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BUSINESS INTELLIGENCE IN NHS WALES

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Abstract

The paper investigates the challenges of implementing Business Intelligence (BI) in NHS Wales. The study is informed by extant literature, a modified Delphi approach that draws on the knowledge of ten expert panellists from the NHS/Welsh public sector, and from the extensive industry experience of one of the authors of this study. Our adapted Delphi methodology lends itself to supporting the nature of this research since it not only structures a group communication process to explore and seek consensus on specific aspects of BI implementation in NHS Wales, but it also identifies the mean priority accorded by our expert panel to approximately eighty BI-related questions. The specific findings are presented under the following six headings – tools, resources, data, business drivers, business process needs and business service needs. The findings, in general, highlight that the existing BI services in NHS Wales are not presently supporting the delivery of evidence-based business decisions.

Keywords: Business Intelligence, Analytics, Healthcare Information Systems, NHS.

1. Introduction

Business Intelligence (BI) can be defined as the transformation of raw data into meaningful information with the objective of providing effective strategic, tactical and operational insights to decision-making (Evelson 2010). Raw data in healthcare organisations are spread across a number of Information Systems; BI provides the tools necessary to analyse these large corpus of data in an efficient and cost effective manner in order to improve healthcare delivery, outcomes and providing evidence-based decision making (Crane and Raymond 2003). BI in healthcare promises to improve patient care by driving evidence-based clinical and business decisions (Carbone 2009; Wanlass 2005).

BI tools of the past have assisted the NHS in Wales with after the event historical reporting and have focused on *reactive rather than proactive* analysis and decision

making. Whilst the former analysis is helpful, it can be argued that it fails to ensure that the business functions can address issues before they happen, or indeed, provide information of what is likely to happen as a result of key actions that may be taken. NHS Wales has previously tried to implement new BI reporting tools but have found such tools to be out of date and not fit for purpose by the time they were ready to be deployed. The purpose of this paper is to investigate the challenges of implementing BI across the NHS in Wales, and to achieve this we have conducted a Delphi study that draws on the knowledge of ten expert panellists from the NHS and the wider Welsh public sector. Given the level of spend in the public sector, the volumes of data to be analysed and the cultures at work, it is surprising that there are limited empirical studies that explore the success of BI in the public sector/healthcare (Arnott et al. 2004; Petrini et al. 2003). Our study therefore contributes to this scant literature on BI implementation in healthcare.

The remainder of the paper is organised as follows. Section 2 reviews existing literature on factors affecting the implementation of BI with particular emphasis on healthcare. Section 3 describes the research methodology. This is followed by a section which described the Delphi study (Section 4). The results of the study are presented in Section 5. Section 6 contains the general discussion and recommendations from this review. Section 7 is the concluding section; it discusses future work and draws the paper to a close.

2. Factors Affecting BI Implementation: A Review of Literature

It is essential to have clearly defined Information and BI strategy and to align them with the enterprise strategy and the vision of the organisation (Hennen 2009). There is also the need to focus on business processes since organisations often get tied up in the technical capabilities and ignore how they want their business operations to run and what their key business requirements are. BI often involves integration of data from several existing Information Systems, and achieving success in BI implementation may require organisations to move away from silo information systems and present one version of the truth (meaning a single view of the data) for all of the data across the organisation (Vasile and Mirela 2008; Stefan 2009); this requires focus on data quality.

The delivery of BI services requires standards, best practice guidance and strategic direction to ensure the stated aims and objectives of BI conform to the requirements of the businesses. These services are delivered through the guidance provided from what are frequently termed as BI frameworks (Tu and Chang 2007; Swarbrick 2007). There are many interpretations of what constitutes a BI framework, with vendors, consultants and researchers sometimes taking a different perspective on the connotation (White, 2009). However, the use of BI frameworks is not widespread in the public sector. Other factors that may positively affect BI implementation include the need for adequate training and change management to help users understand and effectively use BI systems (Williams and Williams 2004), the need to ensure stakeholder sponsorship, strong project management and resource commitments, etc.

The need for using the right metrics in order to quantify the true benefits of BI projects is also important. This is particularly the case since executives often face difficulty when attempting to determine the benefits that Information Technology brings to an organisation (Tallon et al. 2000). NHS projects have traditionally used *Return On Investment (ROI)* to determine these benefits (Kasabian 2009); however, some authors argue that ROI is an inadequate indicator because it does not take into account the real value of embedding BI into the business. They have proposed *Value Of Investment (VOI)* as the true metric to determine the true worth of BI services (Haddad 2011). The argument presented is that ROI focuses on the financial benefits of the projects and is usually expressed in cash terms, and whilst this is important it fails to take into account the 'soft benefits' such as people (skills) and processes (efficiencies). Consequently, ROI could be viewed as a subset of VOI (Schwartz 2010). In this context, it is also important to have a clear understanding of *Total Cost of Ownership (TCO)*. TCO looks at the complete cost of an asset (including initial acquisition and installation, maintenance, employee training and other associated costs). This requires developing a high-level business case, establishing key performance measures, setting baselines and targets for those measures, and tracking performance after the system goes live (Hatch 2009; Williams & Williams, 2004).

Madsen (2011) generally agrees to the majority of the aforementioned success factors of BI implementation, but points out that BI in healthcare is different to BI in other industries. An important cause for this difference is the complexity and sensitivity of the data that needs to be analysed in healthcare. Agosta (2010) suggests caution

because not all BI best practices have found a seamless path in healthcare, in part because of the culture in which the healthcare operates. One of the difficulties for the NHS is in knowing how you measure the outcome from the critical success factors to determine what has been achieved. This can sometimes be based on judgement rather than any statistical or scientific measurements, which can, in turn, lead to additional challenges that need to be managed.

