

Operationalised Business Intelligence: Knowledge Sharing with an Enterprise Ambition at the Amsterdam-Amstelland Police Department

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Abstract

In this article we describe the operationalised Business Intelligence (BI) environment of the Amsterdam-Amstelland Police Department (AAPD) as it presented itself in the spring of 2007. We explicitly focus our attention on the organisational components that support the knowledge process flows required to align the usage of the operationalised BI instruments with their enterprise-wide goal to develop an “Intelligence Led Policing” capability. We illustrate how two specific organisational innovations - the Management Information and Research department and the Information Brokers - acted as go-betweens for the various levels of the AAPD and the effective design and use of the informational systems. To make our study concrete, we highlight the use of the Early Warning System and Data Detective tool in support of their capacity management process for law enforcement activities. We conclude this descriptive case study with the key building blocks of this case, and we suggest that an enterprise-wide view and knowledge-based perspective be incorporated in future research on operationalised BI environments.

1. Introduction

According to the knowledge-based view of an organisation, management’s primary task is to coordinate the integration of specialist knowledge, held by different individuals or groups of individuals across the organisation, into the daily operations [16, 28]. A key concept in this perspective is that of the knowledge process flow: that is, a “sequence of transformations performed by agents on knowledge artefacts in support of specific actions or decisions” [26].

Sustaining a knowledge management life cycle to contain and develop these knowledge process flows requires adequate assistance from organisational components and information technologies (IT) [6, 38].

This article focuses on a specific group of technologies and its organisational complements, i.e. operationalised “business intelligence” (BI). These complements have been playing a distinct role in efforts to further develop the knowledge process flows at the Amsterdam-Amstelland Police Department (AAPD). We describe how the AAPD tried to avoid ending up with a cluttered operationalised BI setting of functionally disconnected and locally optimised information products. This paper describes the set-up of both the technical components and the organisational complements in support of the AAPD’s enterprise-wide “Intelligence Led Policing” (ILP) vision.

The material we present reflects what emerged as the technological and organisational keystones of the AAPD’s ILP capabilities in the spring of 2007. The data for this case study came from a series of semi-structured interviews with police officers at different levels in the AAPD. The results of these interviews were triangulated with data from direct observations, internal reports and the AAPD’s intranet [42].

Our article aims to contribute to existing literature in the following ways. First, although we have encountered some first-person accounts and position articles on topics related to operationalised BI in non-specialist literature [15, 22, 32], little academic research exists that provides an insight into the full breadth of an operationalised BI setting. By framing the Management Information and Research unit (MIR) as a “business intelligence competency centre” (BICC) and introducing the Information Brokers role, we aim to contribute to a knowledge-based view of operationalising BI. Second, the same holds for ILP. While ILP has been around for about 15 years, apart

from a couple of notable contributions [8, 24] academic research on ILP in the information sciences domain remains scarce. Therefore, this article also aims to contribute to building the body of knowledge on how ILP is enacted in a real-life setting.

The article is structured as follows. The first section elaborates on the concept of operationalised BI. This is followed by an introduction to the ILP philosophy and its instantiation into four guiding principles for an ILP decision-making process. We then present the case study at the AAPD. After a short description of the AAPD and its context, we discuss the enterprise data warehouse, the MIR, and the Information Broker role. We then illustrate how it all came together by describing how two operationalised intelligence tools are used in the capacity management process for law enforcement activities such as preventive patrolling and maintaining the capacity for rapid interventions in case of reported crimes. We conclude the paper with a summary and discussion of the case by highlighting the key building blocks of the AAPD's set-up and by making suggestions for future research.

2. Operationalised BI

Roughly speaking, BI technologies have evolved through three generations [35]. In the early 1970s, decision support systems were application-centric. Data was used to support only a single application or perhaps a few related applications. The second generation of technologies, the data warehouses, appeared in the 1980s. These were more data-centric, and they could feed various applications. Around the turn of the century, a third generation of technologies emerged. No longer limited to understanding past events, these technologies were also designed to anticipate what was likely to happen in the future.

Although these technological capabilities have now been around for some time, finding the most appropriate ways to leverage them for business success remains an issue for a significant number of organisations.

This issue is compounded by the fact that many organisations find themselves confronted with the rapidly changing nature of operating and competing in a globalised economy. Many feel that these pressures require them to develop more decision-making agility. For them, the possibilities of real-time data delivery and analysis have become increasingly promising [19, 20].

The application of BI technologies has often been confined to support a limited group of back-office analysts or a very small fraction of top-level decision

makers. The notion of “operationalised BI” tries to break away from this limited view of the business potential of BI technologies [13].

