JOURNAL OF DECISION SYSTEMS, 2016
VOL. 25, NO. S1, 85–95
http://dx.doi.org/10.1080/12460125.2016.1187415

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# A business value oriented approach to decision support systems

Fergal Carton[a], Tim Hynes[b] and Frederic Adam[a]

[a]Business Information Systems, University College Cork, Cork; [b]Allied Irish Banks, Dublin

**ABSTRACT**

With an increased emphasis on cost reduction and device agnosticism, Chief Information Officers (CIOs) increasingly struggle to justify investments in technology, typically lacking a vision linking those investments (in applications, infrastructure or integration) with value to business decision makers. Without guidance from a proper model of custodianship for enterprise wide master data, both structured and unstructured, exploring and exploiting value from the information assets of the enterprise becomes problematic. This paper uses a case study on management decision-making in a corporate environment to illustrate the fragmentation of enterprise data models, and argues for a different approach to understanding the value of data in organisations, where enterprise data assets are conceptualised in their entirety rather than from within application silos. It is proposed that data access should be governed in a centralised and secure manner, such that decision support applications consuming that data can be created quickly and economically. In this scenario, CIO attention is re-dispositioned from infrastructure maintenance to business decision value.

**KEYWORDS**

Information value; CIO; decision support; Digital Business Pyramid; Decision Support System (DSS); Enterprise Integration; ERP

## Introduction

Research has shown that the type of information provided to managers in support of decision-making can have a fundamental impact on their contribution to the organisation (Pinsonneault & Kenneth, 1993; Pinsonneault & Suzanne, 1998; Pfeffer & Sutton, 2006). Yet, mandated to use the vertical 'line of business' applications implemented by their organisation to support 'best practice' business processes, managers typically have to rely on pre-specified and inflexible reports (Ilmola & Kuusi, 2006; Hiltunen, 2008; Carton & Adam, 2008) that are ill adapted to their ongoing, evolving information requirements for decision support. There is evidence that the information made available to them is insufficient, therefore these managers resort frequently to the use of spreadsheets which they design themselves on the basis of often incomplete raw data which they must rearrange manually to obtain the support they need (Hosack, Hall, Paradice, & Courtney, 2012; Panko, 2006; Pemberton & Robson, 2000).

**CONTACT** Fergal Carton f.carton@ucc.ie

The decision problems faced by managers are frequently related to the need to make fast decisions, due to the acceleration of business cycles and the concentration on short term performance. Added to that, the consumerisation of hardware platforms has driven Bring Your Own Device (BYOD) policies and social media integration to the fore, all the while increasing the urgency and importance of data governance guidelines. This leaves little time or energy to devote to the 'value layers' of the technology investment: the richness that can be mined from internal and external data, both structured and unstructured, and the exploitation of that richness in rapidly deployed 'lite' applications that support decision makers with real time access to dashboards and data analytics. So CIOs are constantly being drawn back to work on the information delivery mechanisms, instead of having time and resources to contribute to the organisational efforts on the information itself. As Courtney (2001) has indicated, understanding that information and knowledge are important to support decision-making in the firm is not the same as understanding how to manage and deliver the underlying data.

In this paper, we use a case study to illustrate the changing role of managers and the problems they encounter in effectively and efficiently running the segment of the business under their direct control, due to the lack of dedicated decision support and the inflexibility of the Enterprise Resource Planning (ERP) system. The paper also illustrates the very tangible technical and business issues arising from the need to deliver near real time decision support and highlights the uncertain impact this may have on the quality of managerial decision-making. Based on that evidence, we propose a framework to better capture the value embedded in corporate information assets and emphasise the potential value-adding role of the CIO in the modern organisation.

The paper is organised as follows: first we examine the changing role of managers administering processes involving complex transactions. Then a narrative of the business process we investigated is presented which explores the ins and outs of managers' decision-making within this process. We then analyse this narrative based on three research questions: (1) what goals are managers pursuing and what decisions must be made in order to achieve these goals and (2) what impact support systems are having on the decision process and (3) how does the inadequacy of the underlying data (for instance its latency) affect this impact. Leveraging our observations, we propose the Digital Business Pyramid, and suggest how this framework might be validated through empirical study.