3. Research Methodology

Building consensus is an essential component of any policy-making process (Raynes and Hahn 2000). Use of structured interviews and direct observation methods do not lend to seeking consensus and use of focus groups could alienate some users, especially those from the smaller health organisations. The hallmarks of the Delphi method are to bring together stakeholders with opposing views and to systematically attempt to facilitate consensus as well as to identify divergence of opinion (Strauss and Zeigler 1975). In the case of the public sector, the need to seek consensus is important in order to support collaboration and the delivery of strategic initiatives such as BI services.

Norman Dalkey and his associates at the Rand Corporation originally developed the Delphi technique in the 1950s. The method requires knowledgeable and expert contributors individually responding to questions and submitting the results to a central coordinator. The coordinator processes the contributions, looking for central and extreme tendencies, and their rationales. The results are then fed back to the respondents. The respondents are then asked to resubmit their views, assisted by the input provided by the coordinator. This process continues until the coordinator observes that a consensus has formed (Grisham 2008; Hsu et al. 2007). The technique was intended to remove the bias that is possible when diverse groups of experts meet together. In the Delphi technique, the experts do not know who the others experts are during the process. The technique has been described as '*a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem*' (Linstone and Turoff 2002, page 3). Researchers have applied the Delphi method to a variety of situations as a technique to engage with subject matter experts to resolve a complex problem using

two or more rounds of questionnaires and feedback (Skulmoski et al. 2007; Okoli and Pawlowski 2004).

Since its inception, several variations of the Delphi Method have evolved to tailor the method to specific problem types (Linstone and Turoff 2002), e.g., 'modified Delphi', 'policy Delphi' and 'real-time Delphi' (Green et al 1999), and indeed our application of the Delphi is adapted to an extent. Our adapted Delphi methodology lends itself to supporting the nature of this research since it not only structures a group communication process to explore specific aspects of BI implementation and to seek consensus (this is the objective of our first round questionnaire with open-ended questions; described in Section 4) but it also identifies the mean priority accorded by our expert panel to approximately eighty BI-related questions (this is the objective of our second round questionnaire with likert scale questions).

4. The Adapted Delphi Process

Our adapted Delphi study was structured into three rounds. Round one involved the design of the initial questionnaire consisting of open-ended questions to test the problem domain. The questionnaire was administered to our expert panellists through email (please refer to section 4.1 for the constitution of the Delphi panel). The responses from the questionnaire were summarised (names of the participants remained anonymous) and a feedback report was prepared for the experts to comment; they had the opportunity to make amendments to any aspect of their original response based on the shared findings that were circulated. This was part of developing a consensus.

Round two of the Delphi study involved the design of a second questionnaire with the purpose of identifying the mean priority accorded by our expert panel to approximately eighty BI-related questions. It is to be noted that the first questionnaire, which sought consensus, informed the design of the subsequent questionnaire. The second questionnaire was again emailed to each of the panel members. Finally, the round two feedback report was prepared based on the analysis of the responses of the expert panel.

Round three consisted of only one stage and it involved the final evaluation of the responses from rounds one and two. This was achieved by means of distributing to the panel members a summary of the findings and a proposed outcome for group

consensus. This step provided an opportunity for the experts to verify the findings and provide any final comments on the proposed outcome. This round was also supported by one-to-one interviews with some of the panel members; its purpose was to reconfirm that the expert responses have been correctly interpreted. It is to be noted here that the questionnaires that were developed for the study were first tested on colleagues that were not directly involved in the study and changes were made based on the feedback received. Further, in order to avoid situations whereby the participants did not understand the questions which could then lead to inappropriate responses, a number of participants were phoned at random to reconfirm their understanding of the consensus-building process and questions.

4.1 The Delphi Panel

Selection of people knowledgeable in their respective business areas and having a commitment to complete multiple rounds of questions is essential for the Delphi method (Alexander 2004; Linstone & Turoff 2002). With regard to our study it was important to select panel members who were impartial, who understood the needs of their respective businesses, and who also had an interest in BI in the context of the information needs for their organisations. Participants for this research consisted of six experts from NHS Wales (primary source) and four experts from the wider public sector in Wales, e.g., the Welsh County Councils (secondary source). The chosen experts had the following characteristics ranked in order of importance: they had a good understanding of information and BI needs specific to their organisation, they understood the need for having relevant and timely information to support their respective decision making processes, they were heads of their respective departments, they had a pressing need to improve information but were uncertain on the best way to address this, and they had many years' experience within their organisation. The constitution of the 10-member expert panel is listed below:

- Head of Procurement, NHS Wales Shared Services Partnership
- Head of Business Systems, Betsi Cadwaladr Health Board
- Director of Informatics, Hywel Dda Health Board
- Business Manager, Facilities, NHS Wales Shared Serves Partnership
- Business Manager , Welsh Risk Pool, NHS Wales Shared Serves Partnership
- Managers, Central Team - eBusiness Services, NHS Wales

- Group Accountant, Neath Port Talbot County Council
- Operational Manager, Vale of Glamorgan County Council
- Solutions Architect, Swansea County Council
- Change Manager, Ministry of Justice, Shared Services

It was recognised that where data is collected at different points in time there can be loss of participants from the study (Hanafin and Brooks 2005). With the limited number of experts in the NHS/public sector available and able to partake in supporting the study, it was important to decrease any potential attrition between each round of the Delphi method. The participants were therefore kept fully informed about the study and there was a short follow-up period between study rounds.

