ERP and Functional Fit: How Integrated Systems Fail to Provide Improved Control

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Abstract: Companies have been investing in integrated enterprise applications (such as ERP) for over a decade, without firm evidence of a return from these investments. Much research has centred on the factors which will lead to a successful implementation project (eg: Holland and Light, 1999; Shanks and Seddon, 2000), but to date there appears to be little research on the longer term impact of ERP systems on the organisation (Heili and Vinck, 2008). Although the greater level of system integration brought on by ERP has meant that there is more operational information available to managers than ever before, the information stored in ERP applications requires much off-line manipulation in order to be meaningful to managers. The data held in ERP databases originate in physical processes that evolve over time, and thus inevitably a gap opens between the ERP system, and the reality it is designed to capture (Lee and Lee, 2000). Taking the evaluation of management performance against organisational objectives as research domain, and focusing on a case study in the pharmaceutical sector, this paper looks at the footprint of a global ERP system in the day to day decision making of managers both at a manufacturing site level and at Headquarters level. Although the ERP implementation resulted in major improvements in data integrity at an operational level, resulting in improved visibility of costs and traceability of transactions for head office, many of the benefits associated with exploiting the information thus collected have been compromised by the need to rely on non-integrated tools for certain specific functions. Thus, for decision making purposes, managers must still download data to spreadsheets, where they are manipulated and combined with data from other, non-integrated systems. Thus, this paper examines the role of ERP systems in supporting management activity in a manufacturing environment, highlighting the gap between management performance and the informational and decisional support provided by the ERP.

Keywords: ERP, decision making, data integrity, organisational goals, KPI, skills

1. Introduction

In streamlining the administration of day to day manufacturing activity, ERP systems are implemented with the aim of reducing the potential for error in information handling in the procurement, production and distribution processes. By incorporating efficient data capture technology with powerful networking capacity, the vital transactional information is captured at source by users as an integral part of their work processes, and then made available instantaneously for management (Kalakota and Robinson, 2001). This theoretical ideal makes the concept of ERP an enormously attractive one for large firms faced with on-going struggles to reduce costs and report detailed results to shareholders in a timely fashion (Holsapple and Sena, 2002).

However, the time saved by the organisation in automating administrative processes does not necessarily imply faster decision processes or better decisions (Chang and Gable, 2002). Management decisions are generally based on the ability to compare *actual* data (often provided by the ERP system) with *planned* data (frequently managed in less integrated systems, and subject to much fluctuation). The ERP system is a vital link in this process of management control, being the unique source of the "as-is" situation for procurement, inventory, customer orders and fulfilment (Rowe, 1999). Crucially, as a centralised repository of company data, both site and headquarter level management have equal access to transaction status and history. However, there appear to be several constraints concerning the value of ERP systems to managers in exploiting these systems to their full potential.

Firstly, when selecting and implementing an ERP system, companies are looking at a good fit with operations, not with the more abstract decision processes. Secondly, management is highly concerned with the efficient use of all company resources, including people and manufacturing capacity. The data model of ERP applications is inventory centric, however, and therefore lacks the scope to be able to support managers in decisions that involve trading off the costs related to these resources. Finally, an ERP implementation implies a certain number of assumptions about the company and how it operates at a specific point in time (Davenport, 1998). These assumptions may change over time, due to the organisation changing what it does, without clear means to update the application as these changes occur, as evidenced with the rigidity and daunting complexity of relational data models in market leading ERPs (SAP is based on 8000 distinct data tables).

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In this paper the authors present the background to the use of ERP systems to support management decision making, before presenting the research approach and the main findings of the case study and conclusions.

2. Background to this research

As Ackoff (1967) suggests, it is important in looking at the impact of information systems on decision making to differentiate between the decision process itself and the information required to support that process. It was Ackoff's contention, well before the age of global ERP systems that most managers suffer not from a lack of relevant information, but rather from an over-abundance of irrelevant information.

Gorry & Scott Morton (1971) described the characteristics of the information required by operational, management and strategic levels in the firm as significantly different. Operational control activities require information that is detailed, real-time and based on the actual use of internal resources. Managerial control, on the other hand, requires more summary information, not necessarily real-time and includes external sources of information.