Operationalised BI refers to an organisation's ambition and ability to provide BI capabilities to as many of its constituents as possible. This means putting the most suitable systems and applications in the hands of operational decision makers, as well as top-level managers and experts, so they can all benefit from access to relevant and accurate information at the right level of detail, and at the right time. This idea is echoed in slogans such as “BI for the masses” and “pervasive BI”.

Operationalising BI is certain to engage an organisation in an arduous journey. It is not easy to get to a point where the use of BI is inextricably linked to the daily activities of decision makers within and across all levels of the organisation [4, 13, 34].

But the potential benefits of succeeding in this effort are high. Several organisations are already successfully leveraging their analytical capabilities as a distinctive source of competitive advantage. These are the so-called analytics competitors [5, 9].

Still, to follow their example, an organisation will need to surmount the challenges of having a disconnected collection of locally optimised instances of BI that may have cropped up over the past several years [18].

The AAPD decided to use operationalised BI in support of their enterprise management philosophy: Intelligence Led Policing.

3. Intelligence Led Policing

Policing is a knowledge-intensive affair – over the past fifteen years, voices have risen to make a shift away from the traditionally more reactive, intuition-led style of policing to a more proactive, and intelligence-led approach [7].

Intelligence Led Policing (ILP) promotes the use of factual and integrated information and evidence-based analyses on which to base management direction and guide police actions at all levels of a police organisation. This does not mean replacing intuition-led police actions, but rather to complement them with information coming from analyses on aggregated operational data, such as reported crime figures and characteristics [8].

ILP requires an integration of technologies and processes to organise, formalise and distribute relevant information for police officers in their efforts to reduce crime. However, the ILP philosophy does not elaborate on the practical roll-out of such a

setting. Therefore, the AAPD based itself on a related framework – called Compstat – to steer their efforts.

Developed at the New York Police Department in 1994 [39], Compstat is a goal-oriented, strategic management process combining IT, operational strategy, and managerial accountability to guide police operations [33]. It has served to instantiate ILP and has been an example to many other police departments all over the world.

Four guiding principles summarise the cornerstones of Compstat [23, 33, 41]:

- (1) Information availability. Accurate and timely information on crime facts and perpetrators is to be made available at all levels in the police force (e.g. on corps level, district level and neighbourhood level).
- (2) Actionable information. Collier [5] defines actionable intelligence as the capability to determine the most effective tactics (e.g. patrolling a certain area) to tackle specific problems (e.g. a crime wave in a specific neighbourhood) from what is delivered by the available information products.
- (3) Swiftiness of reaction. A sense of urgency is very specific to the context of policing. Therefore, officers at different levels in the police force must be able to swiftly roll out a target deployment of the available resources based on readily available information.
- (4) Feedback and learning. Closing the loop on the decisions made through relentless follow-up and assessment can make the first three principles more effective.

ILP can also be generally understood as an instance of an enterprise performance management framework, such as the “Balanced Scorecard”, but designed specifically for policing. Typically, an enterprise management framework stresses the following management features, all of which are present in the ILP/Compstat principles: (1) the use of metrics to guide decision making; (2) the use of a balanced set of metrics, i.e. reflecting the extensive span of business objectives rather than only financials; (3) the right time delivery of actionable management information; (4) horizontally integrated enterprise management, i.e. cutting across functional and other organisational silos; (5) vertically integrated enterprise management, i.e. linking strategy formulation to operational execution; and (6) closed-loop management, i.e. emphasising continuous improvement and double-loop learning [31].

4. The AAPD Case Study

The Amsterdam-Amstelland Police Department (AAPD) covers the municipalities of Aalsmeer, Amsterdam, Amstelveen, Diemen, Uithoorn and Ouder-Amstel in The Netherlands. This region stretches across 357 square kilometres and has a population of 900,000 citizens. It is divided into 5 districts and has 32 neighbourhood police teams that serve a total of 211 neighbourhoods. The AAPD has 5,800 officers and an annual budget of 394 million euro.¹

The two core processes of the AAPD are (a) law enforcement and (b) criminal investigations. The first focuses on the daily policing tasks: i.e. keeping public order, and protecting lives and property through preventive patrolling and rapid interventions. Criminal investigations, on the other hand, involve detectives solving a reported crime. The AAPD is organised along the boundaries of these core processes, with only a limited overlap between the two. This article concerns research on the law enforcement activities.

