Technology alignment and business strategy: A performance measurement and Dynamic Capability perspective

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Abstract

Rapid changes in market structures and technology lead to misalignment between strategy and operations. Whist this phenomenon is most prevalent in technology based manufacturing industries, utility organisations (e.g. electricity and telecoms) provide a useful context to explore the Performance measurement (PM) and technology alignment challenges from a Dynamic Capabilities Theory perspective where there is a progressive shift towards deregulated markets. The aim of this paper is twofold: First, to explore the role of Dynamic Capabilities Theory and PM approaches in improving the alignment between business strategy and technology strategy (Level 1 alignment); second, to explore the role of Dynamic Capabilities Theory and PM approaches in aligning technology strategy with operational technology routines and practices (Level 2 alignment). In the absence of overarching theory an inductive approach which draws upon Dynamic Capabilities theory . Four longitudinal case studies are used leading to the development of a conceptual framework and propositions for multilevel technology alignment. Data from 38 interviews and eight separate focus groups, documentation, and participant observations (over a three-year period) are used. The theory-building process shows the need to identify and develop PM-based technology alignment Dynamic Capabilities (PM-DCs) which help in improving and maintaining alignment between business strategy and technology strategy (Level 1 alignment) and between technology strategy and technology practices (Level 2 alignment). This approach requires critically reflective action-learning approaches to identify and nurture these PM-DCs.

Keywords: Performance Measurement, Technology Alignment, Strategy, Operations, Utility, Multiple Case Studies

1. Introduction

Rapid changes in market structures and technology often leads to misalignment between strategy and operations. Literature reports that this phenomenon is most prevalent in technology based manufacturing industries (Chang et al, 2015; Johnston and Pongatichat, 2008). This paper seeks to increase understanding of the role of performance measurement (PM) approaches in improving technology alignment using utility organisations to show the challenges involved. It is reported that, with respect to technology alignment, whist utility organisations demonstrate similar challenges to that in manufacturing, they provide a more transparent platform for studying this phenomenon due to more direct effect of strategy and operations impact on the end customer expectations (Fearon et al, 2013; Bardhan et al, 2007).

In this context, PM approaches refer to frameworks such as the balanced scorecard (BSC), business excellence model (BEM), Lean measurement frameworks and other similar approaches consistent with Jasti and Kodali (2015) and Neely et al (2005). Alignment is viewed as a dynamic and multilevel construct (Shin et al, 2015; Fearon et al, 2013; Hanson et al, 2011; Bardhan et al, 2007) where lack of an existing overarching theory has led to an inductive theory-building approach being used (Chang et al, 2015; Pratt, 2009; Pero et al, 2010; Baker et al, 2011; Hong et al, 2011; Congden, 2005; Peak et al (2005, 2011). Grunewald et al (2012) show that utilities are challenged by increased market deregulation, competition from new entrants, rising customer expectations and rapid development of new technology. They also need to create new technology-based business units and opportunities in unregulated markets as traditional markets erode leading to an increase in technology misalignment problems (Romer et al, 2012; Danneels, 2002; Hong et al, 2011), e.g. failed product/service launches (Pero et al, 2010), loss of competitiveness (Brown and Blackmon, 2005), delayed time to market (Raunier et al, 2008), higher costs due to misused technology resources (Bardhan et al, 2007), and lack of agility in key markets (Kolehmainen, 2010).

Simoes et al (2016), Hong et al (2011) and Fearon et al (2013) suggest that alignment in this environment is complex and multilevel, where established technology routines and practices of existing markets are juxtaposed with new or emergent technology. Omrani et al (2010) and Peak et al (2005) show that organisations often do not systematically consider alignment in a commensurate or timely manner with that of changing business strategy resulting in misalignment. Danneels (2011), Ambrosini et al (2009a and b) and Barreto (2010) suggest the need for organisations to develop dynamic alignment capabilities, i.e. organisational capabilities to achieve or maintain alignment in times of environmental change.

There is a lack of studies and conceptual frameworks on how to improve alignment at both strategic and operational levels (Bititci et al, 2011; Pero et al, 2010). Furthermore, Baker et al (2011) and Sousa and Voss (2008) conclude that there is a lack of overarching theory in the area to guide alignment studies. Raunier et al (2008) suggest there is an innate tendency, or atrophy, towards misalignment, especially in rapidly changing and technology driven business environments (Bjorn and Ngwenyama, 2010; Danneels, 2011). Sousa and Voss (2008), Kolehmainen (2010), Hanson et al (2011) and Bititci et al (2006) suggest the need for exploratory theory building case studies to develop alignment conceptual models and propositions. Hence this paper seeks to contribute by using an exploratory theory-building approach involving longitudinal case studies.

A number of writers (e.g. Kolehmainen, 2010; Hanson et al, 2011; Johnston and Pongatichat, 2008) have referred to the role of PM approaches as having potential to improve alignment.

For example, Simoes et al (2016) explore alignment at operational and strategic levels in relation to the maintenance function. Hong et al (2011) suggest the need to use PMs in technology alignment-based problem solving, consistent with Taticchi et al's (2015) for integrated performance measurement systems and Jasti and Kodali's (2015) review of performance measurement in Lean production. Cotterman et al (2009) suggest customer-based PM methods such as Voice of the Customer/Quality Function Deployment (VoC/QFD) can help in sharing knowledge across levels to improve strategic fit. However, such studies relate to overall alignment rather than multi-stage alignment with a lack of theoretical underpinning (Johnston and Pongatichat, 2008; Pero et al, 2010; Sousa and Voss, 2008). In the absence of an overarching theory the aim of this paper is to explore, through an inductive theory building approach, two distinct aspects of technology alignment. First, to explore the role of Dynamic Capabilities and PM approaches in improving the alignment between business strategy and technology strategy (Level 1 alignment). Second, to explore the role of Dynamic Capabilities and PM approaches in aligning technology strategy with operational technology routines and practices (Level 2 alignment). These routines and practices refer to operational level technology-related activities that are regularly practiced at this level (Baker et al, 2011; Bardhan et al, 2007). Thus the paper seeks to make a contribution to the alignment challenges within the production-based research literature by developing related dynamic alignment conceptualisation based on Dynamic Capabilities theory linked to performance measurement concepts at strategic and operational levels from a linked theory development and empirical perspective. This contribution is consistent with Simoes et al (2016), Hong et al (2011) and Fearon et al (2013)'s calls for further research in this area of production research.