Moreover, the "nimbleness" of large integrated systems has been questioned in the light of the rapidly changing context of managerial decision processes. Dearden (1972) felt that the notion of experts designing for a firm one "completely integrated supersystem" was "absurd". Changes in available technologies have clearly made this overly ambitious target more realistic (less "absurd"?), but Dearden's arguments are still compelling today.

Banker et al. (2006) review the research on the impact of IS on the organisation, coming to the conclusion that much of it has focused on either IT spending globally or on company performance at a general level. Their research premise is that impact may more usefully be studied at an application level (eg. ERP systems) and also within defined functional boundaries (eg. manufacturing plant performance).

Enterprise Resource Planning (ERP) systems are commercial software packages that enable the integration of transaction-oriented data and business processes throughout an organisation (Markus et al. 2003). Implemented as a suite of integrated software modules, ERP systems are used to administer the physical movement of inventory through the supply chain and the allocation of sales orders to finished goods in the demand fulfilment cycle (Russell and Taylor, 1995).

Mason (1969) pointed out that much information system design is based on the activity of the organisation, rather than the decision making processes, and it could be said that more than 30 years later, ERP systems enshrine *the administrative process for transactional activity* as a structuring force in the running of the business, and therefore still failing to address the decision making processes as a design parameter. Furthermore, it embraces the intended formal process, the *canonical process* in the words of Lee and Lee (2000).

The pertinence of the "ancient" writings we have quoted in these few paragraphs, some of them dating to what can only be described as the pre-history of information systems, to the challenges faced by today's managers is striking. Indeed, we argue that the warnings delivered by these early IS researchers, whilst perhaps very often quoted in research papers, have still not been translated into the design of better systems. Thus, we contend that ERP, notwithstanding the way they are marketed, may not lead to improved decision making, for the reasons highlighted in this section. The aim of this paper is to bring definitive empirical validation to this contention. The next section refines the research domain discussed above into 3 research questions.

3. The research objective

In this research, a case study of a large multinational operating in the pharmaceutical sector is used to explore the role of ERP in supporting managerial decision making. This research objective is operationalised in 3 separate research questions which lead to a definitive judgement of the level of support afforded by the ERP application to managers in different areas of the case study firm.

Research Question 1 is concerned with discovering the top down goals to which the different functions work, the way in which these goals are "internalised" and disseminated throughout each functional organisation:

What are the goals of the organisation? How are these goals operationalised, and therefore what are managers expected to deliver?

Research Question 2 is concerned with a more granular view of the execution of these goals:

What decisions do managers make on a day to day basis, and what are the chief issues in making these decisions?

Research Question 3 draws on the output from Research Question 2 and attempt to analyse the footprint of ERP in the decisional domains thus identified:

How does ERP provide informational support (or hindrance) to managers in the different activity domains identified in Research Question 2? How can the value of an ERP system be represented in the map of managerial decisional activity?

These questions were investigated during an in-depth field study of a large multinational manufacturing organisation. Over an 18 month period, over 50 interviews were carried out with middle managers in all functional areas of the firm, covering a number of locations at local and headquarters level. The next section provides the background to the case studied.

3.1 Profile of the case study

The Key Pharma Company, KPC (real name withheld to allow more detailed reporting), is a leading manufacturer of pharmaceutical products, with a highly successful product portfolio in consumer healthcare, prescriptions drugs and vaccines. With annual sales of nearly €30 billion, and a R&D budget of €5 billion, KPC is in a dominant position in its marketplace.

The manufacturing organisation involves more than 20 autonomous plants worldwide. These plants are involved in different stages in the production process. Active ingredients are produced at bulk manufacturing sites, and this material is subsequently used by multiple formulation sites in the production of finished product. A vast network of commercial organisations, distribution sites and 3rd party licensees is then responsible for worldwide distribution.

Managing the supply chain to efficiently satisfy demand is extremely complex. With over 30,000 Stock Keeping Units (SKU's) or lines of product, any one of the 600 sources of demand could be ordering 300-600 SKU's each.

