The role of Business Process Re-engineering and Object Orientation in Organisations

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ABSTRACT

Organisations must be increasingly flexible and adaptable if they are to remain competitive in today's environment. Business Process Re-engineering (BPR) and Object Orientation (OO) have both been put forward as ways to improve flexibility and adaptability. This paper presents a model of the possible synergistic links between OO and BPR and the findings of research that suggests such a relationship may exist. The paper concludes that there are potential benefits to be gained from both, but the real value of these approaches lies in the application of only those parts of the model needed to make it work for the organisation in question.

KEYWORDS
Business Process Re-engineering
Object Orientation

INTRODUCTION

In the early 1990s BPR was described as "the hottest management concept since quality management" (Byrne, 1993) and "the hottest trend in management" (Stewart, 1993). Essentially, BPR is concerned with the radical re-design of workflow and business processes, i.e. logically related tasks performed to achieve a defined business outcome (Davenport and Short, 1990). Its stated aim is to transform an unresponsive organisation, based on functional divisions, into a more flexible and dynamic one based on processes. In BPR, IT is seen as the key technology that will break down the traditional functional boundaries and enable new and effective cross boundary communication to take place.

Although BPR has generated a lot of interest, many have observed that there is nothing particularly new about these ideas. Klein (1993), for example, suggests that Henry Ford and the US Navy were using re-engineering at the turn of the century. Earlier research by one of the authors showed that elements of what would later be called BPR, were present in companies attempting to implement Computer Integrated Manufacturing (CIM) in the late 1980s (Kimble and Prabhu, 1988). Similarly, in later research, the reasons given for the development of more sophisticated information systems by managers could also be seen as BPR, although the term was never used at the time (Kimble and Mc Loughlin, 1995).

Few would deny that the concept of BPR, and more specifically the link between BPR and IT, was oversold (Davenport, 1996). However, although the hype that once surrounded BPR has now been recognised as such, the underlying issues still remain. The overall aim of this work was to examine possible links between BPR and one approach to systems development to which it seems particularly suited: Object Orientation (OO). The question being asked is, are there synergistic links between BPR, as a technique, and OO, as a systems development methodology?

At the most basic level OO is simply an approach to the modelling of systems in which a system is thought of as a set of objects. Organisations are systems, and a formal way of visualising an organisation's structure and relationships, both internally and externally, is to build a business model of it. A business model might describe the organisation's function in the world, what it does, how and when. It might also describe the static architecture as well as the flow of events and the dynamic behaviour of the elements of the architecture.

Proponents of OO claim that all of the above may be modelled in OO as objects, and the relationships between them as associations between objects. OO emphasises modularity and reuse. It not only allows the static structures of objects and their relations to be represented but also allows dynamic changes to be modelled. It is a holistic approach that deals with data and functionality together as opposed to traditional "structured" approaches of systems analysis that treat data and functionality separately. The proponents of OO claim that organisations can be modelled in a more realistic way and that object-oriented models are consequently easy to use and easy for end users to understand. For example, Jacobson (1995) argues that its models are simultaneously adaptable, changeable, comprehensive, reusable and understandable.

While proponents emphasise the benefits to be gained from OO, others suggest there are gaps in our knowledge concerning the benefits of the object-oriented paradigm. Jones (1994a) believes that there is insufficient coverage of some topics in the OO literature and a lack of definitive data to substantiate the case for OO. He argues that the data on the actual use of OO is too sparse to either validate or challenge the claims of improved productivity and quality.

One of the strongest arguments for the use of OO is its potential for producing reusable code. However, as Graham (1995) points out, although there is a widespread belief that OO results in less code, easier maintenance, high levels of reuse and good extensibility, there is little empirical proof. Jones (1994b) lists 10 reusable elements associated with software projects and argues that, so far, the literature on OO has only addressed four of them in depth.

Bennett (1995) suggests the expected use of reusable components has been slow to develop because objects in today's programming languages are not providing certain features. However, he goes on to add that software objects *can* become reusable components if certain programming conventions are applied to existing languages. Griss (1993), for example, describes the Hewlett-Packard's successful corporate reuse program but also emphasises that effective reuse is not just about code and library technology: it also requires that careful consideration be given to people and processes.

THE MODEL

The model described in this paper is an attempt to delineate the central features of BPR and OO and provide a mapping of the links between them. There are two essential aspects to the model: the vertical or classification, and the horizontal or mapping.