It all started when an audit report appeared shortly after the appointment of a new Chief of Police in November 2004. The report proposed the ILP philosophy to transform the AAPD into a more efficient and effective police department within and across its three levels: corps management, district management and neighbourhood management [40]. The AAPD already had some reporting tools available (e.g. on crime trends), but they were rather disconnected from each other. They did not contribute to any coordinated and shared overarching police goal, nor were they supported by enterprise-wide organisational structures, roles and processes, or common data definitions.

However, the goals for ILP were clearly connected to enterprise-wide knowledge sharing and operationalised BI. This is illustrated by how the ILP philosophy envisaged efficient and effective policing and by its adherence to the Compstat principles. Efficient policing alluded to the availability of information products (i.e. tools or reports), the smooth flow of information, and exchange of experiences among the various hierarchical levels. Effective policing referred to improving public safety by anticipating prioritised crime based on easily accessible facts and figures, providing information to all levels of decision making, and embedding the knowledge in the whole organisation.

¹ For more information on the AAPD, please visit their website: <http://www.politie-amsterdam-amstelland.nl>.

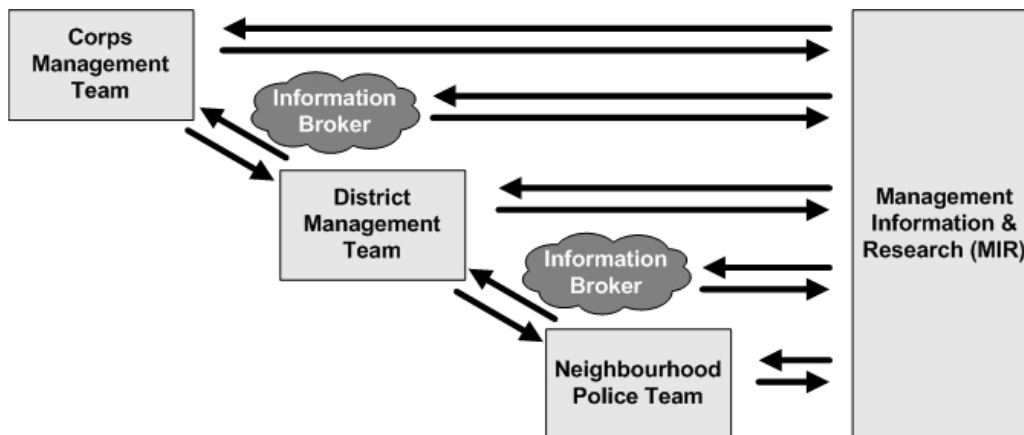


Figure 1. Most important law enforcement knowledge flows

Consequently, the AAPD installed the required technical and organisational components (see Figure 1): a data warehouse, the Management Information and Research team, the Information Broker roles, and information products such as the Early Warning System and Data Detective tools.

4.1. The Data Warehouse: Enterprise Platform for Execution

A data warehouse is a subject-oriented, integrated, time-variant and non-volatile collection of data in support of decision making [17]. The data warehouse typically feeds dependent data marts, which have a narrower scope to enable faster processing when transforming data into actionable information for different decision support tools [1, 34].

A data warehouse had to enable the AAPD to operationalise their BI and work on connecting all partners in the “chain of contacts”. This chain of contacts refers to the set of a (potential) suspect’s interactions as he/she moves through the policing and judicial processes. This chain includes, for example, police officers, courts of justice, and the prison system.

Data and information systems across multiple justice and policing functions in the Netherlands have been notoriously disconnected from each other, as they have been in many other countries as well. Without the necessary data integration, the AAPD would not be able to get to a single version of the truth.

The AAPD understood that it needed an enterprise platform for execution. The potentially relevant data sources were located with different

partners in the chain of contacts. There were already some data marts and relational databases combining operational data to serve specific subject areas of police decision making. However, these data sources were not systematically reconciled into a single data warehouse. This gave rise to challenges such as poor data quality, lack of a standard naming convention, inconsistent meta-data, incompatible data structures, missing connections, or conflicts about data ownership.

The AAPD chose not to go for “building the ultimate data warehouse before anyone could use it”. Instead, they opted to work in small, discrete phases to guarantee the continuation of law enforcement operational processes. This pragmatism allowed them to rapidly iterate between the “build” phase and the “run” phase, supporting real-time decision making.

With a new data warehouse and architecture in place, the AAPD had a single and integrated version of the truth regarding crime and perpetrators. This enabled the AAPD to start the deployment and support of timely and actionable information products.

4.2. Management Information and Research

A pivotal organisational innovation in the ILP roll-out was the Management Information and Research (MIR) unit. Its mission statement read as follows: “The MIR supports developing, generating and evaluating management policies by providing management information and research results.”