Demand is aggregated from local markets back up the supply chain to the primary sites via a demand requirements planning (DRP) system. Demand can also be "manual" in that formulation sites can place additional requirements on bulk sites outside the scope of the DRP.

Our case study focuses on the KPC plant in Cork, Ireland, a bulk site which is part of the global Manufacturing and Supply organisation. KPC Cork ships 4,000 batches of goods per year and local managers are proud of their "customer service" record for deliveries, in the context of the complex and sometimes unpredictable scenario described above.

KPC Cork was part of the roll-out programme for a new ERP system (based on SAP version 4.0), which involved all the sites in the Manufacturing and Supply organisation. The ERP project had the overall goal of implementing FDA compliant business processes throughout KPC, using the best practice templates that had been designed by KPC around SAP standard functionality.

The scope of the ERP project at KPC Cork was the integration of processes in all the main business areas (Production, Finance, Sales, Quality), only excluding process control at the manufacturing execution level.

3.2 The research methodology

This pilot case was a longitudinal study running from the first meeting of the local implementation team prior to go-live, in April 2003, through to a post go-live survey in February 2004. This work was then complemented with in-depth interviews 18 months after go-live (in August 2005) with managers from the Cork site, sister manufacturing plants at different locations in the UK, and with "above-site" managers from the head office in London.

In total, this case study is the result of 52 interviews both pre- and post- go-live and 36 questionnaires, summarized in table 1 below:

Table 1: sources of data (interviews and questionnaires)

Interview Table	GSK			
	Cork 03	Cork 05	UK 05	Total
Finance	2	1	1	3
Manufacturing / Distribution	14	9	7	23
Sales	2	1		3
IS	3	3	3	6
Engineering	2	1		3
HR	3			3
Total	26	15	11	52
Questionnaires	36			

An original facet of this research method is that interviewees themselves were asked to define their own areas of organisational focus (goals) and then describe their related decision processes. This ensured a rigorous sampling of the decision processes studied and a tight coupling with organisational objectives. Thus, our study was pertinent to the organisation as a whole.

The next section presents the case study according to the three research questions outlined in the introduction above.

4. Findings of the case study

4.1 Research question 1:

What are the goals of the organisation? How are these goals operationalised, and therefore what are managers expected to deliver?

An intense focus on quality and the critical "compliance" standards that stem from legislative constraints on the pharmaceutical industry as a whole are ever present concerns for managers in the company. More recent legislation regarding financial practices such as Sarbanes Oxeley is also becoming onerous in terms of reporting and documentation.

The primary goal in terms of materials management is to ensure availability of sufficient raw material to satisfy the planned level of demand for finished goods (availability). Doing this while keeping supply costs under control and keeping inventory to a minimum is the key challenge for planning managers.

Production planning takes place over 3 timelines. A bi-annual Product Review Meeting (PRM) takes place at headquarters and brings together the key personnel involved in planning, production, sales and logistics from the supply network. Production numbers are agreed at this meeting over a 3 year time horizon, based on estimated sales figures. This is considered as the global "strategic" plan.

At a site level, a monthly Supply Chain Group (SCG) meets to review forecast orders coming in via the DRP system, and this is considered the "tactical" plan. Also at site level, a weekly Supply Chain Management (SCM) meeting takes place to review the "operational" plans, that is, the process orders that will go into production based on the actual orders (translated at this point to process orders for production). This seemingly robust framework cannot hide, however, that production planners suffer from the extreme variability in the demand picture coming through the DRP:

Some weeks we could have 2 or 3 changes within the one week, you could have it daily, and then you might go 2 weeks with no changes, but it's not the way to work.

Production planning at KPC Cork also needs to incorporate, in addition to the fluctuating forecast demand coming via the DRP, a buffer stock of 2.4 months' supply, and an "operational" cover stock of 1 month's supply, to allow for contingencies in the demand or supply cycle. These contingencies can arise for external reasons, such as changes in customer demand, or internal reasons, such as lower than expected yield, or production shortfall due to maintenance or capacity issues.