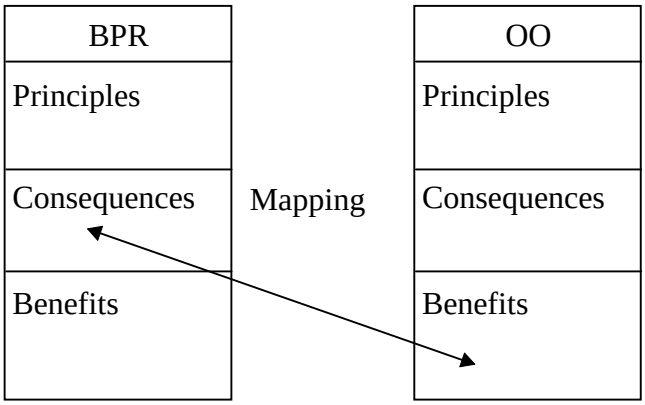

Figure 1 - The model

The Classification (vertical aspect)

A review of the literature on BPR and OO identified the essential features of each and classified them as principles, consequences or benefits. This classification forms the vertical aspect of the model and describes a progression from the principles of the approach, through the consequences of the application of those principles, to benefits that should be realised. The idea behind this progression is that the application of a set of principles will, in turn, imply certain consequences, that ultimately should provide a set of benefits. For example, the effect of the BPR principle, "workers make decisions and the process itself has built-in controls" will be that there is "greater empowerment of individuals". Similarly, consequences should imply certain benefits. For example, the benefit that results from the OO consequence "improved means of altering components" should be "improved ability of the system to be adapted and extended".

BUSINESS PROCESS RE-ENGINEERING
Principles
1) Have one person or a team of people with the appropriate skills become responsible for a larger span of the process.
2) IT can provide the ability for departments or individuals to do more for themselves. Have work performed where it makes most sense.
3) Have those that generate the information also process it and act on it.
4) Treat geographically dispersed resources as though centralised: physically decentralised resources are seen as though logically centralised.
5) Carry out work in a natural order. Where work is performed in parallel, integrate the strands early rather than later by setting up links between the two activities.
6) Workers make decisions and the process itself has built-in controls.
7) If information is to be shared effectively, it must be captured once at the source.
8) Continuous improvement is required.
Consequences
9) Structuring of organisations supports process and cross-functional activities.
10) Increased multiskilling of individuals.
11) Greater empowerment of individuals.
12) Flattened and decentralised organisations.
13) Increased simultaneous working of complementary and parallel processes.
Benefits
14) Increased flexibility of the organisation to meet customer requirements.
15) Respond quickly to meet changing customer requirements.
16) Reduced costs.
17) Reduced rework.
18) Reduced cycle times.

OBJECT ORIENTATION
Principles
a) *Objects* - An object is a collection of data and operations or methods. The data defines the object's state and the operations the object's behaviour.
b) *Encapsulation* - The data and private operations of objects are hidden from their surroundings.
c) *Abstraction* - Allows us to concentrate on only those important characteristics of an object.
d) *Classification* - Allows us to categorise, or class, objects that comply with a set of criteria specified by the same general description.
e) *Inheritance* - A mechanism for managing classes and for sharing commonality. One class of objects can be defined as a special case of a more general class automatically assuming the functionality and attributes of this class.
f) *Message passing* - The means by which objects communicate with each other and the only way in which one object can invoke another's functionality.
g) *Polymorphism* - The ability of different objects to understand the same message but to respond in a different way on receipt of the message.
Consequences
h) Improved integration of data and functionality.
i) Improved means of altering components.
j) Improved systems maintenance.
k) Increased re-use of components.
l) Reduced errors and more robust systems.
m) Simplification in dealing with complexity.
n) Enhanced versatility of systems.
o) Ability to develop systems incrementally.
Benefits
p) Improved ability of the system to be adapted and extended.
q) Reduced system development costs.
r) Increased reliability and quality of the system.
s) Improved accessibility of complex business information.
t) Shortened system development time scales.
u) Long life span of the system once built.
v) Facilitation of distributed systems.

Figure 2 - Vertical aspect of the model

It is not the case that every principle has a specific consequence or every consequence a specific benefit. For example, the principles of OO often have several identifiable consequences whereas BPR's consequences tend to consolidate and contribute to a smaller number of benefits. While an attempt has been made to identify all possible consequences, benefits and mappings, the model does not claim to be exhaustive. A more detailed account of the classification process and the rationale behind it can be found in Quarmby (1995).