The MIR acted as a centre of excellence in knowledge sharing at the AAPD. It functioned as the enterprise-wide authority overseeing management information support and assumed many of the

responsibilities of what Gartner² calls a BI Competency Centre (BICC) [12].

A BICC is often defined as a cross-functional team with specific tasks, roles, responsibilities and processes for supporting and promoting the effectiveness of BI. The MIR essentially took up five roles [2, 12].

First, it took care of all BI-related education and training. Promoting and rewarding the consistent use of these information products throughout the organisation was also an important objective.

Second, it performed enterprise project management tasks. This included overseeing the process for intake and prioritisation of BI projects, as well as enabling user-supported requirements analysis, prototyping and pilot testing. The MIR also took care of the development, roll-out and subsequent support of information products, often by bringing in externally sourced help.

Third, the MIR acted as a data steward. Important issues were the management of the meta-data and the quality of the data input.

Fourth, the MIR was also available to address very specific ad hoc information requests that required, for example, the application of advanced analytical techniques. The MIR's expert analysts would then prioritise and handle these information requests.

Fifth, the MIR maintained and further developed the enterprise data warehouse architecture, linking different sources into data marts, which in turn were connected to engines for analytics and reporting.

4.3. Information Brokerage

A second organisational role was that of the Information Brokers, also known as business-IT hybrids [36]. At the AAPD, Information Brokers were sourced largely from within the police force to liaise, orchestrate and facilitate communication between different stakeholders. These officers had knowledge of both policing and information management.

Pawlowski and Robey [30] attribute Information Brokers a facilitating role in the knowledge process flow concerning IT and business practices across the boundaries that separate work units within organisations. Here is the Information Broker's role in a nutshell:

- (1) Information Brokers are mandated to cross the boundaries, share information and leverage resources.

- (2) Through a wider view of the business activities, the Information Broker surfaces and challenges assumptions, stimulates reflection, and assesses the impact of suggested change on the organisation.
- (3) Information Brokers are able to reframe, explain and clarify information. Information Brokers also help bridge the gap between business groups (e.g. police officers) and the IT department (e.g. MIR).
- (4) End user involvement, sponsorship and commitment are essential to project success. Here, the role of the Information Broker is to liaise between the various actors and pursue goal congruence.

The AAPD had about 20 Information Brokers, whose role was similar to that of a "business analyst" in many organisations. They were supposed to stay close to the officers at the different levels through personal contacts and presence in management meetings.

First, Information Brokers helped superior officers translate strategy and communicate decisions to their subordinates. For example, performance against corps management's priorities were systematically updated and tracked in all reports. This enabled quicker reactions to limit discrepancies between observed and anticipated crime trends.

In addition, Information Brokers helped consolidate the feedback from the lower level officers and send it back up the line. By being present at meetings and steering committees all over the AAPD, Information Brokers could help lower levels to direct the attention of higher level police management towards emerging hot spots or deviations from the projections.

Furthermore, Information Brokers were responsible for picking up the semi-structured and unstructured requests for potential information products and relay them to the MIR. They would assist in further fleshing out the requests, and, once the information products had been developed, they would help colleagues interpret, improve and work with the historical and anticipated crime facts that would be reported.

In this way, they played a central role in lubricating the channels of enterprise-wide knowledge sharing and development with respect to the use of the operationalised BI capabilities.

² For more information on Gartner, please visit their website: <http://www.gartner.com>.

4.4. Two information products for capacity management: ILP in action

During our interviews, police officers across the organisation confirmed that capacity management was one of their most challenging, yet critical, responsibilities within the law enforcement pillar of the AAPD.

Capacity management refers to determining which and how many police resources need to be made available in what parts of the AAPD region and when.

In the past, these decisions (made at all three sub-levels of the AAPD) had been based on perceptions of past experiences and seasonal crime trends held by senior and less senior officers, in combination with local ambitions and sensitivities.

In line with the ILP goals, the AAPD developed a capability for integrated, reliable and actionable intelligence to support the capacity management decisions. This would integrate the different levels and support a rapid, flexible and focused deployment of the available policing capacity towards the areas and types of crime that needed them the most.

Two information products – the Early Warning System and the Data Detective tool – illustrate how the different components (both the technical and the organisational components) worked together to support ILP at the AAPD.

Figure 2 shows how these two key applications connect different aspects of police decision making as a performance management problem. The MIR and the Information Brokers are located on the knowledge-sharing arrows between the different

performance management activities.