At the same time, planners face a challenge ensuring that Days Forward Cover, the amount of days stock for a particular product that is held on-site at any point in time (including all the buffer stocks), is maintained within certain tolerance ranges:

> *They don't marry, the reality of having it, Days Forward Cover or Targets and whatever, and the reality of what we actually do, and how we have to make the product and keep the customer happy, they don't marry*

At the headquarters level, it was questioned whether the "did I meet my plan?" Key Performance Indicator (KPI) culture alone would drive the right behaviour, as a given node in the supply network could "meet the plan and yet sub-optimise the supply chain". In addition, it was acknowledged that the widespread application of KPI's across all manufacturing sites might overlook some initiatives at a local level to improve process efficiencies.

For instance, managerial effectiveness in the bulk manufacturing site at KPC Cork translates this goal into a customer responsiveness rating. Customer responsiveness corresponds to the % of shipments that are made on time (or within pre-defined tolerance limits). Cork has achieved a 96% rating in customer responsiveness, and, during our study, management were consistently concerned about the potential (negative) impact that the ERP system would have on this rating.

However, this cross company focus on goals introduced a "beauty contest" element to performance reporting:

> *… my personal view would be that sometimes you spend a lot of time collecting – as the customers report on the suppliers, there'll be errors each month, or disagreements on whether they actually hit a target or didn't hit the target – so I think some of the sites spend more time than is justified actually trying to manage those numbers … Which is not a productive use of time.*

Nonetheless, it was evident in our study that KPC was moving on from a historic "silo mentality", where individual sites worked to goals that may not have aligned with other sites goals. The notion of shared responsibility across sites and across functions for more global goals such as customer satisfaction seemed to be evolving. For example, the manufacturing and supply organization as a whole is attempting to move towards a more demand driven model, whereby inventory is pulled through production by customer demand:

> *Demand driven, and customer focused and whatever. So, this is a vision, and this is a strategy, and basically the whole of KPC, the whole of global manufacturing are going to go down this route.*

KPC Cork is quite sophisticated in its use of KPI's to drive performance at the site level. "Visual Workplace" is a traffic light based performance dashboard, emphasising certain operational metrics and making them visible by posting them in high quality hard copy format in highly visible locations such as staff notice boards.

To summarise, question 1, In addition to the maintenance of FDA compliant processes and operations, KPC Cork goals could be synthesised as follows:

- maintain 100% customer responsiveness in terms of on-time deliveries
- procure the right materials, at the right place, at the right time
- use manufacturing resource efficiently (manpower, utilities, materials, …)

The key decisions related to these goals are explored in the next section.

4.2 Research question 2

> *What decisions do managers make on a day to day basis, and what are the chief issues in making these decisions?*

The key management decisions at the KPC Cork manufacturing plant and at the above site organisation at headquarters are concerned with how to orchestrate the supply chain to meet demand effectively, whilst keeping costs at a minimum. This objective can be broken down into 4 principle questions, what to plan, what to buy, what to produce and what to deliver.

4.2.1 What to plan

Planners in the manufacturing plant face conflicting demands in committing their local capacity to production plans, in addition to the variability of that demand as described above in research question 1. The principle issue for the planners at the bulk manufacturing site is the granularity of the individual SKU level orders as they filter back through the supply chain from the markets, as there is no Bill of Materials to relate these quantities back to a requirement for bulk material.

Three further factor complicate greatly the life of the planners. Firstly, the "bays" or physical resources (buildings and equipment) that are used to set-up manufacturing processes are not dedicated to one type of process, they are instead shared by different processes. Thus different products share the same plant capacity. The time it takes to configure and de-configure manufacturing bays for different processes is a matter of days, and therefore must be taken into account in the scheduling of production runs. In general, this would mitigate towards consolidating the demand for a particular active ingredient into one longer campaign, rather than incurring the setup time inherent in frequent de-configuration and re-configuration. The necessity to carry out regular maintenance further adds to the complexity of scheduling production in an optimally efficient manner.