2. Literature

Baker et al (2011), Hanson et al (2011) and Congden's (2005) reviews of alignment between business strategy and technology note a paucity of empirical studies based on underpinning theory and a lack of definition of alignment levels. Similarly, Pero et al (2010) and Peak et al's (2005) case analyses found a lack of conceptual frameworks to represent multi-level alignment (i.e. at both strategic and operational levels). Hong et al (2011) define strategic alignment and fit as a critical link between an organisation's business strategy and its functional strategies (such as technology-based strategy). There is a range of contextual criteria for evaluating the degree of alignment, including: the manager's ability to recognise the need for fit (Ambrosini et al, 2009a), effective environmental scanning (Danneels, 2011), the ability to cope with changes in technology strategy (Fearon et al, 2013), effective and timely communications and ability to rapidly deploy changes (Monahan and Nardone, 2007; Johnston and Pongatichat, 2008). Rauniar et al (2008, p 133) conclude that alignment includes both business and functional level activities where they define strategic alignment as "*the extent to which a firm's overall business, product, and technology guide the product development contents and processes*".

The existing literature on the role of PM approaches in improving technology alignment is limited as shown by Franco-Santos et al (2007). Raunier et al (2008), Hong et al (2011) and Garengo and Bititci (2007) suggest that organisations often use a range of PM and improvement approaches (e.g. Balanced Scorecard - BSC, Business Excellence Model – BEM, Lean Six Sigma) in attempting to improve alignment. However, in these studies alignment was not the main theme and there is a paucity of studies seeking to explore the PM alignment phenomena in which theory and empirical studies are systematically linked. Huang et al (2008) show that competencies in PM aspects of TQM can be both strategic and operational in outlook with potential influences on technology alignment by building competencies in boundary spanning[1]. Cotterman et al (2009) found that higher degrees of alignment between business strategy and technology were associated with use of Voice of the Customer (VoC) approach, i.e. cascading customer requirement in measureable terms to all organisational levels. Raunier et al (2008) discuss a study of the BEM improving alignment by cascading strategy to lower organisational levels. Overall, these studies imply that there is potential for using PM approaches to help in the technology alignment process at both strategic and operational levels using *alignment-based technology management routines*[2] and practices with sufficient encouragement to warrant further explorative study.

In the absence of an overarching theory of alignment, and consistent with Sousa and Voss (2008) and Bititci et al (2006), it is suggested that Contingency Theory is a useful a priori starting point for theory building exploring the role of PM approaches in technology alignment. They suggest that such studies could adopt a contextual case-based approach with a focus on contingency theory constructs as a starting point or an a-priori means for theory-building, unlike a grounded theory approach which would start with more minimalistic a priori constructs (Barratt et al, 2011). For example, Bititci et al (2006) use inductive case theory- building by "*borrowing*" initially from contingency constructs to develop theory using conceptual models and propositions in relation to alignment of PM approaches.

We conceptualise technology alignment at two levels. Level 1 is *Strategic Alignment* between business strategy and technology strategy (Baker et al, 2011). Here, consistent with Raymond and Croteau (2009) and Sousa and Voss (2008), business strategy is identified as a key contingency variable within the alignment process. Level 2 is *Operational Alignment* between

[1] In this context Boundary Spanning refers to cross-functional (sales, finance, engineering, R&D etc) and cross hierarchy (i.e. senior managers, middle managers, team leaders and operatives)
[2] In this context an *alignment-based technology management routine* refers to any organisational routine or process which attempts to achieve alignment between business strategy and technology strategy (Level1) as well as technology strategy and technology practices (Level 2) as illustrated in Figure 1.

technology (functional) strategy and technology practices consistent with the findings of Baier et al (2008). The conceptualisation implies that PM approaches will have an influence achieving alignment at both strategic and operational levels.

Conceptual representation of the contingency variable(s) (CVs) can be defined using typologies as stated by Bititci et al (2006) and Sousa and Voss (2008), to help in determining alignment improvement approaches. The main contingency variable used in theory building alignment studies is that of business strategy. Sousa and Voss's (2008) study of contingency theory shows that this CV meets the test of being relatively exogenous to organisational operations. Sousa and Voss (2008) and Raymond and Croteau (2009) observe that typologies (or gestalts, Baier et al, 2008) to represent and contextualise CVs tend to be borrowed from a range of fields as a priori constructs for inductive theory building using case studies. Hence a number of existing studies have borrowed Miles and Snow's (1978) strategic intent typology to represent market and environmental uncertainty (e.g. Baier et al, 2008; Raymond and Croteau, 2009).

Livvarcin (2007) suggests that the representation of Miles and Snow's business strategy typology includes the strategic intent continuum of the three main strategy types in increasing order of strategic focus from left to right, i.e. Defender, Analyser and Pioneer. The Reactor type is considered outside this continuum as it is essentially a "non-strategic" response (Miles and Snow, 1978). These four strategy types are:

- Defender – emphasis on efficiency and cost reduction to maintain existing markets (low level of uncertainty, e.g. regulated utility provision (Fearon et al, 2013);
- Analysers - simultaneous focus on maintaining and achieving efficiency in existing utility regulated markets using traditional technology routines and practices, while

simultaneously seeking out new technology based markets to sustain and increase growth in a Pioneer manner (Peak et al, 2005, 2011).

- Pioneers - a singular focus on new service and market opportunities to drive growth (high levels of uncertainty), as opposed to the duality of the Analysers (typical approach used by new technology business units within utilities (Fearon et al, 2013, Peake et al, 2005);
- Reactor – no clear strategy with a tendency to react to market changes in a lag manner (Livvarcin, 2007).

In exploring alignment between the business strategy typology and the technology strategy, a functional-level technology strategy typology was also borrowed. The technology strategy typology used is based on the work of Danneels (2002) which is consistent with the typology and Dynamic Capability approach and that of Strategic Alignment (Level 1) being conceptualised as involving alignment between business strategy and technology strategy. The authors have cross-mapped the Miles and Snow (1978) business strategy typology and Daneels (2002) technology strategy typology as the basis of a conceptual alignment model as shown in Figure 1.

This representation in building links between the business strategy and technology strategy implies the need for alignment based technology management routines should be viewed as a series of alignment DCs (Ambrosini et al, 2009a and b; Baker et al, 2011; Helfat and Winter, 2011). Ambrosini et al (2009a, p 9) in a review of the DC literature defines it as, "*the capacity of an organisation to purposefully create, extend or modify its resource base*". They suggest that the alignment competencies associated with existing or traditional markets and business activities can be represented as "*incremental*" DCs involving increased efficiency to "*exploit*" (mainly upper left quadrant of the technology strategy matrix in Figure 1) existing markets and technology, and that those linked with the bottom right quadrant of new markets and technology are mainly "*renewal*" DCs (involving new market and technology competence). Consistent with the conceptual model (Figure 1) it is suggested that the ability to use PM approaches in this role can be conceptualised as a particular set of PM-based technology alignment DCs[3] (i.e. PM-DCs). The upper left quadrant of the technology strategy matrix (Figure 1) suggests that PM-DCs in dealing with existing technology and in handling existing customers is equated to the Defender business strategy type. The Defender type is usually linked to exploiting and improving existing markets and technology through combined customer and technology based PM-DCs (Ambrosini et al, 2009a; Danneels, 2002). In contrast, the bottom right quadrant of the matrix shows PM-DCs combining new technologies and customers that is linked to the Pioneer strategy type. The bottom left and upper right quadrants/types (Figure 1) have been mapped to the Analyser strategy attempting to exploit either existing technologies with new customers or next technologies with existing customers or technologies.