4.2 Design of Questionnaire (Round one)

To understand the issues and challenges that participants of our expert panel faced within their business, it was necessary to allow the panellists the freedom in their response (Raynes and Hahn 2000; Skulmoski et al. 2007). The authors reflected on the appropriateness of using open questions within agreed boundaries for the first round of questionnaire and it was found appropriate for the following reasons, (a) the discussions on BI can be wide ranging, therefore it was important to clearly define the boundary of the study, and (b) the Delphi method generally uses open questions during the first round (Day and Bobeva 2005). The first round questionnaire consisted of 10 questions that were based on existing literature on the implementation of BI services (e.g., the critical success factors) and practitioner experience of one of the authors. The questions focused on strategic, organisational and technical aspects of implementing BI. The findings from round 1 are presented in Section 5 grouped under three key themes (tools, resources and data quality).

4.3 Design of Questionnaire (Round 2)

The design of the questionnaire for round two was informed by several key themes that were identified from administering the first round of our modified Delphi approach. The second questionnaire could have explored one of several specific problem themes that emerged, such as exploring the impact of quality of data on decision making, exploring the flexibility of existing tools to support the strategic direction of the business; however, given that the major BI problem areas raised by

the NHS and public sector are inter-related and the common theme across many of these relate to TCO (refer to tables 1 and 2; the tables are discussed in the section on findings), it was decided that this particular theme warrants further exploration. Thus, the objective of the second questionnaire was to explore the many facets of TCO and the linkages between TCO and the *business drivers*, *business process needs* and *business system needs*.

- **Business Drivers:** Business drivers are the translation of the business strategy into concrete, actionable, obtainable objectives. The aim of this strand is to understand the scope and priorities of the business drivers of the organisation in terms of supporting strategic, tactical and operational decision making.
- **Business Process Needs** - The aim of this strand was to understand the needs associated with successfully managing the business.
- **Business Service Needs** - The aim of this strand was to understand the needs associated with successfully supporting the future BI solution.

Exploring the aforementioned strands would embrace the main findings drawn from the first round questionnaire which identified tools, resources and data quality as three general themes. Unlike questionnaire one, questionnaire two mainly consisted of likert scale questions; however, the design of the questionnaire enabled the participants the choice to provide additional supporting information that was relevant in each of the three strands. It is generally the case that the responses from the open-ended questions in the initial round of Delphi need to be classified and reduced for later rounds by the researchers, and towards this the researchers have to exercise their judgment as to what should and should not be counted as consensus (Green et al. 1999).

The second questionnaire was issued to all ten participants that completed the first round questionnaire. Unfortunately responses were only received from six of the ten participants. Four of the participants were unable to complete the questionnaire due to work commitments, albeit they appreciated the importance and value the research could bring to their own organisation. It is recognised in literature that as the number of questionnaire rounds increase, there is a fall in the number of responses expected (Alexander, 2004).

5. Findings

5.1 Findings pertaining to Key Themes (Round one)

Table 1 list the questions in round one and presents a summary of the responses received. The responses are grouped into two categories based on the affiliation of the expert participants (NHS and the County Councils). This separation is useful to identify any commonalities between the responses from panellists belonging to either of the two public sector bodies. Table 2 provides an analysis for questions 3, 4 and 9 based on the percentage of participants agreeing to similar indicators. These questions were chosen because they explore the present risks and challenges associated with BI services and this is a key area of investigation in this study.

In general, the findings from round one suggest that there is no delivered BI strategy for the public sector organisations to which our expert panellists are affiliated. It can be argued that this is one of the reasons why the participants indicated they were not satisfied with their present BI service (refer to table 1, question 1 findings) and consequently have to use a range of legacy services in an attempt to meet their business needs (refer to table 1, question 7 findings). The findings from round one can be grouped under the following three key themes (also refer to tables 1 and 2).

- **Tools** – Concerns were raised regarding the flexibility and suitability of the existing BI tools. It can be argued that inflexibility with tools can impact on business performance by not allowing evidence based decisions to be made (Crane and Raymond 2003; Williams and Williams 2004).
- **Resources** – A number of concerns were raised regarding resources. These include cost of using BI tools, public sector funding concerns, limited visibility pertaining to TCO and the non-availability of resources and capabilities to manage BI services. With regard to TCO, businesses tend to focus on license costs rather than all of the elements required for delivering the complete BI service. The additional elements that may be ignored include costs for maintaining support teams, training, implementation costs, recurring costs, general maintenance, upgrades etc. Consequently, the costs to scale up the service (vertically to other functionality and/or horizontally to additional business departments) become prohibitive and this acts as an impediment to the success of BI.

- **Data** – Concerns related to poor data quality, managing data silos, having lack of accurate information. All of this leads to poor decision making. Data related issues were also raised as a risk for the business. Data quality issues are linked to costs because of the resources needed to address data inconsistencies as a pre requisite to successfully delivering BI services (Hatch 2009; Khan et al. 2010). The author considers NHS organisations are interested in data transparency to deliver more accountable care.

The findings highlight a range of issues the NHS and County Councils face with implementing BI. All of the identified themes are important indicators to determine the successful outcome of a BI project and in understanding the continued commitment and support necessary from the business (Hatch 2009; Kasabian 2009). However, it can be argued that the broader definition of TCO provides a common denominator linking the above three themes together. It also highlights that failing to understanding costs increases the probability of not achieving the expected outcome from BI projects. In the present austerity climate across the UK public sector, it can be argued that TCO is an important area that a business needs to understand as this will help identify opportunities to minimise costs. Consequently, the broad area relating to TCO was presented to the participants for further investigation during the second round of our adapted Delphi process, the findings of which are discussed next.