Technically, on top of the enterprise data warehouse, the MIR had installed an automated information processing capability, called the Early Warning System. The system collected data from different historical crime report repositories and kept a record of how current crime rates were running against the projected figures based on a) historical data and b) the objectives set by the different decision-making levels. The outputs of the Early Warning System were indicators that highlighted significant deviations from the projected figures. As shown in Figure 2, the system's main function was monitoring, though it could also be used for deeper analyses by navigating through the data of the different levels.

The Data Detective tool had more detailed analysis and reporting capabilities (see Figure 2). It in fact replaced the local manual work of the so-called “dotters”. Doters were police officers who would locate reported crimes on large printed maps by means of dots and thumbnails. The Data Detective tool would do the same, but: a) it was based on integrated data across the different levels, and b) it presented the information by means of visually enriched data navigation and deep analysis functionalities. It pinpointed the main crime “hot spots” on a map to inform resourcing decisions. For example, through this tool the officers could drill down in the data to identify travelling burglary gang activities.

Organisationally, the MIR and Information Brokers supported the knowledge flows between the different activities.

For example, the MIR took care of automating the

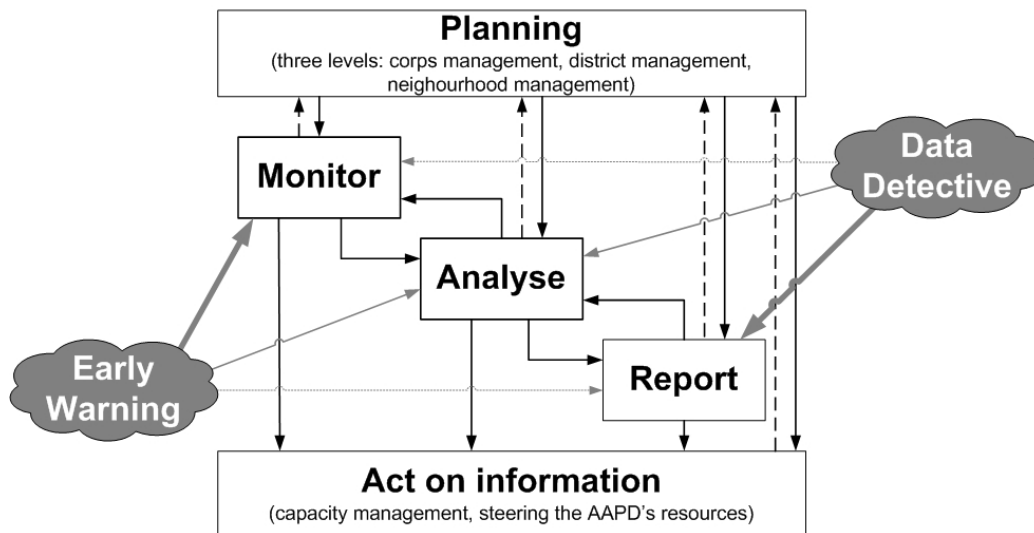


Figure 2. Components of the police management processes at the AAPD (based on Eckerson, 2006 [14])

information flows, distributing scorecards and notifications via the intranet to the different decision makers in the organisation. As for the Data Detective tool with its advanced analytical functionalities, a number of expert analysts within the MIR made the necessary analyses. In addition to answering ad hoc information requests, a monthly report summarising the most frequent questions was made available via the intranet. Next to sharing the information, the MIR kept the tools relevant and attractive to users.

The Information Brokers would sit in on corps, district, and neighbourhood capacity management meetings to: a) pick up on new informational needs, b) help with the interpretation of the designed reports, and c) communicate common or contradicting capacity management trends between the levels.

5. Summary and Discussion

By installing both BI technology and its organisational complements, the AAPD built, and stimulated the continuous improvement of, an operationalised BI environment in support of their ILP vision. The following four building blocks were crucial in their approach [based on 9, 10, 36].

First of all, adequate attention was given to the data foundation. The value of, for example, standard naming conventions, a normalised data structure, clear-cut meta-data, superior data quality and unambiguous data ownership across the chain of contacts cannot be overestimated. This responsibility was allotted to the MIR, who functions as a BICC, a centre of excellence for information management practices at the AAPD.

Second, it was insightful to promote a culture where data would be regarded as a corporate asset. At the AAPD, the new Chief of Police clearly subscribed to the ILP philosophy to complement intuition-led policing with facts and figures on crime.

Third, the role of the Information Brokers was essential in managing the knowledge flows at the AAPD and acting as the go-between linking the different levels in the organisation.

Finally, the success of the information products, such as Early Warning and Data Detective, depended on constantly creating, evolving and recreating the fit between the technological capabilities, the organisational needs and the existing organisational capabilities. The MIR and the Information Brokers played a pivotal role in effectuating this dynamic state of business-IT alignment.