## The changing face of management

Managers administer processes which are increasingly distributed across business units and business partners in delivering products and services (Marjanovic, 2010; Zhao, Liu, & Yang, 2005). Product & services designs, market reactions and customer demands are also increasingly diverse and variable (Kumar, 2001), making the task of managing the customer facing domains highly specialised. Furthermore, the provision of the information dedicated to supporting managers in these positions is also equally difficult and specialised (Davenport, Harris, & Morison, 2010). Yet, the bulk of information technology (IT) expenditure and effort is dedicated to the operational dimension of business processes, not the decision support dimension. Furthermore, standardised 'Line of Business' applications (ERP[1], CRM[2], SCM[3], MES[4], PLM[5] …) are typically interfaced to highly specialised legacy applications that require specific integration resources. This means that organisations' centralised data repositories are often

far more fragmented and inconsistent than the theory of enterprise wide systems suggests.

Where the business cycle accelerates, the speed with which decisions are made impacts on the profit margin on the organisation, Evidence-based management (Pfeffer & Sutton, 2006) underpins the enlightened selection, and accurate measure of, the critical indicators most useful to business managers. Additionally, the sensitivity of managers to emerging patterns of weak signals, data outliers or process exceptions is crucial in stimulating critical insights (Yeoh & Koronios, 2010). Such indicators may come from internal or external sources, and may be structured or unstructured in nature. Recent Data Analytics / Business Analytics literature presents evidence of firms that are achieving success with data analytics Davenport, 2010), (Negash & Gray, 2008, at least in terms of specific processes, such as those upon which sales staff rely in call centres (Hopkins & Brokaw, 2011).

Overall, however, the extreme complexity and dynamism inherent in managerial requirements for decision support explains why managers continue to rely on simple self-developed spreadsheet tools to drive certain aspects of the business (Panko, 2006; Pemberton & Robson, 2000). Previous research has noted that the timeliness of managerial information is critical to its importance (Pfeffer et al., 2006; Davenport et al., 2010). The hypothesis tackled by this paper is that providing timely and ubiquitous access to managerial information has a radical impact on decision-making, but that current IS resources are poorly adapted to delivering such access.

## Research objective and methodology

The objective of this research, therefore, is to examine the relationship between business decision-making and enterprise applications, such that the potential for providing real time data and real time decision support to middle managers facing a high velocity activity in their functional area is better understood.

A structured interview guide was used to elicit views pertaining to the three research questions posed by this study: (1) what goals are managers pursuing and what decisions must be made in order to achieve these goals and (2) what impact support systems are having on the decision process and (3) how does the inadequacy of the underlying data affect this impact.

The data analysed in this paper was extracted from a subset of 28 interviews with managers which provided direct or indirect evidence pertaining to the Deliver process. The stories and raw data yielded a rich basis for our analysis of the potential of real time decision support (Baxter & Susan, 2008).

## Introduction to the case study

SIT is a market leader in data management solutions, employing over 26,000 staff in 52 operations worldwide. Manufacturing is concentrated in three sites, one of which is in Cork, Ireland. SIT has evolved into a 'solutions' company, delivering not just hardware, but also information 'lifecycle' tools and consulting services. A key complexity of such full service offerings is the management of the information flows related to executing large single customer orders, which increasingly are constituted of bundles of hardware, software and services. Many of these revenue lines are executed by multiple locations, over different time

horizons, yet the customer will require a single sales order, single invoice and single goods shipment. The Chief Executive Officer (CEO) of the company suggests that the challenge for corporate growth is not in customer acquisition, but in execution on actual customer commitments.

To compound matters, every quarter sees an acceleration of the deals being closed at quarter end (the 'hockey stick' effect) due to customers waiting until the best deal is put on the table. The Deliver process is therefore a high intensity case study (Patton, 1990), and it is in this context that we studied the impact of access to real time data at critical stages in the decision-making process.