5.2 Findings pertaining to TCO (Round two)

The findings from round two of our study suggest that none of the organisations affiliated to the expert panellists had a clearly defined BI strategy, although their organisation was using BI and reporting services in some capacity. Specific findings of round two are now discussed under the following three strands - business drivers, business process needs and business service needs.

Business Drivers: Table 3 sets out an analysis of the responses returned, grouped by NHS and County Councils, based on the mean score to each question. The findings suggest that the public sector has a clear understanding of their business drivers and understand the importance of managing the data to deliver greater efficiencies and support more informed decision making. These findings will assist the study by placing into context the responses returned in the next two strands of questions (business process needs and business service needs).

Business Process Needs: Table 4 sets out the responses provided to the questions pertaining to process needs. The findings from this strand of questions highlighted that public sector organisations have process needs and these were recognised by the organisation. However, a review of all of the participant responses identified that there was a clear disparity between the priories for the NHS and County Councils. For example, County Councils viewed streamlining the financial close process as a 'must have' needs but this was deemed to be 'nice to have' for the NHS. The NHS viewed the need to address supplier contracts to be higher than County Councils. Whilst this was not unexpected, it can be argued that responses were biased towards the participant field of expertise but this was not expected to influence the final outcome from the study.

Business Service Needs: Table 5 sets out the mean responses scores associated with questions pertaining to business service needs. The key messages that can be drawn from the findings can be summarised as follows:

- Software and hardware – Although most aspects of software and hardware were deemed to be important for both the NHS and County Councils, having non-intrusive software upgrades was deemed to be less important to County Councils than to the NHS. The reasons for this are unclear but it can be argued that for the NHS, any form of service downtime (i.e. unavailability) could have a greater impact on the business, especially given that the NHS is delivering a 24-7 service and ensuring patient safety is at the forefront of any service consideration.
- Infrastructure – There were a significant number of areas where there was a difference of opinion on what was important between the NHS and County Councils. Both groups agreed that the BI solution should not lock the business into the vendor ERP/CRM product, a position shared by Mantfeld (2010).
- Data Architecture – The NHS and County Councils generally agreed to the importance of having quality data and being able to manage this process. In the case of the NHS this was about smarter decision making through data transparency in order to deliver more accountable care. The findings support the participant responses to the business drivers about having one version of the truth for data and improving the quality of data (table 3). What is also recognised is the importance to address data integration and data quality issues (Fitzpatrick 2009).

- Administration IT and business – The NHS and County Councils generally agreed to the importance of having appropriate skilled resources, managing changes, dealing with security and managing user authentication.
- Software features and functionality – The NHS and County Councils generally agreed with the importance of the features and functionality listed in the questionnaire. The one area where there was a clear difference relating to the importance of having access to real time data, this was less important to County Councils.
- Governance and processes – Although most aspects of the governance process was deemed to be very important to both the NHS and County Councils, establishing an Enterprise Business Analytics (EBA) team was viewed to be less important by the NHS and even less important by County Councils. Although this feedback reflects the response provided in the business driver this position differs from the literature findings that suggests that organisations should have an EBA team to bring the business and IT together and to manage the corporate data.

6. General Discussion and Recommendation

The study has highlighted that there are many factors to consider when implementing BI in the public sector. These factors do not solely relate to understanding the cost of purchasing the tool and hardware, they also point to many other considerations such as defining the BI strategy for the business and clearly defining the business and system needs, all of which are linked to provide a better understanding of TCO (section 2). The research findings suggest that the public sector is not aware of the true impact of TCO or the consequences of not having a BI strategy, however, the literature highlights these as important considerations.

Complex social, economic, political and environmental pressures are placing significant demands on public sector organisations to make smarter decisions and deliver desired outcomes (Messatfa & Reyes et al., 2011). The research highlighted that BI services are just as important for the public sector as they are for any other industry. Evelson (2008) states that "*other than the public sector [Health care] has the lowest level of [BI] adoption*". The research findings suggest that one of the potential reasons for this low adoption could be due to the challenges the public sector face in implementing BI and in understanding the key considerations such as TCO.

The data silos, large volume of data and its increasingly diverse and interactive nature can also paralyse the public sector as they try to filter the noteworthy from the not-worthy information. The research findings (section 5) suggest that although the public sector recognise the challenges with their present BI services and the importance of data quality, they did not relate quality of data to business practices and the need to define a BI strategy(section 2) in order to deliver a BI service. The lack of a common BI strategy for the public sector organisations has meant that businesses and individual departments have worked in silos to try and address their specific local information needs. This narrow perspective makes it difficult and challenging for businesses to collaborate and create an umbrella view of information (one version of the truth) across the organisation.

The findings suggest that the public sector face challenges with their BI services (sections 5) and these challenges are similar to those experienced in other industries (section 2). Although there is empirical research on business ethics and linking culture and business decision making (Mannion et al., 2008 and Sorensen, 2008), there is limited empirical studies available on why businesses find it challenging to implement BI services. The authors have argued that the complex culture and ethics within the public sector does play an important part on the decisions made regarding services and solutions that are delivered (section 2 and section 5). Although public sector bodies have to abide by stringent EU Procurement rules (OGC.gov.uk) there is an element of self-interest (protectionism) that exists and why some of the findings presented in this study, for example although participants view the importance of one version of the truth regarding the data across their organisation, it can be argued that in reality this can only happen if there are cultural changes in place to ensure the data can be manage centrally through an EBA team. Because of the complexity and changing nature of cultures within modern health care systems there is still much to unravel about how to understand, shape and assess this important facet of organisational life (Mannion et al., 2008).