Secondly, the manufacturing process for any particular active ingredient will involve several stages, and each stage must wait for the completion of the preceding stage in order to progress. This implies that planners cannot plan for the production of one batch of active ingredient (finished product) in one go, each stage in that process will be the object of an individual process order and material batch record.

Finally, certain raw materials, solvents in particular, are shared across many different processes and products. Their consumption, as with the yield of active ingredient, will be subject of some variability. This introduces complexity particularly for the buyers, discussed in the next section, but also represents a constraint for production scheduling, as it will only make sense to launch a campaign when all the necessary resources and materials are known to be available.

The above site organisation suffers the consequences of these constraints in that it operates as a remote valve in the supply chain: in situations where demand cannot be met by campaigning manufacturing sites, headquarters must intervene to come up with a solution, and be the arbitrator of priority in the event that production schedules are required to change.

Production planners at the local plant level are required to periodically work towards specific short term goals that will drive a certain type of decision making. An example would be a year-end stock re-evaluation, where the normal rules for buffer stock may be abandoned in favour of finishing the year with the lowest possible levels of inventory.

Other short term decisions might involve scenario planning for specific situations. Planners are asked to evaluate the impact in the event of particular occurrences (eg. shortening cycle times, reducing door to door times, implementing KanBan, stock-out simulation, defect rates, production
bay sharing between 2 competing products, a power outage, increasing effective capacity, …).

The requirement to carry out "what-if" analysis including all the possible parameters for such scenarios means that planners could not work without their spreadsheets, notwithstanding the implementation of the costly and all covering ERP application.

4.2.2 What to buy

Procurement of raw materials using an MRP model is not feasible for 2 reasons. Firstly, KPC's products are characterised by the lack of a Bill of Materials relating the demand for finished goods to their constituent active ingredients, and the active ingredients to their constituent raw materials. Secondly, the variability in demand discussed earlier also militates against an MRP type system:

> *Well I mean you could, if you wanted to, if you used the system to sort of, … you can ring the suppliers today and say I don't need this load till next Wednesday, and tomorrow or the day after your plans change again, you'd be bringing it forward again, you know, you'd be continuously changing.*

Procurement participates in the sequence of events outlined for production planners: customer demand, coming from the Product Review Meeting, will update the requirements for each product. This is then fed into the site's rolling quarterly review of annual volumes. Small demand shifts may not mean any change to the plan. In any case, updates to the plan drive changes to the purchasing schedule. Buyers are therefore subject to the same constraints as production planners with respect to the vagaries of the demand picture:

> *the whole element of planning, and the actual adherence to that plan by production impacts us to an extent, we're continuously re-planning, revising plans on an almost daily basis, certainly weekly basis*

Furthermore, actual consumption of raw materials, and therefore the level of on-hand available, will not be known till the end of any particular campaign, and planners therefore will allow for a year end campaign to use up the outstanding raw material.

Lead times for products can be anything up to 6 months, and some raw materials are manufactured specifically for KPC.

4.2.3 What to make

Production is organised in shift teams of operators and these teams work around the clock, only stopping for planned maintenance, including an annual plant shutdown during the summer months.

Manufacturing is organised locally in “campaigns”. A campaign is the result of the orchestration of plant capacity (vessels, filters, pumps, …) with labour and materials to a schedule such that a certain quantity of bulk active ingredient will be produced. This quantity is what must be set in advance by the planners. Actual yield may vary from the planned quantity for a variety of reasons, related to any of the resources involved. Chemical reactions may affect yields in unforeseeable ways, breakdowns or maintenance issues may affect the physical plant, and sickness / holidays may affect the labour availability.

At the end of any given week, the production team will prepare its workload for the following week by printing off all the necessary batch records and related documentation, and they will ensure that the dispensary have physically issued the necessary materials related to those batch records. The existence of the batch records in the ERP system is sufficient for the warehouse to be aware of the requirement for material.

Following the go-live of the new ERP system, and despite extensive training for all operators, it was agreed that the “data maintenance” activities described above would be carried out by specific resources within the production teams.