Still, apart from describing a working operationalised BI and ILP setting, we also wish to take a first step in filling a perceived gap in academic

research into ILP and operationalised BI systems in practice. Generally speaking, the operationalised BI/ILP environment at the AAPD can be described by using established information science theory.

For example, Markus and Robey [21] distinguish three basic perspectives on the interaction between the organisation, individuals and technology: the technological imperative, the organisational imperative, and the emergent perspective. This case study clearly fits within the third perspective. The emergent perspective holds that “the uses and consequences of IT emerge unpredictably from complex social interactions”. In this case, neither technology nor the organisation in itself provided the impetus to drive ILP within the AAPD.

Moreover, in accordance with Orlikowski [29], the case also illustrates how the AAPD sustained the evolution of the system by supporting a redefinition and modification of the meaning, properties and applications of technology after initial development. The maturity of the technology – i.e. that of the data warehouse as well as that of the information products – is then an ever-evolving state.

Still, we believe that two comments in connection with the particular nature of BI systems need to be made. That is, BI is a system whose goal is more of an informational nature, i.e. to deliver better information to constituents. This contrasts with systems that are more of a transactional nature, i.e. designed to automate standard processes and series of actions [37].

We believe that, from an information science perspective, understanding such informational initiatives like ILP and, by extension, operationalised BI can benefit from framing them in: a) an enterprise-wide view of the systems and systems goals, and b) a knowledge-based perspective on business-IT alignment.

First, during our interviews, the MIR staff members and the Information Brokers regularly emphasised the difficulty of striking a delicate balance between the enterprise-wide need for integration and the immediate operational information needs of individual officers. Still, the AAPD seemed to be managing quite well with their enterprise-wide performance management vision, in this case ILP, supported by top management and cascaded by MIR and Information Broker functions. There appears to be a risk for organisations that develop an operational BI environment incrementally.

While there are the so-called maturity models published in popular literature (e.g. the information evolution model by Davis et al. [11]), with the exception of Watson et al. [35] little academic

attention has been given to the organisational evolution of such an environment. More specifically, not much emphasis has been placed on the practices of realising the essential enterprise-wide intentions that are embedded in the technical capabilities of the BI system (e.g. data integration, information sharing, etc.).

The AAPD showed how an enterprise performance management philosophy such as ILP could form a unifying theme under which operationalised BI capabilities were developed, sustained and integrated through an enterprise-wide network of connected technical components and shared organisational processes and go-betweens.

Consequently, we contend that research into operationalising BI should not be blinded by enterprise goals, by remaining all too functionally oriented in its applications or by focusing on “the masses” rather than the enterprise. We therefore believe it necessary for current theories and definitions positioning operationalising BI to target better enterprise management as their aim.

Secondly, the informational nature of the system makes it especially well-suited for knowledge-based investigations into the combination of organisational and technical components that surround the enactment of the system.

For example, Nissen et al. [27] distinguish sharing from non-sharing knowledge management activities. The former implies organising, formalising and distributing knowledge (e.g. by codifying project management best practices in a manual). The latter entails creating, applying and evolving knowledge (e.g. setting up cross-functional working groups to tackle specific problems).

At the AAPD, the MIR (as a BICC) and the Information Brokers played important roles in both sharing and non-sharing knowledge management activities. For example, to enable correct interpretation of the data and to stimulate self-help, the MIR held training and education sessions (a sharing knowledge management activity). But it was also the task of both the Information Brokers and the MIR to safeguard the fact that the information products were designed for user-friendly reporting, such as displaying geographically referenced information (rather a non-sharing activity). Quoting Bush et al. [3]: “information does not become knowledge until the receiver understands what it is they are receiving”.

6. Conclusion

This paper has offered a descriptive account of the set-up of the AAPD’s operationalised BI environment for ILP as it presented itself in the spring of 2007. As illustrated through the capacity management example, they had built an environment where police officers at the different decision-making levels could use fact-based, integrated and aligned intelligence as a complement to their intuition.

Although this paper is essentially descriptive in nature, we believe that two suggestions can be made to guide future research into operationalised BI environments.

First of all, the AAPD’s approach contrasts with merely pursuing locally optimised operationalised BI tooling efforts for lower-level employees. Secondly, this paper also suggests a path for possible academic research by applying knowledge-based techniques to these specific informational contexts.

Therefore, we believe in the further application of knowledge-based perspectives to settings with operationalised BI ambitions. For example, while the BICC has been taken up as a concept by vendors, consultants and the like (e.g. Miller et al. [25]), academic research into the “what” and the “how” of specific organisational mechanisms that can serve as catalysts for executing on the informational promises will prove instrumental.