Although the findings did not identify the use of frameworks, the literature (section 2) suggests that using frameworks can guide organisations through the process of implementing BI services.

6.1 Recommendation

Although the findings have not highlighted the use of frameworks to guide the business through the complexities of delivering and managing BI services, the literature review (section 2) suggests that using frameworks can help by defining a structure to how BI services are delivered. The authors have argued that the present frameworks do not go far enough and therefore, the main recommended outcome from the study is to define a suitable management toolkit framework to address a number of these gaps and assist the public sector work through the key considerations when delivering BI services.

The framework captures information referenced in the literature, but also from the results from the research findings and from field experience. Although the focus of the study and framework has been to understand the many facets of TCO, the framework was extended to capture activities that would reduce the challenges associated with delivering a successful BI outcome. Consequently, the aims of the framework is to: 1) provide additional guidance in the form of stages and checklists for businesses to work through when delivering BI services and 2) reduce the challenges of delivering BI projects and ensure organisations understanding all aspects of costs during the consideration process.

Not every NHS or public sector organisation will be at the same starting point in its use of BI and therefore the starting point in the use of the framework should factor in the organisations present level of progress.

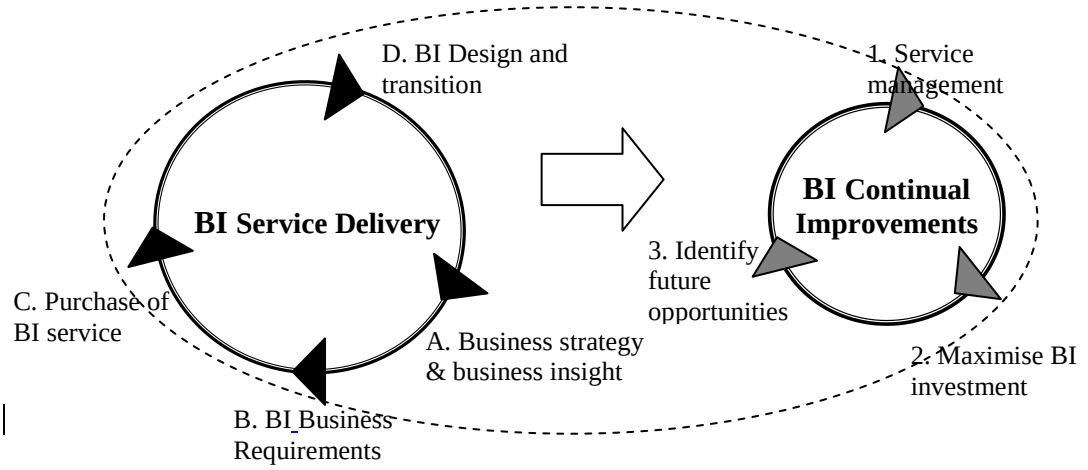

Figure 1 – BI Management Framework Overview

The aim of this framework is to ensure there are clearly defined linkages between the business drivers and business direction of travel to the BI requirements and information needs of the business. Any change to BI needs may potentially require the purchase of additional BI services (infrastructure and support) and to then transition these into operational use. These stages form the basis of the BI delivery and support model. Once a BI service is in operational use, it is important to ensure the services remain 'fit for purpose' to meet its on-going intended use. It is also important to ensure the business maximises the use of the BI services to add value to the business. These stages form the basis of BI continual service improvement model. During the continual service improvement stage, opportunities to extend and deliver BI services to other areas of the business may be identified. When this happens the whole process from BI delivery and support to continual service improvement repeats itself. Taking such a controlled framework approach will help ensure consideration is given to all facets of TCO.

7. Conclusion and Future Work

Across the NHS and other public sector businesses in Wales there are a myriad of business critical enterprise systems in use, for example, *Oracle, IBM, Cedar, and SAP*. Having such a dispersed range of systems usually means that each system will have its own reporting toolsets and data standards. This, in turn, makes it difficult to use the existing reporting tools to create reports that require access to data from different systems. Several researchers and consultancy groups have identified the inadequacy of the present generation of legacy reporting tools that continue to be used in the public sector (Aberdeen Group 2010; DataMonitor 2007; Ovum 2010); the case of NHS is no different and in many parts of the NHS in Wales the users still rely on tools such as *Microsoft Excel* and *Microsoft Access* for key elements of their analytical reporting. The public sector and the NHS may therefore have to ensure that they not only have the right BI and reporting tools to support decision making, but that they also understand the context in which business intelligence is embedded and used within the business at a strategic, tactical and operational level. The research presented in this paper has reported on some of these challenges of implementing BI across the NHS in Wales. Although this study is specific to the NHS in Wales, it is expected that some of the results will also be applicable to the wider public sector

because these businesses are likely to face challenges that are similar to those faced by the NHS today, e.g., performance-driven targets, the need for efficiency savings and the need to analyse big data, etc, and all of which will benefit from BI reporting tools and technologies.

The literature review has identified only a handful of studies on BI undertaken in the context of healthcare and the wider public sector. This, in itself, highlights the gaps in the present research, thereby providing future opportunities to explore the topic further. In terms of future work we have identified the following. First, we have identified the need for a BI framework for healthcare. Such a framework could include the development of a BI value framework model to measure the impact of TCO and VOI on the business. Second, we plan to conduct an empirical study to understand the data quality information needs of a healthcare organisation and to investigate the correlation between quality of data and its impact on business decision making and business practices. Finally, it would be helpful to assess how the different BI vendor offerings could meet the needs of the NHS and the wider public sector. This is considered important because several industry analysts have stated that one BI solution may not meet all of the needs of an organisation (Eckerson 2005).