Planners build their production schedules manually, that is, planned orders are converted into process orders (for execution) only on a weekly time horizon. The process orders for any given week must take into account the actual production (and any related contingencies) from the previous week. Process orders (also termed material batch records) are entered into SAP without the associated sales orders, planners use the “daily tables” screen to bypass the link to customers and drive production activity directly through the weekly launching of batch processes.

Another variable in the campaigning of production processes is the ability of the customer to absorb the active ingredient. Although an annual requirement might be set in advance, the customer can only consume it at a certain rate, therefore bulk sites must bring this into the equation when laying out the campaign plan.

4.2.4 What to deliver

The multiple formulations produced in KPC Cork are shipped to multiple commercial organisations (in countries where KPC have a commercial presence), or to multiple distribution sites (who sell product in those local markets on KPC’s behalf). The site might make 10-15 shipments on average per day, and manufactures about the same number of active ingredients.

The KPC plant in Cork, Ireland, is part of the global Manufacturing and Supply organisation. Cork ships 4,000 batches of goods per year (1,000 batches of finished goods). 70% of shipments are by air (giving rapid door to door delivery times eg. UK within 2 days, US within 7 days).

Firm orders from customers are received via the DRP, and this system is interfaced to the ERP system. These orders are used to co-ordinate the shipment of active ingredient, but not to drive invoicing, as the billing is based on an internal transfer pricing.

4.3 RQ3: Footprint of ERP in key decisions

By collating the decisions identified above with the systems used to generate the information supporting these decisions, we can derive an idea of the footprint of the ERP in managerial decision making at KPC Cork, presented in Table 2 below.

Table 2: Footprint of ERP in managerial decision making (Excel and SAP are ™).

Decision	Information	System
D[1] What to plan?	Forecast Orders	PRF, DRP, Excel
D[2] What to make?	PRF, capacity, de-config needs, shared bays, maintenance, …	Excel
D[3] What to buy?	Demand, shared bays, capacity issues, lead times, …	Excel
D[4] What to deliver?	Customer orders, commit dates, ship-to addresses, …	DRP & SAP

For each type of decision, there is a set of information required by the manager in order to decide what level of action is required if any. This information is contained in a number of systems in the organisation, notably the DRP system, the ERP system (SAP) and manual tools such as spreadsheets. In some cases the presentation of the information for managers involves several systems. The more systems required to satisfy an information requirement, the greater the information latency overhead:

> *The fact of life is that what we have at the moment is like a patchwork quilt of all sorts of systems, all sorts of structures and all sorts of plans, and what they are basically doing is that we are going to carry on aligning those and improving them, and improving the flow, streamlining the whole thing.*

In addition, managers have access to the SAP Business Warehouse system (pre-configured reports from SAP) and financial planning tools (Adaytum™).

In KPC Cork, it was recognized early on in the ERP project that cross-site comparison was one of the key driving forces in rolling out a centralized ERP system to all manufacturing sites. Managers at headquarters use KPI's to drive performance in the supply chain, but equally overall performance of the network is important, rather than performance comparisons between 2 nodes:

> *As a supply chain, what's their performance to their customers, rather than talking about an individual site's performance to their customers*

Thus, although the ERP system is used to drive local inventory control and financial reporting, that is, as an integration tool at a local level, it has not been used to integrate between head office and sites. This seems regrettable given the scope for improvement in this area.

Local planners at KPC Cork carry out their planning on their personal spreadsheets. 60% of the workload is scenario planning, responding to contingencies and events, both external and internal. Process orders (called Material Batch Records), corresponding to the launch of a particular production batch, are launched manually (they are created in SAP one by one) based on the spreadsheet-based plans. When a batch has run, and there are redundant process orders, these can hang around in the system until someone specifically deletes them.