The case study focuses on the Deliver process, which is where sales orders are converted into shipments, and customers are automatically invoiced. This process is key from a sales performance perspective because only when product has been shipped, can the associated revenue be recognised. With hockey stick pressure (an industry tendency for customers to wait for the end of the trading period to confirm sales orders to obtain the greatest possible discounts) on end of quarter shipments, and shareholders and market analysts monitoring in minute detail performance versus target figures, the importance of having a real time view of actual shipments increases as quarter end approaches. However, transactional volumes are also reaching a peak, leading to a systematic conflict between the need to support operations (shipments), and the need to support management (decision-making related to performance objectives). Our case is a highly successful multi-national manufacturing organisation with a mature ERP based architecture and therefore, the conclusion that the problems reported in the case are merely examples of poor corporate performance is not sustainable.

The Deliver process is characterised by the stress which builds on all elements of the Sales Order and Distribution cycle, such that operators must operate in near real time in the last two weeks of each cycle. These two weeks are make-or-break for the company in terms of revenues – the decisions made by managers in the Deliver process in that period of the cycle determine the margins achieved by the firm for the quarter, and quite simply dictate whether the company reaches its revenues targets, satisfying shareholder expectations.

In this process, managers are supported on the one hand by the ERP application which tells them line by line which sales order must be fulfilled. On the other hand, the production control system provides them with list of available inventory in terms of finished goods and their configuration, down to the level of the reference number on each electronic component. Matching supply and demand (the sales order to shipped components) is effected by shipping managers who instruct operators to make up the actual order to be shipped. This is reflected in the ERP application by a matching of shipped goods to each sales order.

In describing the relationship between decision-making and enterprise integration, a key consideration was to be able to differentiate between constraints that were related to the business process themselves, and constraints that were related to the system configuration. This was important because of the embedded nature of enterprise software in organisational processes. It is understood that building decision support value from IT investments requires a good fit between the process and the underlying technology, and that fit is influenced as much by the physical reality of the shipping process as it is by the attributes of the software used to support the processing of sales, allocation and shipping transactions. Arguably, the primary objective should be to address the business concerns rather than the technical concerns.

## Analysing the case study: managerial decision-making in the Deliver process and the impact of support systems

The Deliver process is the junction between a customer requirement coded in the ERP application as a purchase order and a physical piece of inventory on the factory floor. In exploring the value of the ERP system in supporting decision-making, managers cited many constraints and issues that arise because of both the way business is done, and the way the information systems operate. The consequence for managers is that decision-making in the Deliver process remains largely manual not only in terms of moving the physical product, but also in terms of data manipulation and support to decision-making, despite the increasing volume and pace of shipments towards quarter end. This apparent inefficiency seems primarily because of the gap that has evolved between the picture of reality captured in the information systems and the actual reality of doing business in a fast moving technology market. To use a photographic analogy, the picture is blurred because the subject moved or because the 'camera' is poorly adjusted to the conditions, or a mixture of both. As previously discussed, it is critical to classify the factors contributing to this gap as related to the business context or to the limitations of the information systems, because the solution to the problems these give rise to is very different in both cases.

### *Constraints arising from the physical business transactions*

The joint pressures of an expanding product range and increased sales volumes have made the current way of manual process for allocating product to orders ('babysitting the orders' in the words of the managers themselves) untenable. Much of the lower end product requires no configuration, is fixed price, and therefore is suitable for automatic allocation in a way that was never considered for the historical high products of the company. Furthermore, the concept of a global fulfilment process is emerging, where any customer could order any combination of hardware, software or service. These orders could be sourced from any one of seven or eight locations, including other field locations. Doing business in an evolving marketplace necessitates flexibility, in terms of the optimal configuration of plants, subsidiaries, fiscal arrangements and revenue processes.

Cultural differences account for the level of trust shown by distribution in the sales organisation. Sales reps will vary in the reliability of the commitments they ask of manufacturing. Distribution maintain manual performance statistics to track the level of accuracy of sales order activity, including the number of pre-allocated orders, the number that didn't come in, the number that came in but were different. This report gives distribution managers ammunition to judge the integrity of the sales organisation and this can be used in discussions about the performance of the Delivery process.

These contextual factors provide some degree of illumination on the changing nature of the decision-making scenarios for managers involved in the Deliver process, demonstrating that these decisions are subject to external and internal influences on how business is carried out. The deliver process is where 'the rubber meets the road' in terms of what the organisation promises to both customers and shareholders, versus what it can physically deliver. In the next section the constraints on distribution that arise from the use of the ERP system are examined.