[3] *PM-based alignment DCs* (PM-DCs) are organisational routines that use performance measures to achieve level 1 and 2 alignment (Figures 1 and 2) and if appropriate reconfigure its PM-based resources in response to changes in its operating environment.

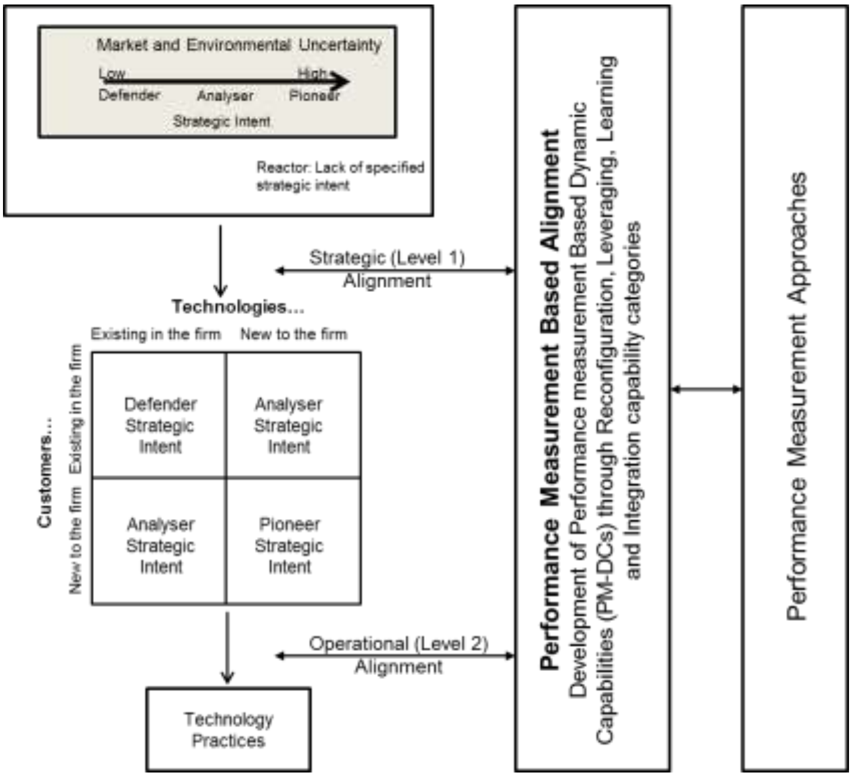

Figure 1 – Conceptual alignment model

In addition to Level 1, the conceptualisation of PM effects at Level 2 alignment (Figure 1) between technology strategy and technology practices is also considered as a series of technology alignment PM-DCs which are more operational in nature, consistent with “efficiency” alignment (Baier et al, 2008, p 36) and what Melynk et al (2004) refer to as “tactical and operational stages” within organisations.

In sum, Figure 1 is the initial conceptual model for the research which shows how the business strategy typology and technology strategy typology are conceptually linked in relation to Level 1 and level 2 alignments. Figure 1 also shows the influence of the PM-DCs in driving this alignment process which, in turn, is influenced by the contextualisation of PM approaches to fit with the PM-DCs (right hand side of Figure 1). Our empirical study that follows focuses on the following three "*how*" and "*what*" type research questions (Yin, 2011) and Barratt et al, 2011):

- RQ1: How are PM based dynamic capabilities (PM-DCs) used to improve the alignment between the business strategy and the technology strategy (Level 1)?
- RQ2: How are PM based dynamic capabilities (PM-DCs) used to improve the alignment between the technology strategy and the supporting technology-based operational routines and practices (Level 2)?
- RQ3: What are the gaps in knowledge with respect to the use of PM based dynamic capabilities (PM-DCs) in enabling Level 1 and Level 2 alignment between business strategy, technology strategy and practices?

In relation to other perspectives and potential research synergies it is noted that this paper explores alignment from the Dynamic Capabilities theory perspective which is developed from a nexus of the Resource based View and organisational learning theory as shown by Ambrosini et al (2009) and Teece et al (1997). This work parallels similar studies conducted from information systems perspective (Cuenca et al, 2011; Cuenca et al, 2014; Goepp and Avila, 2015). These studies extend the theoretical development of the Strategic Alignment Model developed by Henderson and Venkatraman (1993) in which there is a focus on the alignment of Information Systems in relation to strategic fit (alignment between internal and external environments) and functional integration (integration between business and information systems domains). Included in these studies are comparisons of multiple alignment sequences, each of which can be referred to as an alignment level in relation to their various domains and components such as governance and architecture (Avila et al, 2009). However, the current study focuses on strategic and operational level alignment to explore the role of performance measurement (PM) approaches in technology alignment at strategic and operational levels from a Dynamic Capability Theory perspective supported with empirical evidence. This approach builds on the above studies which suggest the need for exploring the dynamics of alignment. For example, Avila et al (2009) refers to the "as-is" and "to-be" states of dynamic alignment and stresses the need to study a more continuous alignment approach in environments which are rapidly changing in unpredictable manners. Similarly, Goepp and Avila (2015) state the need to consider the need to build alignment on an ongoing basis in a dynamic manner. These views are consistent with Henderson and Venkatraman (1993, p 482) who stated "strategic alignment is a journey not an event". It is suggested that these alignment studies are largely parallel to the Dynamic Capabilities body of work on alignment they both conceptualise alignment from a dynamic perspective rather than a state of attainment. Whilst there is an opportunity for further research exploring the role of Dynamic capabilities in Information Systems-based alignment studies, the objectives of the work presented here, based on the three research questions outlined above, is to explore the role of performance measurement (PM) approaches in technology alignment at strategic and operational levels from a Dynamic Capability Theory perspective.

3. Research Methodology

A number of researchers (e.g. Kolehmainen, 2010; Hanson et al, 2011; Congden, 2005; Pero et al, 2010; Raunier et al, 2008; Bjorn and Ngwenyama, 2010, and Sousa and Voss, 2008) suggest that there is an opportunity to use case-based research and inductive theory-building methodologies to address a theoretical gap in alignment studies. In considering alignment as multilevel, complex and dynamic (Kolehmainen, 2010; Baker et al, 2011), the multiple case approach is used to contribute deep rich data on the contextual and dynamic aspects of the study (Sousa and Voss, 2008, Barratt et al, 2011, Bititci et al, 2006). The levels and units of analysis are the strategic and operational levels within the organisation (Levels 1 and 2) and the teams of managers and employees at each of these levels. Eisenhardt (1989) and Barratt et al (2011) show that this multi-case theory-building approach includes juxtaposing data and theory in an iterative manner using multiple case studies to give theoretical replication. The four cases that formed our units of analysis were constituent parts of two parent utility organisations (Table 1), an approach adopted by Barratt and Oke (2007). The four cases represent a blend of traditional and new technologies operating in a fast changing technological environment. In addition, they were all concerned with the alignment of their technology strategies, they were actively engaged in interventions to address this concern, and their interventions included use of performance measurement approaches. Thus, they provided a unique opportunity for developing an in-depth understanding of the role of performance measurement (PM) approaches in technology alignment at strategic and operational levels from a Dynamic Capability Theory perspective.