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APPENDIX 1
ROUND 1: SUMMARY FINDINGS

#	Question	NHS Summary Findings	County Council Summary Findings
1	How would you and others within your organisation describe your existing suite of BI tools and reporting solutions in terms of addressing business needs, flexibility, ease of use, cost effectiveness, performance, internal/external support arrangements?	1) Most organisations indicate that the present tools are limited and cumbersome to use; 2) The business requires better more meaningful and timely reports - this appears to be linked to having the necessary skills and resources to deliver; 3) Consistent data quality across systems remains a challenge; 4) Some departments do not use BI because they are unable to determine how to capture the raw data required to perform KPI and other data analysis.	1) Too many tools; 2) Inflexible; 3) Piecemeal enhancements with lack of clear direction; 4) No visibility of overall cost of ownership; 5) No clear central direction; 6) Resource capacity and capability constraints.
2	How do you presently manage the data held in disparate application systems/other sources to ensure that you can use the data and that the data is of the quality expected to then turn it into meaningful information?	1) Recognised managing data is a problem area - requires manual intervention to ensure 'like for like' comparison ; 2) Cross matching of data to consistency is a manual exercise.	1) Multiple data silos with duplicate data and limited information sharing; 2) Manual intervention to bring data together e.g., using Excel.
3	What do you believe are the top 5 pinch points (if any) with your existing BI and reporting solution?	1) Performance of solution; 2) Inflexibility to work across disparate systems; 3) Skill sets to enhance solutions; 4) The manual manipulation of data - time and effort involved, inconsistency of approach; 5) Data quality across systems and getting the users to fully understand and trust the data in a consistent issue.	1) Lack of consolidated reporting across disparate systems; 2) Fragmented approach ; 3) Lack of internal resources and skills; 4) Cost of ownership; 5) Data quality.
4	What would be the top 3 risks to your business if you did not have access to	1) Lack of accurate information to determine state of business not visible - hampering delivery of savings; 2) Poor	1) Decisions being based on inaccurate data - impact on financial, employee information

	the right business intelligence & analytics information?	decision making - being reactive rather than proactive; 3) changing behaviour of the business.	and public protection and safety; 2) financial risk - control and accounting of funds; 3) Failure to deliver expected services in a timely manner.
5	What security and other controls are in place to ensure the information from your existing reporting solutions is only made available to the right people?	Control managed through network access and data access permissions.	1) Each application having own security model; 2) Information restricted through network; 3) Access to data based on job role and requirements.
6	What arrangements exist for the creation and management of your existing BI reports and any requests for new reports or enhancements to existing reports?	Processes exist to coordinate and manage report creation through appropriately skilled and trained staff.	1) Mixed approach adopted - depends on nature of the solution and internal governance. Can be locally or coordinated through a Finance and System team ; 2) Reliance on experts to write reports, however, resources is a bottleneck and lack of consistency in standard of reports.
7	Are the same BI reporting solutions used across all business functions within your organisation? If not, then please explain the nature of the different solutions and whether the quality and format of the data across these functions are the same	Range of legacy systems used where the business has undergone organisational changes. Several centralised systems continue to exist for core services.	1) Local solutions exist for each system/application; 2) Continued reliance on spreadsheets; 3) Quality of data and data standards vary across systems.
8	How important is it to have real time (up to the minute) access to data for all of your reporting needs?	Not essential to have real time data although it is important to ensure data is relevant to allow timely decision making, e.g., certain elements require hourly updates (like bed management, A&E), with others updated nightly or weekly, monthly or quarterly.	1) Real time data only needed in a small number of areas ; 2) Most reporting requirements can be addressed through last business day data.

9	If you had to change/replace your existing Business Intelligence reporting solution, what would be the main critical success factors to ensuring success. Also detail any barriers that may exist?	**Success:** 1) Cost of ownership; 2) Speed to delivery; 3) ROI; 4) Flexibility across disparate systems ; 5) Ease of presenting information across a range of systems. **Barriers:** 1) Funding (initial purchase or to scale up existing service); 2) Organisation priority; 3) Stakeholder sponsorship	**Success:** 1) ROI; 2) Cost of ownership; 3) Ease of use; 4) Flexibility to work across disparate systems. **Barriers:** Funding and Cashable ROI
10	What governance arrangements are in place to ensure that there is a common business wide view of data, information and BI and reporting solutions across your enterprise?	1) Oracle Strategy group for national Oracle services; 2) Local governance (e.g. Informatics Strategy Board) exist that brings together IT/Systems and Finance Teams.	Limited governance arrangements exist. In many cases limited to where there is a national service for example Oracle eBusiness.