In summary, the implementation of ERP for KPC Cork was not an option, it was an imposed corporate solution to address potential compliance risks and there was only limited scope to work on a good fit between local needs and the application configuration. On the other hand, the move to a new integrated system has had its advantages:

> *we have better traceability on our customers, we have less write-offs. We have more control over manufacturing*

In addition, the ERP system has revealed "stress points" in the organization where the process is in need of optimisation:

> *but ERP is only highlighting what is wrong with our current system, there is nothing wrong with ERP, it's just saying, look, the reason this is difficult is because you are not doing it right anyway, it's showing up issues.*

5. Lessons from the case

The enhanced data integrity brought by the ERP has improved management decision making in 2 ways. Firstly it has removed the time wasting arguments about data integrity, and secondly it has given managers more time to focus on more value-adding activities, such as investigating the causes of variances in operational performance.

It is clear that systems cannot automate the managerial decisions relating to variance analysis for a manufacturing plant, but if, on the other hand, they can provide a clear picture of actual vs plan performance, across a number of operational metrics, plus the ability to look at historic actual vs plan performance, plus the usability and sophistication for managers to create their own "what-if" scenarios, then it could be argued

that the return on systems investment can be quantified in terms of improved decision making (speed and accuracy being the most important decision attributes impacted). This seems to concord with Holsapple and Sena's (2002) survey findings.

However, there appear to be several barriers to site level managers exploiting the richness of information held within the ERP system:

- Lack of skills (both a detailed knowledge of the business processes and ERP)
- Lack of access to data (access to production data is more or less proscribed)
- Incompatibility of transaction data with aggregate management queries

Plant level users are left on their own to master the information held in the ERP system, and yet very few have the requisite level of access to be able to explore the possibilities of using the data to support management questions. Standard reports are more or less ignored, by both users and IT, and there seems to be a commonly held belief that "if it's not in a spreadsheet then it's not acceptable", which is paradoxical in an ERP-enabled business with a strong compliance requirement.

The data itself is jealously guarded, and at best a select group of users will have access to query rights on a copy of the production database. In KPC, the number of people with access to specific (quite powerful) query responsibilities is the strict minimum: 2 people. This is for security and for guaranteeing high availability, but it also has the effect of making it practically impossible for a user to get hold of data in a discovery mode (Adam and Pomerol, 2007).

Finally, ERP transactions are coded in a way that will provide linkages to other elements in the data model, and also in a way that is applicable to the widest range of businesses. For these reasons, the raw data very often does not have the necessary attributes to allow it to be used to answer management questions. These additional attributes (or metadata) are usually added in a data warehouse application, which refreshes from the ERP production database at pre-defined intervals (eg. once a day).

So what would be required is a more flexible investigative approach to data analysis, empowering managers to investigate the root causes of changes to particular patterns or phenomena. This is a pure question of competence, in the same way that if an organisation decided to implement a lean approach to manufacturing, it would to recruit or develop the skills in-house (eg: 6Sigma, etc) to lead the initiative.

It would certainly appear that the complex structure of ERP discourages managers from developing the skills to run queries and establish root cause of symptoms that are experienced. This is particularly true in the area of costs, where ERP systems are capable of providing great detail on current and historic trends, assuming a thorough understanding of the data structure used inn the application's database.

At KPC, KPI's are the means for driving local plant performance, and management are very focused on the quantifiable goals that they are given. Where the data comes from to drive these KPI's is immaterial to managers, they simply require data that they can trust, such that they can be made aware early of any potential variances such that root causes can be investigated and action taken before the issue is picked up at an above-site level.

Here is a key contribution of ERP applications: in the quantitative analysis of work processes which they facilitate and in the cultural change they engender. Thus, ERP could help drive the implementation of KPI's. However, every time there is an interface to another system, and certainly when there is manual manipulation of the data to generate the KPI, the process for calculating and distributing KPI's moves away from a "repeatable / sustainable" model, relying instead on manual intervention. This in turn raises the issues of specialized resources, skills and latency, an important one when processes face time constraints (which are frequent in modern-day supply chains).

This research highlights the gap between the information required to put together these metrics and the information available automatically in the ERP system. The ERP system represents an "actual" picture of the use of corporate resources in terms of inventory, cash and other operational measures. However, "planned" elements and greater representational flexibility are required in order to make these metrics more meaningful for management decision making.