### *Constraints arising from the system configuration*

Product allocation decisions are constrained by several factors arising from the use of supporting information systems. Firstly, technical latency related to the reporting infrastructure impacts management decision-making at the most critical point in the business cycle. High level revenue attainment decisions can only be made with clear visibility of up to the minute aggregated information for bookings (incoming sales orders), backlog (approved sales orders ready to ship), billings (shipped) and available inventory. This information derives from the ERP system, as the only system of record for customer orders and their status. SIT employ a three tier infrastructure for management information, mirroring live ERP data to a data warehouse, from where it is 'published' via a Business Intelligence (BI) tool. As quarter end approaches, and the system is dealing with heightened bookings activities, the single instance ERP system exhibits a degradation in response times. Its ability to keep backlog and billings up to date is impaired, in some cases resulting in the system running up to several hours behind the physical transactions. This means that despite shipment transactions being completed, management cannot see the corresponding orders moving off backlog, and therefore lose visibility of performance to target. This slowdown can have drastic consequences from a decision-making perspective, as a corporate controller for revenue reporting iterated:

> that lag means people are making bad decisions, uninformed decisions, and having a disconnect in time between incoming and outgoing, people wasting their time with transactions that are incomplete

The effect of this slowdown in core transaction processing on decision-making is amplified in a vicious circle, as explained by a senior director in corporate Finance:

> Performance issues, are 2 things, process and reporting, and they are correlated, as part of the process relies on data coming back out of Oracle. Processing time, that starts to lengthen, then reporting is impacted, then visibility …

The IT department has reacted to the technical latency issues by tuning the system for better performance, investing in higher processing power, but also by prioritising the processing power for the critical tasks. Native ERP reports are not adequate, as users are unable to filter or aggregate the information displayed, as confirmed by a Cork based Distribution supervisor:

> But it's not OK if you want to see how many orders do I have now, what's the total backlog, how many Product A's are there in the UK operating unit, how many Product B orders, how does it break down, you can't see any of that on Oracle [vanilla reporting]

Secondly, the flexibility in allocating (and re-allocating) product to sales orders proves difficult to incorporate into a generic ERP model, which considers that allocated inventory is 'consumed', and therefore initiates a sequence of transactions that would be complicated, if not impossible, to roll-back in the event of a re-allocation. At the time of the case study, and with the benefit of hindsight, managers could see how customising the ERP system to their own local processes for the high margin product, has ultimately limited its usefulness as the importance of that product line in revenue growth is diminishing. As one distribution manager put it:

> A lot of what we developed in ERP in terms of processes was developed around Product A, it still is, but there's a hell of a lot of business has grown up around it. The other side of it, we

> customized the hell out of the ERP system instead of meeting it half and half, and I don't think that has helped us, so everything you try and do, there is always a block ahead of you

Thirdly, using such a rigid process template for the administration of operational activities ignores the fact that the way of doing business evolves over time. Workarounds are implemented to adapt to the new business context that undermine data integrity. The growing volume of business with channel partners, for example, meant that the situation arose where SIT was shipping the same product via two different distribution channels, one direct from an SIT plant, the other via a channel partner. In order to differentiate between the two types of revenue, two different model numbers were used, without a second thought for the impact on data integrity.

The above constraints of technical latency, data integrity, workarounds and process flexibility hamper the usefulness of ERP to the allocation and shipment process. The net effect of these constraints is a slowdown in administrative processes which threatens the actual execution of shipments. Attributable both to the limitations of the software, and to the self-imposed constraints of a micro-managed distribution process, the result is that the value of an integrated tool for decision-making is forfeited at the very moment it is most required. All these observations, however, are made with the benefit of hindsight and at least some of the impact of past implementation decisions is totally unpredictable. Definitely, changes in the nature of the business transactions due to the emergence of new business models are hard to predict. Yet many ERP implementation decisions will end up having a disproportionate impact on what managers can do or not do.