Table 1: Round 1 – Summary Findings

APPENDIX 2
ROUND 1: ANALYSIS OF KEY CHALLENGES

ID	Specific Questions and Key Indicators	Score
A	**Question 3: Top pinch points with your existing BI reporting**	**% of experts agreeing**
A1	Present tools are limited and inflexible	75%
A2	Quality of data	75%
A3	Resource capacity and capability constraints	50%
A4	No visibly on cost of ownership	25%
B	**Question 4: Key risks to the business by not having the right information**	**% of experts agreeing**
B1	Financial	88%
B2	Being reactive rather than pro active	63%
C	**Question 9: Main critical success factors to ensuring success and main barriers**	**% of experts agreeing**
	Success:	
C1	Flexibility, ease of use and presenting information	75%
C2	Cost of ownership/ value for money	63%
	Barriers:	
C3	Funding and ROI	50%
C4	Organisation priority	38%

Table 2 - Round 1 - Analysis of key challenges

APPENDIX 3
ROUND 2: BUSINESS DRIVERS

#	BUSINESS DRIVERS	**NHS** *Mean Response*	**County Councils** *Mean Response*
		Values: '5' = essential for the business, '4' = very important for the business, '3' = important for the business, '2' = not important for the business, '1' = not applicable/unknown	
1	Have a deeper insight into strategic, management and operational business information	**5**	**4**
2	Receive business insight information less expensively	**4**	**4**
3	Rationalise and reduce total cost of ownership for corporate reporting	**4**	**3**
4	Deliver reporting solutions where there is clearly a defined return on investment opportunity	**4**	**2**
5	Minimise risk exposure to delivering and supporting BI tools and services (resources, skills, support etc.)	**4**	**5**
6	Adherence to regulatory compliance	**4**	**5**
7	Deliver greater process efficiencies within the business	**5**	**4**
8	Improve the quality of day to day decision making - moving away from 'gut feel' to 'fact based' decisions - forecasting and trend analysis	**5**	**4**
9	Deliver relevant, contextual insight into the business	**4**	**4**
10	Deliver the timeliness of the information received to support decision making	**5**	**4**
11	Align decision making across all parts of the business	**5**	**4**
12	The business requires 'one version of the truth' when analysing information from a range of different systems	**4**	**4**
13	To support greater productivity of our end users (consumers of the dashboards and reports)	**4**	**4**
14	To support self-service BI by allowing key business users to customise/create their own dashboards and reports	**4**	**3**
15	To have a BI centre of excellence team to manage reporting for the organisation	**3**	**2**

16	To support greater collaboration across the business	**4**	**3**
17	Rationalise the number of different tools used for decision making	**4**	**4**
18	Improve the quality of data (coding, formatting) within the business - recognising that the quality of the data drives the quality of the analysis	**5**	**4**
19	Provide intelligence insights to solve business problems around the following areas:		
19A	■ Inefficient internal business process	**4**	**4**
19B	■ Effective customer relationship management	**5**	**3**
19C	■ Effective marketing	**3**	**2**
19D	■ Supply & Demand chain	**4**	**4**
19E	■ Financial and operational performance management	**5**	**5**
19F	■ HR/Payroll performance management	**4**	**5**
19G	■ Streamline budgeting and forecasting process	**3**	**4**
19H	■ Fraud detection	**4**	**5**
19J	■ Others (please specify)	**0**	**0**

Table 3 – Questionnaire 2: Business Drivers

APPENDIX 4
ROUND 2: BUSINESS PROCESS NEEDS

ID	BUSINESS PROCESS NEEDS	**NHS** *Mean Response*	**County Councils** *Mean Response*
		Values: '4'= must have, '3' =important to have, '2' = nice to have, '1' = of little importance, '0' = not important at all	
1	Streamline Financial close process	**2**	**4**
2	Improve productivity (e.g. through activity based planning) for planning & budgeting	**3**	**4**
3	Ability to analyse the extent of intra organisation invoicing not handled entirely from within the ERP system	**1**	**2**
4	To be able to identify duplicate invoices	**2**	**3**
5	To understand Invoices not paid within the prompt payment policy	**2**	**3**
6	To Identify the extent of credit notes not netting off against invoices	**2**	**4**
7	Reduce invoice on hold cycle to meet expected KPI targets	**2**	**3**
8	Need to identify orders not raised on contracts	**2**	**4**
9	Ability to analyse supplier spend	**2**	**4**
10	Need to improve procurement data quality v productivity	**2**	**0**
11	Ability to understand orders raised against incorrect financial codes (subjective, cost centre etc.)	**1**	**4**

Table 4 – Questionnaire 2: Business Process Needs

APPENDIX 5
ROUND 2: BUSINESS SERVICE NEEDS

ID	BUSINESS SERVICE NEEDS	**NHS** *Mean Response*	**County Councils** *Mean Response*
		Values '5' = essential for the business, '4' = very important for the business, '3' = important for the business, '2' = not important for the business, '1' = not applicable/unknown)	
	Hardware and Software		
1	Flexible license model (subscription, processor, per user/developer) to support different business models: shared service, departmental, ad hoc usage as well as being easily scalable to support additional users across organisational boundaries and across the public sector -pervasive deployment	**4.5**	**4.0**
2	Service, support, maintenance and training costs (incl. service desk, hardware maintenance, license recurring costs, speed to deliver reports, service downtime etc.) should be less than 30% of the overall initial software purchase price. If the % figure used should be different for your organisation then please detail the requirements under additional information	**4.3**	**5.0**
3	Major and minor upgrade/patching of the software and hardware is not intrusive on the business with downtime of the BI service being no more than 1 business day	**4.5**	**3.0**
4	The software can work on industry standard hardware and operating systems that do not require specialist skills to manage and support	**4.0**	**5.0**
	Infrastructure		
5	The 'footprint' (i.e. size and demand) of the BI tool lends itself to using network traffic in an optimised and efficient manner thereby limiting any additional network cost exposure to the organisation	**4.8**	**5.0**
6	The software can operate using web based technology and does not require full scale desktop deployment	**4.8**	**4.5**
7	Software architecture is scalable and flexible to support large number of	**4.8**	**3.5**