Table 1. Case Organisations and Units of Analysis

Case	Key Business Drivers	PM Approaches Used	Units of Analysis
A Electrical utility employing c.1200	Privatisation and deregulation; rapidly changing market; new entrants with less overheads; programme of diversification and investment.	ISO9000; Lean, Six Sigma; BEM; Balanced Scorecard; Chartermark; Benchmarking	A1 Traditional Electricity Transmission Business Unit
			A2 New Geographical Information System Business Unit
B Telecoms employing c.2000	Deregulation; new entrants with fewer overheads; new and rapidly developing technologies; programme of new product development.	ISO9000; Business Process Reengineering; Business Excellence Model; Benchmarking, Lean, Six Sigma.	B1 Traditional Telecoms Business Unit
			B2 New Internet Services Business Unit

The two utility organisations faced considerable technology alignment challenges and were involved in longitudinal university-industry partnerships each of a three-year duration - an electrical utility company (Organisation A) and a telecommunications utility company (Organisation B). Following ten initial scoping interviews with management team members the data gathering included observations where a three-person team of researchers and consisting of one part-time and two full-time researchers spent considerable time blocks in the organisation observing technology management activities at strategic and operational levels. Over the three years there were a total of 38 semi structured interviews, both on-going and summative at monthly stages, with managers at both Level 1 and Level 2 (i.e. Managing Director, management team, supervisors and employees), each lasting between one and 2.5 hours. The repeat interview approach was used with each of the managers being interviewed at least four times to add clarity. This approach (including telephone calls, emails and document exchanges) established a relationship of trust and produced reflective practitioner inputs as suggested by Alvesson and Skolberg (2009) and Yin (2011). The interviews probed how alignment issues were recognised and addressed and how training and development approaches were used to improve alignment (per case study). Eight Focus Groups (two per case study) spanning levels 1 and 2 were held with management and a cross section of employees involved in strategy and technology management (on average five to eight people per focus group) each lasting 1.5 to two hours. The focus groups were based on the key alignment issues identified from the interviews and probed how differentiation was made between Level 1 and Level 2 alignment. Interviews were also held with the respective government regulatory bodies (2 off). Company documentation sources included regulatory reports, technology investment documentation, minutes, effectiveness reports and Business Excellence Model (BEM) award application documentation. The interview and focus group details are presented in Appendix 1.

4. Analysis and results

This section covers how the data from the research was analysed in relation to the three research questions leading to the results as presented in the evidence tables (Appendices 2 –

4). Next section, discusses these findings in relation to the literature and theory leading to propositions and a revised theoretical framework (cp Figures 1 and 2). The analysis was based on Radnor and Boaden's (2004) qualitative data analysis approach where:

- All interviews were taped recorded, transcribed and coded using NVivo 12.
- Progressive narratives were developed (Appendix 2) from the coded interview transcripts.
- Evidence tables (Appendix 3) were constructed consistent with Miles and Huberman (1984) based on the narratives and the coded transcripts.
- Activity maps (Appendix 4), consistent with Bititci et al's (2006) method for representing longitudinal qualitative data; which were constructed from progressive narratives and evidence tables
- Following, Ambrosini et al's (2009a, 2009b) general DC classification the findings were classified as a specific PM-related set of DCs, as illustrated in Table 2. Ambrosini et al (2009a) suggest that the adjective "dynamic" in DCs refers to changes within the resource base. In the literature the term "resource" is defined as structures, capabilities, routines and practices, the use and change of which enable the organisation to generate competitive advantage (Janssen and Castaldi, 2016; Helfat and Winter, 2011; Barreto, 2010 and Ambrosini et al, 2009a). In this context, PM-based resources include Performance Measurement Systems (PMS), PMs, and PM practices (i.e. how PMs were used in organisations). In exploring PM-DCs we were particularly interested in understanding how PM-based resources affected alignment and how these resources changed to improve levels of alignment.

Table 2. Classifications and Examples of Performance Measurement DCs (PM-DCs

	Renewal DCs Changes of resources at a level where the underlying assumptions are questioned and changed	**Incremental DCs** Change resources by extrapolating from current positions
Reconfiguration DC transformation and recombination of resources	Introduction of new leading and lagging PMs thus transforming the PMS	Combining existing PMs in a way that transform the PMS
Leveraging DC deployment of resources into a new domain or business area	A PMS developed for one function being applied in a different function	A PMS developed for one function being rolled out to different parts of the same function
Learning DCs experimentation and critical reflection on resources	Developing new PM routines in a trial and error manner	e.g. Improvement of existing PM routines in a trial and error manner
Integration DCs integration of resources	Combining separate PMs into a new single PM	Combining separate PMs into an improved single PM

Table 2 provides the basis by which the data were analysed, categorised and presented in Appendices 2 – 4. Using the interview and focus group data (cross checked with the document analysis) each of the four cases were analysed and documented individually, followed by a cross-case analysis leading to the further development of the conceptual framework and propositions similar to that of Barratt and Oke’s (2007) method for case study analysis. Our discussions and conclusions, presented in the next section, are based on the lines of evidence that emerged from each case study. In analysing the data and addressing the research questions, explicit definitions for the concepts used include:

- ***Business strategy*** is the strategic intent of the organisation in responding to changes in its external environment, operationalised through Miles and Snow’s (1978) typology.
- ***PM approaches*** are the tools and techniques used by the organisations to measure and improve performance. For example: BSC, BEM, Lean-Six-Sigma.
- ***Technology strategy*** is the approach organisations use to deploy technologies (existing or new) to deliver their business strategies to selected markets (existing and new) based on Daneels (2002).

- ***Technology routines*** are the organisational routines or practices that are purposefully pursued to implement technology strategy. For example, if the technology strategy is to deploy Geographical Information Systems (GIS) technology, technology routines supporting this strategy could include digitising conventional maps, and developing smart ways of searching these maps.
- ***PM based Dynamic Capabilities (PM-DCs)*** are organisational routines that use PMs to achieve Level 1 and 2 alignment and, if appropriate, reconfigure its PM based resources in response to changes in its operating environment. For example, at Level 1, if the business strategy is to become a significant player in GIS products and services, measuring technology readiness levels in relation to deployment of GIS technology will ensure alignment between business and technology strategies. Similarly, as Level 2, measuring the percentage of maps digitised will reinforce alignment between technology strategy (deploying GIS technology) and technology routines.