## Discussion and conclusions

The SIT case study indicates the lack of decision support provided by information systems in the SIT case, to managers involved in key activities relating to allocation of finished goods to sales orders and their timely shipment to customers. A combination of incomplete support, as the revenue maximisation and customer prioritisation factors are not supported at all, and latency in both transaction processing and reporting by information systems contribute to managers in the deliver process having to make complex decisions in the absence of certain types of data. Furthermore, the SIT case study indicates that when the business cycle accelerates, even in a predictable fashion at the end of each accounting period, the quality of the incomplete support provided further deteriorates as systems slow down and eventually operators are forced to leave the transactional systems behind, leaving managers without any data at all. This gives rise to management by walkabout as managers go on the shop floor and babysit their largest orders – a possibility which does not exist where orders are shipped from other sites in the corporation.

The case indicates that the real time informational needs of decision makers are particularly difficult to meet, because in the real world the accurate capture of complex transaction is difficult. The SIT case study furthermore illustrates the difficulty of reproducing this captured reality in a way that supports managerial decision-making. The problem of disconnect between information systems and the decision-making needs of managers, especially the real time decision-making needs, is of a fundamental nature and is inherent in the architectures and application designs used in deploying enterprise and BI systems. This is further complicated by one key observation: the only way to bridge the gap between reality and systems is to move towards a greater level of customization which captures the full

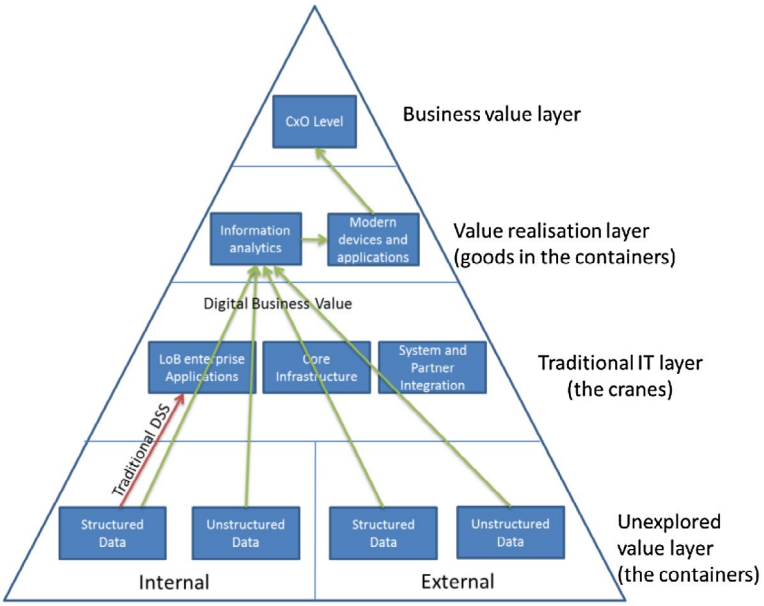


**Figure 1.** The Digital Business Pyramid.

idiosyncrasy of the business reality at a given time. This customisation may deliver some good returns initially, even in decision support terms, but it is likely to act as additional rigidity in the medium terms as evolutions in the business reality move the goalposts and turn the customation into an obstacle to change. It is not certain how to move beyond this observation. In the specific context of the SIT case study, and certainly borne out by evidence in other organisations in this study, the fit between the ERP system and reality degrades over time, until there is a complete re-implementation of the ERP system (Carton & Adam, 2005).

Thus, the solutions to the above problems are not to be found within silo-ed applications, because they fail to integrate a data model for the entire enterprise. In this case study, the attention and resources of the IT organisation are consumed by an emphasis on the applications and infrastructure that support the Deliver process. This reduces their availability to work on the complex revenue optimisation decisions although they have instant and quantifiable business impact.

To conceptualise a more flexible relationship between the data and the decision support requirements of managers, we propose a business value oriented approach. This model is hinged on the concept of value derived from data for decision support (the 'containers'), rather than the traditional IS organisation, which articulates around the technologies used to deliver the data (the 'cranes'). Figure 1 shows this proposed model, called the Digital Business Pyramid.