6. Further research

Further research should be oriented towards frameworks for modelling and actively managing the gap between business processes and the enterprise system, such that adequate resources can be deployed to address the gap before the benefits of a centralised IT infrastructure are frittered away in a blossoming of local data warehouse solutions and personal spreadsheets.

This research should address the means the organization needs to put in place to plan for the eventual divergence of ERP systems from reality, and to mitigate against this gap with skills and tools. A non trivial starting point would be to design a framework for the tools, skills and resources capable of reporting on the gap, such that the gradual tendency towards system obsolescence is visible, and can be rectified on the fly. Arguably, if ERP applications are not gear towards such evolutionary patterns, the task of organizational actors will continue to be very arduous.

References

Ackoff, R. L. (1967) “Management Misinformation Systems”, *Management Science*, Vol. 14, No. 4, pp 147-156

Adam, F. and Pomerol, J.C. (2007) “Developing Practical Support Tools using Dashboards of Information”, in Holsapple and Burstein, *Handbook on Decision Support Systems*, International Handbook on Information Systems series, Springer-Verlag, London, forthcoming

Banker, R.D. et al (2006) “Plant Information Systems, Manufacturing Capabilities, and Plant Performance”, *MIS Quarterly*, Vol. 30, No. 2, pp 315-337

Chang, S. and Gable, G. (2002) “A Delphi examination of public sector ERP lifecycle implementation, management and support issues”, *Journal of Decision Systems*, Vol. 10, No. 1, pp 27-49

Davenport, T. (1998) “Putting the Enterprise into the Enterprise System”, *Harvard Business Review*, Jul/Aug, Vol. 76, No. 4, pp 121-131

Dearden, J. (1972) “MIS is a mirage”, *Harvard Business Review*, Jan/Feb, Vol. 50, No. 1, pp 90-99

Gorry G. A. and Scott Morton, M. S. (1971) “A Framework for Management Information Systems”, *Sloan Management Review*, Fall, Vol. 13, No. 1, pp 55-68

Heili, J. and Vinck, D. (2008) « Penser les relations entre technique et organisation : un examen de la littérature », in Vinck and Penz (eds), *L’équipement de l’organisation – Les ERP à l’usage*, Hermes, Paris, forthcoming

Holland, C. and Light, B. (1999) “A Critical Success Factors Model for ERP Implementation”, *IEEE Software*, May/June, pp 30-36

Holsapple, C. and Sena, M. (2002) “Beyond Transactions: The Decision Support Benefits of ERP Systems”, *Journal of Decision Systems*, Vol. 10, No. 1, pp 68-90

Kalakota, R. and Robinson, M. (2001) *E-Business 2.0: Roadmap to Success*, Addison Wesley Longman Inc., Reading, MA

Lee, Z. and Lee, J. (2000) “An ERP implementation case study from a knowledge transfer perspective”, *Journal of Information Technology*, Vol. 15, No. 4, pp 281-288

Markus, M. L. et al. (2003) “Learning from Experiences with ERP : Problems Encountered and Successes Achieved”, in Shanks, G., Seddon, P. B. & Willcocks, L. P. (Eds), *Second-Wave Enterprise Resource Planning Systems* : *Implementing for Effectiveness,* Cambridge University Press, Cambridge, UK, pp 23-55

Mason R.O. (1969) “Basic Concepts for Designing Management Information Systems”, *Accounting Information Systems*, Research Paper No. 8, Graduate School of Management, University of California, LA, pp 81-95

Rowe, F. (1999) “Cohérence, Intégration informationnelle et changement: esquisse d’un programme de recherche à partir des Progiciels Intégrés de Gestion”, *Systèmes d’Information et Management*, Vol. 4, No. 4, pp 3-20

Russell, R.S. and Taylor, B.W. (1995) *Production and Operations Management: Focusing on Quality and Competitiveness*, Prentice Hall, Englewood Cliffs, NJ

Shang, S. and Seddon, P. (2000) “A Comprehensive Framework for Classifying the Benefits of ERP Systems”, *Proceedings of the 6th Americas Conference on Information Systems*, August, Long Beach California, USA, pp 1005-1014