Overall, the results from the data analysis and theory-building approach shows that business strategy and technology alignment is both multilevel (Hanson et al, 2011; Bardhan et al, 2011) and path dependant (Ambrosini et al, 2009a and b), i.e. there is a need to first resolve strategic alignment (Level 1) issues and then proceed to operational alignment (Level 2) issues. As stated by the managing director, Case A1: "… *once it [alignment decision] goes to the strategy team, it would then go to this [technology function level] management team. For example, we had a meeting just last week, whereby we were looking at altering the number of high level KPIs throughout the organisation… we sat down with them [boundary spanning team] and agreed on the final set of KPIs for this year*". Our analysis of data from the four case studies, using the method described above, in relation to our first two research questions yielded insights in four areas as summarised in the following paragraphs.

First, the analysis showed there was a need to identify and understand the strategic intent of the organisation (Miles and Snow, 1978; Livvercin, 2007) as shown in the results of Appendix No 2. In relation to the cases the use of the contingency theory (Bititci et al, 2006) and Miles and Snow's (1978) typology was useful in showing how the case organisations represented the duality of the Analyser strategy type i.e. maintain core business (i.e. Case A1 and Case B1) while also exploring the development of new markets through technology development (Case A2 and Case B2). A typical example was that of metering technology capability from Case A1 which was further developed by Case A2 as a commercial product, as exemplified by the Case A2 Technology Manager, "*Well you see what we do, in that, we can do sub-metering for organisations, we can sell new metering systems, we have put those in for the Police, we got a contract in for water utilities. This was external revenue… so we are competing and we are looking to develop our technical skills and everything else*".

Second, the analysis showed that to achieve Level 1 alignment, there was a need to determine the technology strategy and then to map the business strategy onto the most appropriate technology strategy (Appendix 2). Danneel's (2002) typology framework for technology management provided a useful reference for this cross mapping with the Miles and Snow (1978) typology framework as shown in Figure 1.

Third, from the analysis it was found that there was a need for the cases to develop both renewal and incremental PM-DCs across all four categories to facilitate Level 1 alignment (addressing RQ1) as shown in Appendices 2 and 3. The use of PM approaches to achieve this alignment required PM approaches to be applicable at a strategic level. This approach required contextualisation of the PM approaches as suggested by Sousa and Voss (2008) which was found in Case A1 and A2, in contrast to the more top down best practice approach found in Case B1 and Case B2 which limited employee empowerment and involvement. For example, Case A2, using bespoke business process reengineering methods, developed GIS technology which was successful in selling GIS products and services to other organisations such as Road Services and Telecoms.

Fourth, the findings from the data (results shown ion Appendix No 3) showed that the cases had to develop incremental PM-DCs, again across all four categories, to aid Level 2 technology alignment (addressing RQ2). Furthermore, observation from Appendix 3 suggests that classification of the PM-DCs into reconfiguration, leveraging, learning and integration categories is helpful in developing smart strategies, practices and training programmes to target specific Level 1 and Level 2 alignment challenges.

Primarily, in relation to RQ3, the analysis of the findings also revealed that the training and development within all four cases to aid the development of PM-DCs at Levels 1 and 2 was limited (results in Appendix No 3). For example, in all four cases there was training in technical management of existing and new technology coupled with training in a range of PM approaches. However, there was limited training on how to contextualise PM approaches and nurture PM-DCs, other than that learned by experience, which required new managerial skills in addition to engineering expertise, as noted by the Case B2 technology manager: "*We just look at well the technical training when we went back and looked at where we were going wrong. So the training has really been driven by the demands of .....circumstance rather than an overall training plan*".

5. Discussion

Overall, the analysis and results section from a conceptualisation perspective show that organisations should treat technology alignment as a complex, multilevel and path-dependant process where idiosyncratic approaches can be developed to reduce costs and aid competitiveness (Ambrosini et al, 2009a; Danneels, 2002). Based on these findings the conceptual model has been revised (Figure 2) leading to the development of propositions based on the style adopted by Barratt and Oke (2007) and Bititci et al (2006). The revised conceptual model (Figure 2) reflects the findings outlined above and shows that organisational effectiveness in addressing alignment is conceptualised as a series of incremental and renewal PM-DCs that can be broadly classified into reconfiguration, leveraging, learning and integration categories to aid specific training and development in PM-DCs (Ambrosini et al, 2009a and b; Teece et al, 1997).

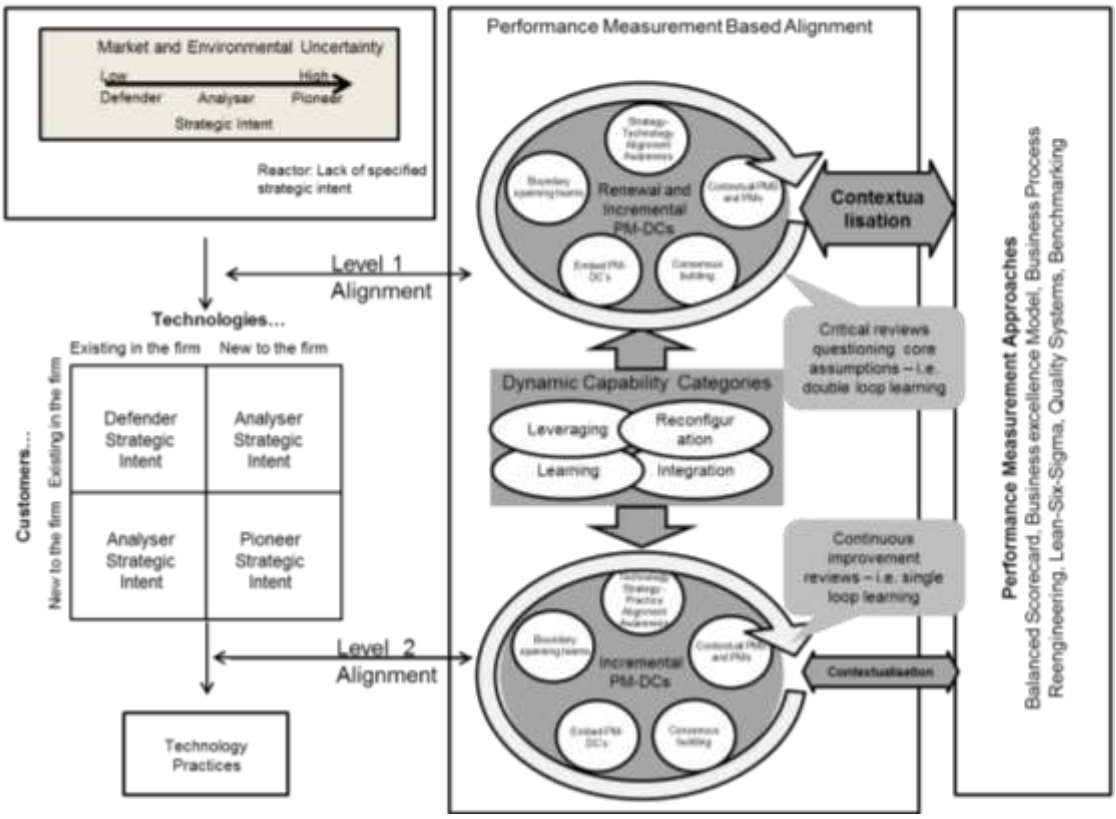

Figure 2 – Final Conceptual Model

Based on the conceptual representation of technology alignment from Figure 2 and the findings (Appendices 2 – 4) a number of propositions are advanced in addressing RQ1 (level 1 alignment) and RQ2 (level 2 alignment). The findings show the need to clearly distinguish between Level 1 and Level 2 technology alignment (Hanson et al, 2011) and to develop DCs which address both levels, leading to our first proposition:

> ***The role of PM approaches in improving technology alignment occurs at two levels: Level 1 (business strategy – technology strategy) alignment and Level 2 (technology strategy – technology practices) alignment.***

The findings, as shown in Figure 2, show the path dependency attribute of multilevel alignment improvement using PM approaches where Level 1 and Level 2 technology alignment is a recursive and dynamic process involving legitimisation and normative evaluation (i.e. a dynamic process of comparing the existing or normative state of alignment with the desired state of alignment to increase legitimation of the emerging state) (Bardhan et al, 2007; Suchman, 1995), leading to our second proposition.

> ***The improvement of multilevel technology alignment using PM approaches is iterative path-dependant where critical reviews progressively shape the use of the PM approaches in technology alignment.***

Throughout the case findings the capability to adapt and contextualise PM approaches to address alignment challenges proved beneficial (Cases A1 and A2). Reliance on the application of best practice and top down approaches led to incongruities and lack of boundary spanning based learning, hence our third proposition:

> ***To address Level 1 and 2 technology alignment, PM approaches should be adapted and contextualised using consensual and boundary spanning based learning rather than applying a top-down and best practice based standardised approaches.***

The predominance of renewal based PM-DCs in relation to incremental PM-DCs (Ambrosini et al, 2009a) for Level 1 alignment leads to our fourth proposition:

> ***Effective Level 1 technology alignment requires the development of a series of predominantly renewal PM based technology alignment DCs which occur in the categories of reconfiguration, leveraging, learning and integration.***

Consistent with Baier et al (2008) PM-DCs occurring at Level 2 were found to be mainly incremental in nature with relatively less emphasis on contextualisation (Baier et al, 2008), leading to our fifth proposition:

> ***Effective Level 2 technology alignment requires the development of a series of predominantly incremental PM based technology alignment DCs which occur in the categories of reconfiguration, leveraging, learning and integration.***

At Level 1 the trigger or catalyst for invoking the use of renewal DCs was the initial awareness of the need for alignment together with the critical review of the status quo. This is consistent with the development of learning DCs (Teece et al, 1997). Thus our sixth proposition:

> ***Learning based DCs acts as a trigger for showing the limitations of incremental PM based technology alignment DCs in increasing alignment at Level 1 and helps to legitimise renewal PM based alignment DCs.***

Concerning our third and final research question RQ3 relating to the gaps in knowledge we have demonstrated that performance measurement approaches act as dynamic capabilities in underpinning strategic change in general and technology alignment in particular. However, our understanding of PM based dynamic capabilities are at their infancy. This is best demonstrated by our classification of PM-DCs where the same PM-DC is classified as both an incremental and renewal DC depending on its context. Consequently, more research is required to further our understanding of strategic and operational PM-DCs, their classification and interaction with other DCs at times of strategic and technological change. As theory in this area is scarce, more inductive longitudinal research based on fine-grained case studies will be required to advance our understanding of this particular area.

4. Conclusions

It is argued that the paper makes a reciprocal contribution to both Dynamic Capability and performance measurement literature and conceptualisation in relation to production research literature where Dynamic Capability theory is emergent in nature and where alignment is treated a multi-level complex and dynamic (Simoes et al, 2016, Hong et al, 2011 and Fearon et al, 2013) First, in relation to PM theory the findings show the importance of not only probing the effects of PM frameworks and PMs in organisations in times of rapid change but also the need to identify and assess the PM-DCs which result in dynamic changes to the PM-related resource base (e.g. PMS, PMs, PM goals and PM routines and practices).

Second, in relation to DC theory, Helfat et al. (2007) suggest the need for further studies to show specific sets of DCs which are contextually grounded and related to a particular organisational change issue. We developed the idea of PM-related DCs and by using Ambrosini et al's (2009a and b) classification we further developed and explored the specific PM-related DCs in the context of organisational change. The study can also act as a guide for further studies of specific sets of DCs in other contexts in production based research where the use of Dynamic Capability theory is emergent in nature e.g. knowledge-based DCs (Verreynne et al, 2016).

A third contribution is made to overall technology alignment. The use of PM-DCs in helping to probe alignment at two levels (strategic an operational) shows the need to treat technology alignment as a rapidly changing and dynamic phenomenon. Moreover, the abstracted tables show how such dynamic changes in technology alignment can be observed and classified. Thus, there is a contribution to production research literature in that alignment is not seen as a state to be achieved but rather as a continuous journey as suggested by Venkatraman (1993) and Ambrosini et al (2009).

The limitations of the paper include the reliance on four cases as business units within two organisations. Further case analysis could be used to increase generalisation. Such studies could use this initial conceptualisation with case studies from other sectors and non-utility organisations where organisations are challenged to grow and develop new markets in addition to maintaining current markets. Such research could lead to further conceptualisation and further establish the robustness of the propositions in relation to Level 1 and Level 2 alignment. A further step could be to develop the framework and propositions into measureable and testable hypotheses as suggested by Verreynne et al (2016) and to use a large cross-sectional study to further test such measures. Furthermore, as discussed earlier, there is potential for further interdisciplinary exploratory research agendas in exploring a nexus between the parallel bodies of existing Information Systems-based alignment studies and Dynamic Capabilities alignment conceptualisations which have the potential to further contribute to alignment conceptualisation and related empirical studies.

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Appendix 1

Overview of Interview and Focus Group Protocol

List of interviewees by job title equivalence in each of the four cases (actual job titles varied across the four cases)

- Regulator
- Managing director
- Manager of business strategy
- Manager of technology strategy
- Business strategy – technology strategy liaison manager
- Manager of technology practices
- Technology supervisor
- Technology strategy – technology practices liaison manager
- Technology operative 1
- Technology operative 2

Focus group participants by job title equivalence in each of the four cases (actual job titles varied across the four cases)

- Manager of business strategy
- Manager of technology strategy
- Business strategy – technology strategy liaison manager
- Manager of technology practices
- Technology strategy – technology practices liaison manager
- Technology operative

The summary of semi-structured interview guides is shown below which varied dependant on the interviewee location in the organisation (in addition to person placement information). The focus groups also used a combined version of these guides using a critical incident approach – i.e. a focus on alignment problems at each level.

