2-10.

Appendix

Quantitative Survey

The surveys were analysed according to the number of points on each scale taken from the original scales, where applicable.

Question: To what extent you agree or disagree with the following statements?

ACAP Measures

ACAP Acquisition

- Q1) Management support for data exchange exists in my organisation.
- Q2) Departmental data management exists in my organisation.
- Q3) There is support for well-established relations with data providers.
- Q4) Research development activates, and investments exist in my organisation.
- Q5) Periodical Meetings and workshops with experts occur in my organisation.
- Q6) Human resource competencies are highly encouraged.
- Q7) My organisation does allocate financial budgets supporting different initiatives for data exchange purposes.

ACAP Assimilation

- Q8) Timely data flow is organised and noticeable in my organisation.
- Q9) Well-established development exchange meetings occur in my organisation.
- Q10) Departmental employee's communication occurs in my organization.
- Q11) In my organisation employees have a degree of literacy regarding acquired data from other resources
- Q12) Technological readiness is apparent in employees in terms of data processing competencies.

ACAP Transformation

- Q13) in my organisation, there is adequate availability of technological infrastructure.
- Q14) in my organisation technical ability and tendency of employees is highly present.

- Q15) Robust, and effective data security measures are implemented in my organisation.

ACAP Exploitation

- Q16) in my organisation, there is an acceptable degree of quality decisions and decision-making.
- Q17) in my organisation exists apparent innovative products and service.
- A1) we have prototype production support.
- Q19) My organisation always seek the adoption of new technologies.

BI systems Efficiency

Question: To what extent you agree or disagree with the following statements?

- Q20) BI systems improved data collection from different systems resources using BI technical tools.
- Q21) In my organisation using the BI system and BI technical tools increased employee productivity.
- Q22) BI system improved data collection from different systems resources.
- Q23) BI systems added enhanced coordination between partners, suppliers, and our organisation internally.
- Q24) BI systems lowered the cost of transactions with business partners/suppliers and data providers.
- Q25) BI system improved data processing and storage using data warehouse and OLAP online analytical processing tools.
- Q26) BI systems improved the efficiency of internal processes.
- Q27) BI systems in my organisation lowered operational cost.
- Q28) BI systems reduced the time and cost-to-market products/services.
- Q29) BI systems reduced the cost of effective decision-making.

Organisational Efficiency:

Question: To what extent you agree or disagree with the following statements?

- Q30) Organizational success in our organisational is higher compared with key competitors in the same industry.
- Q31) We have increased organisational ownership of market share compared with key competitors in the same industry.
- Q32) Organizational development in our organisations is at a quicker pace compared with key competitors in the same industry.
- Q33) We have Increasing organisational profit comparing with key competitors in the same industry.
- Q34) Organizational product and services innovation is better compared with key competitors in the same industry.