This paper is only a small step along the way, as it is descriptive and based on a rich but single case study of a specific situation. Still, given the increasing popularity in the market for operational BI technologies, we foresee the relevancy of research on this topic growing only greater in future.

Acknowledgements

This research was supported by Vlerick Leuven Gent Management School’s Chartered Research Programme on Business Intelligence. We would like to thank the supporting member companies: Belgacom Group, KBC Group, the Amsterdam-Amstelland Police Department, Volvo and VRT. Finally, we would like to express our most sincere thanks to all the people at the AAPD that freed up their time to contribute to this study.

References

- [1] H. Baars, and H.-G. Kemper, "Management Support with Structured and Unstructured Data - An Integrated Business Intelligence Framework", *Information Systems Management*, Vol. 24, No. 2, 2008, pp. 132-148.
- [2] J. Bruno, "Facilitating knowledge flow through the enterprise", *International Journal of Intelligent Systems in Accounting Finance & Management*, Vol. 11, No. 1, 2002, pp. 1 - 8.
- [3] A.P. Bush, D. Richards, and C.N.G. Dampney, "The graphical interpretation of plausible tacit knowledge flows", *Proceedings of the Asia-Pacific symposium on Information visualization*, Vol. 24, 2003, pp. 37 - 46.
- [4] T.A. Carte, A.B. Schwarzkopf, T.M. Shaft, and R.W. Zmud, "Advanced Business Intelligence at Cardinal Health", *MIS Quarterly Executive*, Vol. 4, No. 4, 2005, pp. 413 - 424.
- [5] J.O. Chan, "A Conceptual Model for Operations-Analytics Convergence", *The Journal of American Academy of Business*, Cambridge, Vol. 8, No. 1, 2006, pp. 48 - 54.
- [6] W.F. Cody, J.T. Kreulen, V. Krishna, and W.S. Spangler, "The integration of business intelligence and knowledge management", *IBM Systems Journal*, Vol. 41, No. 4, 2002, pp. 697 - 713.
- [7] P.M. Collier, "Policing and the Intelligent Application of Knowledge", *Public Money & Management*, Vol. 26, No. 2, 2006, pp. 109 - 116.
- [8] P.M. Collier, J.S. Edwards, and D. Shaw, "Communicating knowledge about police performance", *International Journal of Productivity & Performance Management*, Vol. 53, No. 5, 2004, pp. 458 - 467.
- [9] T.H. Davenport, "Competing on Analytics", *Harvard Business Review*, Vol. 84, No. 1, 2006, pp. 98 - 107.
- [10] Davenport, T.H., and D. Dreyfus, *Working Knowledge: How Organizations Manage What They Know*, Harvard Business School Press Books, Boston, MA, 1997.
- [11] Davis, J., G.J. Miller and, A. Russell, *Information Revolution: Using the Information Evolution Model to Grow Your Business*, John Wiley & Sons, Hoboken, NJ, 2006.
- [12] H.J. Dresner, F. Buytendijk, A. Linden, T. Friedman, K.H. Strange, M. Knox, and M. Camm, "The Business Intelligence Competency Center: An Essential Business Strategy", Gartner Research, Gartner, 2002.
- [13] W.W. Eckerson, "Best Practices in Operational BI - Converging Analytical and Operational Processes", TDWI Best Practices Report, TDWI, 2007.
- [14] Eckerson, W.W., "Performance dashboards: Measuring, Monitoring, and Managing Your Business", John Wiley & Sons, Hoboken, NJ, 2006.
- [15] A. Gonsalves, "Operational BI: The Evolution Of Business Intelligence", *Intelligent Enterprise*, Vol. 10, No. 8, 2007, pp. 22 - 22.
- [16] R.M. Grant, "Toward a knowledge-based theory of the firm", *Strategic Management Journal*, Vol. 17, 1996, pp. 109 - 122.
- [17] Inmon, B., "Building the Data Warehouse", John Wiley and Sons, New York, 1992.
- [18] G. Lawton, "Making Business Intelligence More Useful", *IEEE Computer*, Vol. 39, No. 9, 2006, pp. 14 - 16.
- [19] C.H. Li, "ERP packages: What's next?", *Information Systems Management*, Vol. 16, No. 3, 1999, pp. 31-35.
- [20] A. Marjanovic, "The Next Stage of Operational Business Intelligence: Creating New Challenges for Business Process Management", *Proceedings of the Fortieth Annual Hawaii International Conference on System Sciences (CD-ROM)*, January 3 - 6, 2007, Computer Society Press, 2007 (10 pages).
- [21] M.L. Markus, and D. Robey, "Information technology and organizational change: causal structure in theory and research", *Management Science*, Vol. 34, No. 5, 1988, pp. 583 - 598.
- [22] J. McAdams, "What's next: Business Intelligence", *Computerworld*, Vol. 40, No. 1, 2006, pp. 24 - 26.
- [23] P.P. McDonald, "Implementing CompStat: Critical Points to Consider", *The Police Chief*, Vol. 71, No. 1, 2004, pp. 33 - 37.
- [24] E.F. McGarrell, J.D. Freilich, and S. Chermak, "Intelligence-Led Policing As a Framework for Responding to Terrorism", *Journal of Contemporary Criminal Justice*, Vol. 23, No. 2, 2007, pp. 142 - 158.
- [25] Miller, G.J., D. Bräutigam, and S.V. Gerlach, *Business Intelligence Competency Centers: A Team Approach to Maximizing Competitive Advantage*, John Wiley & Sons, Hoboken, NJ, 2006.
- [26] Newman, B., *Agents, Artifacts, and Transformations: The Foundations of Knowledge Flows* (chapter 15). In Holsapple, C.W. (Ed.), *Handbook on Knowledge Management 1: Knowledge Matters*, Springer, Germany, 2003.
- [27] M.E. Nissen, M.N. Kamel, and K.C. Sengupta, "A Framework for Integrating Knowledge Process and System Design", *Information Strategy: The Executive's Journal*, Vol. 16, No. 4, 2000, pp. 17 - 26.
- [28] M.E. Nissen, "Dynamic Knowledge Patterns to Inform Design: A Field Study of Knowledge Stocks and Flows in an Extreme Organization", *Journal of Management Information Systems*, Vol. 22, No. 3, 2005, pp. 225 - 263.
- [29] W.J. Orlikowski, "Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations", *Organization Science*, Vol. 11, No. 4, 2000, pp. 404 - 428.
- [30] S.D. Pawlowski, and D. Robey, "Bridging user organizations: knowledge brokering and the work of information technology", *MIS Quarterly*, Vol. 28, No. 4, 2004, pp. 645 - 672.
- [31] S. Viaene, and J. Willems, "Corporate Performance Management: Beyond Dashboards and Scorecards", *Journal of Performance Management*, Vol. 20, No. 1, 2007, pp. 13 - 32.
- [32] B. Violino, "BI for the Masses", *Computerworld*, Vol. 38, No. 25, 2004, pp. 38 - 39.