Questions mainly for business strategy management and technology strategy management (varied due to the semi structured approach)

1. What are the key business challenges facing the organisation?
2. How are the key markets of the organisation changing?
3. What strategic position has the organisation adopted to address these challenges?
4. Is there a strategic planning process and how does it work?
5. What is the role of performance measurement in the strategic planning process?
6. What performance measure approaches are used in this process?
7. What are the key roles and responsibilities within these approaches?
8. Describe the types of performance measures used.
9. What are the key technology challenges and opportunities facing the organisation?
10. What technology strategic position has the organisation adopted to address these challenges?
11. Is there a technology strategy planning process and how does it work?
12. What is the key business strategy – technology strategy alignment challenges?
13. Give examples of good and bad alignment and the consequences.
14. How is boundary spanning used to aid this alignment process?

15. What is the role of performance measurement in the technology strategy planning process?
16. What performance measure approaches are used in the alignment process?
17. What are the key roles and responsibilities within this approach?
18. Describe the type of performance measures used.
19. How have performance measurement approaches and measures been developed and changed to address business strategy and technology strategic alignment challenges?

Questions mainly for technology strategy management and technology practice staff (varied due to the semi structured approach)

1. How are technology practices developed in support of the technology strategy?
2. What are the challenges facing the development of technology practices?
3. How are technology practices identified to maximise the use of resources?
4. How are technology practices being developed to maximise the use of resources?
5. Is there a technology practices planning process and how does it work?
6. What is the role of performance measurement in the technology practices planning process?
7. How are technology strategy and technology practices aligned using performance measurement approaches to maximise the use of resources?
8. How have performance measurement approaches and measures been developed and changed to address these alignment challenges?
9. What performance measurement frameworks are used in this process?
10. What are the key roles and responsibilities within this approach?
11. Describe the type of performance measures used.
12. How are technology strategy and technology practices aligned using performance measurement approaches to maximise the use of resources.
13. How is boundary spanning used to aid this alignment process?
14. How have performance measurement approaches and measures been developed and changed to address alignment challenges?
15. Give examples of good and bad alignment and the consequences.
16. Discuss the training and development at all levels in relation to alignment and performance measurement practices.

Appendix 2

Evidence Tables - Progressive narrative - Case overview and emerging performance measurement based Dynamic Capabilities (PM-DCs) based on the data findings and analysis

<table>
<tr><th></th><th></th><th>Case A1</th><th>Case A2</th><th>Case B1</th><th>Case B2</th></tr>
<tr><td rowspan="6">Summary Narrative</td><td>Market and Environment</td><td>• Deregulation
• Open competition
• Increased consumer choice</td><td>• Deregulation
• Competition from established hi-tech providers</td><td>• Deregulation
• Rapid technology development
• Imposed performance measures
• Increased competition</td><td>• Innovation in products/services
• Rapid technology development
• High levels of uncertainty,
• Global competition</td></tr>
<tr><td>Strategic Response</td><td>• From Defender
• To Analyser</td><td>• From Analyser
• To Defender</td><td>• From Defender

• To Analyser</td><td>• From Analyser
• To defender</td></tr>
<tr><td>The Challenge</td><td>• Changing from hierarchical engineering led organisation to a responsive customer led organisation
• Using new technology to deliver value</td><td>• Alignment of technologies with GIS market opportunities
• Changing culture from customer solutions ethos to technology leadership.</td><td>• Radical improvements in: costs; quality; customer satisfaction
• Changing from hierarchical engineering led culture to a responsive customer solution focused culture.</td><td>• Rapid capability development through:
○ transfer of staff from B1
○ joint ventures and acquisitions</td></tr>
<tr><td>Original PM approach</td><td>• Performance measures based around standard BEM, BSC and 6Sigma approaches
• Separate business and technology strategy teams with no boundary spanning</td><td>Sole focus on innovation using

• BEM self-assessment
• Benchmarking
• Process improvement using standard 6∂ techniques</td><td>• Top-down senior management driven approach
• Over reliance on mechanistic measures based on ISO9000
• Using BSC to drive technology strategy.</td><td>• Top-down senior management driven approach learned from B1</td></tr>
<tr><td>Technology alignment issues</td><td>• High technology costs
• Operationally overreliance on outdated technology
• Poor customer service</td><td>• Limited supplier leverage with embryonic supply chains
• High levels of product risk</td><td>• Middle management resistance due to lack of misalignment with existing measures
• New product launch problems</td><td>• Sub=optimal resource use and performance in relation to technology based acquisitions and joint ventures</td></tr>
<tr><td>Revised PM approach</td><td>• Contextualised PM approaches
• Increased boundary spanning and cross over between business strategy and technology strategy teams</td><td>• Using technology roadmaps with new contextualised PMs linking business with tech. strategy
• Learning from Case A1
• Co-location of PM development teams</td><td>• Limited effort to involvement, engagement and networking.
• Predominantly top down management driven approach</td><td>• Using mechanistic deployments models such as BSC and Hosin Kari Planning
• Limited effort to involvement, engagement and networking.
• Predominantly top down management driven approach</td></tr>
<tr><td colspan="2">Outcome</td><td>Emergence of incremental and renewal PM-DCs at strategic and incremental PM-DCs at operational levels.</td><td>Emergence of incremental and renewal PM-DCs at strategic and incremental PM-DCs at operational levels.</td><td>Emergence of incremental PM-DCs both at strategic and operational levels.</td><td>Emergence of incremental PM-DCs both at strategic and operational levels.</td></tr>
</table>

Appendix 3

Evidence Tables – PM-based Dynamic Capabilities types for each of the four cases based on the data findings and analysis

		Case A1	Case A2	Case B1	Case B2
PM based dynamic capabilities for Level 1 Alignment	**Reconfiguration DC** Transforming and recombining resources	***Incremental:*** • Environmental scanning of existing regulated utility technology and markets using benchmarking routines • Identification and application of best practices • Use of cross functional teams ***Renewal:*** • Contextualisation of PM models to address alignment • Reconceptualisation of PM methods • Application of contextualised and reconceptualised PM approaches • Normative evaluation and legitimising new PM based alignment routines	***Incremental:*** • Environmental scanning of unregulated markets using benchmarking routines • Identification and application of best practices from the regulated markets • Involvement of cross-functional teams ***Renewal:*** • Application of contextualised and reconceptualised Lean Six Sigma and VoC PM models to alignment in the unregulated technology strategy • Normative evaluation of existing technology and legitimising new technology using cross-functional teams	***Incremental:*** • Environmental scanning using process benchmarking • Identification and application of best group practices • Involvement of cross functional TQM teams • Application of ISO:9000 based PMs to control alignment ***Renewal:*** • Limited contextualisation of PM models based on value stream mapping and variation reduction	***Incremental:*** • Environmental scanning of unregulated business and markets using process benchmarking routines • Identification and application of best practices using BPR • Involvements of staff in cross functional teams ***Renewal:*** • Application of Design for Lean Six Sigma to the product design process to increase alignment
	Leveraging DCs Deployment of resources into a new domain or business area	**Incremental:** • Translation of strategy to multiple business areas • Wider application of continuous improvement principles to alignment routines **Renewal:** • Recognising, valuing and applying strategic inputs from multiple levels to alignment • Effective communication and listening using VoC and IiP alignment routines • Spreading legitimacy of reconceptualised PM based alignment routines	***Incremental:*** • Extrapolation of existing technology to new markets using benchmarking routines • Translation of unregulated technology strategy to multiple business areas using the BSC • Application of Continuous improvement principles from A1 ***Renewal:*** • Learning from technology benchmarking • Recognising and applying tech inputs from multiple sources within and without the org • Effective communication using VoC and IiP routines	***Incremental:*** • Using BSC to deploy strategy to multiple business areas • Wider application of continuous improvement principles • Wider application of ISO:9000:2008 to address technology alignment issues ***Renewal:*** • Applying contextualised PM models to a wider range of projects to resolve technology alignment issues • Increasing legitimacy of contextualised pm models to improve technology	***Incremental:*** • Translation of business strategy to functional level with separate teams using the BSC • Continuous improvement of technology alignment ***Renewal:*** • Increasing legitimacy of contextualised pm models to improve technology alignment