	users (potentially over 2500 end users) and large volumes of data (potentially over 7 years of data, equating to over 1 Tera Byte).		
8	BI dashboard and reports should typically 'refresh' on average in less than 5 seconds.	**4.3**	**3.0**
9	Where a data repository (e.g. data warehouse) needs to be refreshed with the latest data, then this should ideally happen without the need to taking the BI service down or causing significant disruption to business users	**4.5**	**3.5**
10	The BI service should typically be available 24/7 except where maintenance downtime has been pre agreed	**4.8**	**3.5**
11	The BI solution does not lock you into any one specific vendors enterprise application solution	**4.5**	**5.0**
	Data architecture		
12	The outline BI vision depicts a potential BI vision for your business sector. Does the diagram capture the key services and outcomes that you would expect to see in any ideal BI vision for your organisation? *Please detail anything missing from the diagram under any additional information*	**4.8**	**2.0**
13	Supports the delivery of 'one version of the truth' for the business by having a single enterprise information model.	**4.3**	**4.0**
14	Supports the easy management (analysis, coding and cleansing) of the rising volumes of data generated by the business	**4.3**	**4.5**
15	Allows for data inconsistencies (in terms of quality/format) and incomplete and unreliable data to be 'corrected' in a simple manner	**4.5**	**4.5**
16	Supports the easy integration of data from different data sources (for example: third party systems, feeder files etc.)	**4.0**	**4.5**
17	Supports the easy and timely update of the data architecture/model to support any business requirement changes	**4.3**	**4.5**
	Administration (IT & Business)		
18	Supports user and group role based security to simplify administration of user accounts and access privileges	**4.5**	**5.0**
19	Supports the segregation of user privileges to allow consumers to view dash boards/reports, developers to create dashboard/reports and administrators to manage the data marts and user setup/management	**4.0**	**5.0**
20	Effort and resources to learn the BI tool is minimal. Should allow business users to create/amend dashboards/reports. Should allow technical competent IT personnel to administer the tools	**4.8**	**4.5**
21	The effort and resources to maintain the tool and services should be minimal. Should not require the need to establish large teams (more than 5 people typically) to manage and support the solution	**4.8**	**4.5**

22	Can support business change in a timely manner by enabling the creation of 'simple' complexity of dashboards/reports within 1 business day. The creation of 'medium' complexity of dashboards/reports within 3 business days and the creation of 'complex' types of dashboards/reports within 10 business days	**5.0**	**4.0**
23	Require any administration of the BI tools (maintain data model, standardisation, change management, user access etc) to be managed centrally rather than locally within each user department	**3.3**	**3.0**
24	Average deployment time for 'out of the box' solution across at least 2 business functions to be within 3 months of software and hardware purchase.	**3.5**	**3.0**
25	Deployment time of any additional customisation and configuration to deliver the complete enterprise system to be within 12 months of software and hardware purchase.	**3.3**	**3.5**
26	Suppliers that have the knowledge and skills to provide a managed service (including service desk) to support the enterprise BI solution	**3.8**	**3.0**
27	Suppliers that have the knowledge and skills to manage any data warehouse/data architecture models	**3.8**	**2.5**
28	Suppliers that have the knowledge and skills to produce dashboards and reports based on the business requirements	**3.8**	**3.5**
29	Suppliers that have the knowledge and skills to successfully implement an enterprise BI solution	**4.3**	**5.0**
	Software features & functionality		
30	Offers a high level of features and functionality out of the box	**4.8**	**5.0**
31	Dashboards and reports that are visibly appealing and that can be changed immediately (i.e. in 'real-time')	**4.5**	**4.5**
32	Present summary information in the form of charts (dashboards, scorecards etc.) and then be able to interactively drill down to granular levels of information and where necessary to the underlying transaction record	**5.0**	**4.5**
33	BI tools that work with mobile devices to support the mobile work force?	**4.8**	**4.0**
34	BI tool that can work a range of our data sources and is platform independent to give us greater flexibility	**4.5**	**4.5**
35	Provides analytical workflows to create notifications and alerts by email or by other means when information goes outside pre- defined thresholds and to be easily able to set these workflow parameters	**4.5**	**3.5**
36	Require access to real time (up to the minute) changes to performance information in order to make business decisions.	**4.5**	**2.5**
37	Integration with Microsoft Office Suite	**4.5**	**5.0**

38	Supports collaboration between users across the business enterprise	**4.5**	**2.0**
39	Supports transaction reporting and ad hoc reporting	**4.3**	**5.0**
40	Allows reports to be published to SharePoint and other output media sources.	**4.3**	**3.5**
41	Can easily customise to address specific local business needs	**4.3**	**5.0**
42	Has capabilities to update the operational data sources, where this is required	**2.8**	**1.5**
43	Can export data in Excel, XML and CSV formats as a minimum.	**4.8**	**5.0**
44	Can process up to 7 years of operational data.	**4.3**	**5.0**
	Governance & processes		
45	Empower business users with interactive data analysis to create their own dashboards and reports	**4.3**	**4.0**
46	Enable the business to have the skills and resources to support an enterprise BI service	**4.8**	**5.0**
47	Enable business departments to have more control to manage BI solution rather than leaving this to IT departments?	**4.3**	**4.0**
48	Have a sound change management processes and governance infrastructure in order to deliver any BI service and support on-going enhancements to the solution?	**4.3**	**5.0**
49	Ability to consolidate and standardise reports, tools, data marts across the business enterprise	**4.8**	**4.5**
50	Establishment of a BI Centre of Excellence to coordinate and manage the delivery of BI services from an IT and Business perspective	**3.0**	**2.0**

Table 5 - Questionnaire 2: Business Service Needs