The unexplored value layer at the bottom of the pyramid reflects the type of raw information which could be used by managers for decision support, which includes both structured and unstructured data, both internal and external in origin. Simple examples of unstructured information would be the critical data communicated in unstructured communications via email and social media. The technical capability to analyse unstructured

data is constantly evolving, however, such as the use of Closed Circuit TV (CCTV) footage, which, although not traditionally considered as data, can be exploited for business value in certain contexts. There is evidence in many fields of activity that this type of data will become the mainstay of certain activities (e.g.: in skills validation in the medical field).

Traditionally, the scope of decision support in organisations has been constrained by the attributes of the structured data available internally. With resources devoted to the exploration of value in this more broadly defined data layer, correlations may be found across multiple data sets in the same way that big data applications seek to find relationships and patterns in the real world by examining and analysing disparate data sets. Consequently, managers can start to focus on extracting meaning and decision relevance from information, rather than struggle with the constraints of the IT layer.

Structured data requirements are, of course, met partially by internal line of business applications. External sources of structured data include all those resources pertaining to external market and competitor driven activity. These sources facilitate the manager in measuring organisational effectiveness in achieving strategic goals, and the efficiency of the processes whereby resources are consumed in achieving those goals.

The evidence of SIT managers having to make critical business decisions 'off-line' endorses this broader view of the data layer. The traditional IT layer (the cranes) consists of all of the resources that are typically deployed to manage information technology within the organisation. This includes line of business enterprise applications, core infrastructure and system / partner integration. As mentioned above, IT leadership attention is focused to a large extent on the implementation and maintenance of this layer. Previous action research by one of the authors to develop this framework involved discussions with CIOs of global organisations. He found that CIOs were struggling to be relevant in their organisations because they were spending up to 85% of their resources on this IT layer. Worse, as amply demonstrated by the SIT case in this paper, even then the benefits in terms of decision support are ultimately confounded by the real world evolving at a different pace than the virtual picture of that world as instantiated in these applications. In any case, cloud based models for software, infrastructure and platform as a service will gradually reduce the reliance on valuable in-house resources on this 'utility' layer, probably releasing these resources to work more actively in the data and business value layers of the model.

It is clear, but not the subject of this paper, that in order to derive value from this model, fundamental work on identifying common data elements across the different line of business applications would be required (normalisation, removal of duplicates, cleaning up incomplete or incorrect data, resolving issues of data ownership, reconciliation …). The role of IS in this restructuring of the corporate data model is primordial, there simply are no other skill-sets in the organisation capable of undertaking such work. Decision to invest large volumes of corporate resources in this activity will need to come from the top however. In the short term this would certainly have the effect of exacerbating the problem of IT time spent on non-value adding work.

Once enterprise data has been categorised and refined into the unexplored value layer, with stringent rules and controls as to its usage and particularly relating to update rights and the maintenance of data integrity, the IS organisation are very well positioned to now turn its attention to understanding how to get value out of this data.

At this value realisation layer, the IT capability transfers to the 'goods inside the containers', that is, useful information for decision support, rather than being mired in the data layer or

IT layer. Working alongside the business to understand both the problem domains and the pertinent information required to reduce uncertainty in those domains, agile 'ship early, fix fast' applications may be developed, with read only access to the data layer. Such applications would leverage the interface and accessibility and dynamic visualisation attributes associated with the most recent technologies, for instance smartphone applications, and would aim to shorten the typical systems development and deployment lifecycle to a matter of months rather than years. Crucially, these applications would consume data and present it using dashboard techniques adapted to the decision context at hand. They would ultimately be retired over time as their utility for decision-making had expired.

The purpose of the proposed model is twofold, firstly to stimulate reflection and further research on a more dynamic role for information systems in organisations, and secondly to conceive of a data driven architecture that would align more flexibly with the decision support requirements of the business.

The next stage in this research will involve validating this model in the case of a large provider of retail financial services. This longitudinal study will trace, over a 2 year period, the transformation of a traditional IT layer focused organisation to one focused on business value. The publication of the results of this work will also lead to the development of a strong theoretical model for the practice derived Digital Business Pyramid.

## Notes

1. Enterprise Resource Planning.
2. Customer Relationship Management.
3. Supply Chain Management.
4. Manufacturing Execution System.
5. Product Lifecycle Management.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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