	Learning DCs Experimentation and critical reflection on resources	**Incremental:** • Review of the strategy translation effectiveness linked to efficiency improvements using the BEM and BSC **Renewal:** • Alignment trigger recognition based on double loop learning • Formative evaluation of technology strategy using TQM involvement routines • Critical review and evaluation to drive reframing of PM model routines to step change alignment • Value stream analysis to simplify alignment • Longitudinal alignment review using BEM routines linked to BSCs	***Incremental:*** • Cross learning from regulated technology alignment • Use of BEM and BSC to review deployment of strategy to improvement programmes ***Renewal:*** • Appraising emerging technology and its alignment using benchmarking routines • Alignment review triggered by double loop learning process • Formative evaluation of technology strategy through employee empowerment • Critical review to drive reframing of PM model • Longitudinal review using BEM self-assessment	***Incremental:*** • Reviewing effectiveness of PM models on alignment • Reviewing deployment effectiveness using the BSC • Single loop alignment learning • Cognitive understanding of the technology alignment problem • Limited operational rather than strategic interpretation of PM models in relation to alignment ***Renewal:*** • Formative evaluation of technology strategy alignment using TQM • Involvement and engagement routines • Reviewing technology alignment using BEM	***Incremental:*** • Review of the business strategy translation effectiveness linked to efficiency improvements using the BSC • Single loop alignment learning • Building awareness of the technology alignment problem ***Renewal:*** • Formative evaluation of new technology alignment • Employee empowerment through involvement mechanisms • Development of skills sets to align with new technology and market requirements
	Integration DCs Integration of resources.	**Incremental:** • Cross functional teamwork on alignment using BEM self-assessment at multiple levels **Renewal:** • Co-producing technology strategy in combined business strategy-functional strategy team using PM based routines • Value streaming of cross functional alignment activities using Lean principles • Use of alignment focused CoPs based on TQM project team principles	**Incremental:** • Cross functional teamwork on alignment using BEM self-assessment at multiple levels **Renewal:** • Co-producing technology strategy in combined business strategy-functional strategy team using PM • Value stream analysis of alignment activities using Lean principles • Use of CoPs based on TQM project team principles	***Incremental:*** • Using cross functional teamwork on alignment using BEM self-assessment at multiple levels • Cross functional process teams to control alignment using ISO 9000:2008 ***Renewal:*** • Value stream analysis of alignment activities using Lean principles	***Incremental:*** • Multifunctional process alignment teams across old and new technology based on ISO 9000:2008 ***Renewal:*** • Application of value streaming thinking to alignment

		Case A1	Case A2	Case B1	Case B2
PM-based dynamic capabilities for Level	**Reconfiguration DCs** Transforming and recombining resources	• Differentiation of technology activities for the traditional and the new technology parts of the business (minimal cross fertilisation)	• Distinctive technology unit reporting • Technology road mapping and process change	• Increasing the separation between the technology units and activities (i.e. unregulated and new business units)	• Development of distinctive technology management routines for the unregulated business

	Leveraging DCs Deployment of resources into a new domain or business area	• Development of distinct performance measures for each technology unit. Involvement of customers in technology development (e.g., smart meters) • Development of measures of contextualisation – language adaptation, changes, culture fit - formative measures using the technology management team monthly meetings and summative using the BEM self-assessment (summative role) • Process-based benchmarking of technology with benchmarking partners (mainly efficiency measures)	• Development of distinct performance measures for new technologies • Process-based benchmarking of technology management routines using generic benchmarking (using leading measures i.e. technology development costs; cycle times; emerging market trends)	• Cross fertilisation between traditional and new technology, e.g., electronic components • Use of measures of best practice applications • Benchmarking with partners in both the traditional business (mainly efficiency measures) and with the new emergent business (lead measures such as adaptations and developments of existing technology for new products and services)	• Leverage of technology cross fertilisation based on relevant PMs from Case B1 • Increasing use of lead measures such as adaptations and developments of existing technology for new products and services
	Learning DCs Experimentation and critical reflection on resources	• Measurement of skills required and anticipated at all key stages of the technology management alignment process • Review of effectiveness of team solutions for technology alignment • Tests for consistency of two-way communication from functional strategy level to multiple points of the technology management process – timeliness, content, consistency; feedback effectiveness and review effectiveness (i.e., number of resultant changes) • Evaluation of contribution and potential contribution from each PM model and methodology to the supply chain practices and measures	• Training and measurement of new technology based skills-sets at operational levels • Comparative measurement of technology alignment activities at functional level • Monthly technology strategy team meetings and summative review using the BEM self-assessment	• Joint use of performance measurement approaches with training at an operational level • Measurement of contribution of each technology process to the technology strategy • Testing for consistency of communication from functional strategy level to multiple points of the technology management process • Evaluation of the contribution from each performance measurement model and methodology to technology management practices and measures	• Training of redundant Case B1 employees (transferees) in new technologies • Measurement of contribution from the new technology using projected sales and product lifecycle measures • Experimental applications of Lean process mapping to improve alignment • Initial technology skills forecasting applied
	Integration DCs Integration of resources.	• Use of PM approaches to align technology practices with technology strategy with training, at both operational and strategy levels • Measurement of the contribution of the technology alignment action to the technology strategy using process capability measures • Joint use of functional strategy-operational technology alignment improvement teams	• Joint meetings liaison between functional and operational technology management teams • Two-way communication between functional strategy level to key points of technology management processes	• Development of a balanced range of measures for technology • Joint team activity at both operational level and technology strategy levels • Measurement and development of skills required and anticipated at all key stages of the technology management process	• Development of a range of performance measures for the majority of technology management activities • Joint technology strategy and operations teams recently established at operational level • Insipient two-way communication methods at operational level using the BSC

Appendix 4

See attached PDF file