- [33] W.F. Walsh, and G.F. Vito, "The Meaning of Compstat", *Journal of Contemporary Criminal Justice*, Vol. 20, No. 1, 2004, pp. 51 - 69.
- [34] H.J. Watson, and B.H. Wixom, "The Current State of Business Intelligence", *IEEE Computer*, Vol. 40, No. 9, 2007, pp. 96 - 99.
- [35] H.J. Watson, B.H. Wixom, J.A. Hoffer, R. Anderson-Lehman, and A.M. Reynolds, "Real-time business intelligence: Best practices at Continental Airlines", *Information Systems Management*, Vol. 23, No. 1, 2006, pp. 7 - 18.
- [36] B.H. Wixom, H.J. Watson, A.M. Reynolds, and J.A. Hoffer, "Continental Airlines Continues to Soar with Business Intelligence", *Information Systems Management*, Vol. 25, No. 2, 2008, pp. 102 - 112.
- [37] Weil, P., and M. Broadbent, *Leveraging the New Infrastructure: How market leaders capitalize on IT*, Harvard Business School Press, Boston, MA, 1998.
- [38] J. Weir, "A Web/Business Intelligence Solution", *Information Systems Management*, Vol. 17, No. 1, 2000, pp. 41 - 46.
- [39] D. Weisburd, S.D. Mastrofski, R. Greenspan, and J.J. Willis, "The Growth of Compstat in American Policing", *Police Foundation Reports*, The Police Foundation, Washington, 2004.
- [40] Welten, B., "Politie in Ontwikkeling", Drukkerij van Gerwen, 's-Hertogenbosch, The Netherlands, 2004.
- [41] J.J. Willis, S.D. Mastrofski, and D. Weisburd, "Making Sense of Compstat: A Theory-Based Analysis of Organizational Change in Three Police Departments", *Law & Society Review*, Vol. 41, No. 1, 2007, pp. 147 - 184.
- [42] Yin, R.K., "Case Study Research: Design and Methods", Sage Publications, Thousand Oaks, CA, 1994.