The Mapping (horizontal aspect)

The horizontal aspect involves cross-referencing between the two approaches to identify the complementary features that may indicate a synergistic relationship. The cross-references or mappings are independent of the vertical structure of the model. The features shown as parallel in Figure 2 do not necessarily indicate a mapping, e.g. BPR principle 2 "work is performed where it makes most sense" does not map to the OO principle b "encapsulation". The criteria for mapping were considered on three levels:

1. Does OO as a modelling approach help in the implementation of BPR?
2. Does OO as a systems development approach help realise the process designed in BPR?
3. Does OO as a technology help with the implementation of the process?

Using these three criteria, ten possible mappings between the two approaches were identified. These mappings are outlined below. A more detailed description and justification of the mappings is available from the authors.

Mapping 1. *OO Benefit o and BPR Benefit 15- "Ability to develop systems incrementally"* and "*Respond quickly to meet changing customer requirements*".

Mapping 2. *OO Benefit q and BPR Benefit 16 - "Reduced system development costs"* and" *Reduced costs*".

Mapping 3. *OO Benefit p and BPR Benefit 14 - "Improved ability of the system to be adapted and extended"* and "*Increased flexibility of the organisation to meet customer requirements*".

Mapping 4. *OO Benefit t and BPR Benefit 15 - "Shortened system development time scales"* and "*Respond quickly to meet changing customer requirements*".

Mapping 5. *OO Benefit v and BPR Principle 3 - "Facilitation of distributed systems"* and "*Have those that generate the information also process it and act on it*".

Mapping 6. *OO Benefit v and BPR Principle 7 - "Facilitation of distributed systems"* and "*If information is to be shared effectively, it must be captured once at the source*".

Mapping 7. *OO Consequence j and BPR Principle 8 - "Improved systems maintenance"* and "*Continuous improvement is required*".

Mapping 8. *OO Consequence k and BPR Benefit 14 - "Increased re-use of components"* and "*Increased flexibility of the organisation to meet customer requirements*".

Mapping 9. *OO Consequence k and BPR Benefit 15 - "Increased re-use of components"* and "*Respond quickly to meet changing customer requirements*".

Mapping 10. *OO Principle g and BPR Principle 8* - "Polymorphism - *The ability of different objects to understand the same message but to respond in a different way on receipt of the message*" and "*Continuous improvement is required*".

METHOD

A sample of organisations was selected based on their likelihood of using both BPR and OO. To this end a notional target of the top 100 organisations in the financial services sector was set. Organisations were identified and ranked using Butlers Building Society Guide and the Times 1000 according to income (insurance companies) or assets (banks and building societies). In total 94 organisations were identified for inclusion in the survey: 49 building societies, 25 banks and 20 insurance companies. Two questionnaires were sent to each of the 94 companies: one concerned with BPR and one with OO. Where possible, questionnaires were sent to named individuals

RESULTS

The model above proposes a number of synergistic links between BPR and OO. However, before the horizontal links of the model could be tested it was necessary to establish that the banks, building societies and insurance companies represented a homogeneous sample. If the sample was uniform then the respondents' perceptions of the factors that influence change should be identical. The correlation between rankings in the sectors and between respondents was uniformly high. The most significant difference was that insurance companies ranked the influence of government legislation much higher than either building societies or banks. This was attributed to changes in legislation announced in the Budget in November 1994.

Having established uniformity, the responses were summarised and a weighted score calculated such that if all respondents identified a consequence as observed, or a benefit realised, the final score would be +1 and if none did it would be -1. The results appear in Figure 3 and Figure 4 below. In all of the following graphs, the consequences and benefits on the *x*-axes of the graphs can be referenced back to Figure 2 by the numeric (BPR) and alphabetic (OO) reference.

The results clearly validate the vertical BPR aspect of the model as there is evidence that both the consequences cited are observed and, to a lesser extent, the resultant benefits realised. The vertical aspect of the OO part of model however appears to be only partly validated as certain consequences are not observed and certain benefits left unrealised. Nevertheless, it is argued that the model does not necessarily misrepresent OO as reasonable explanations can be offered for this apparent shortcoming; these are discussed in the final section.

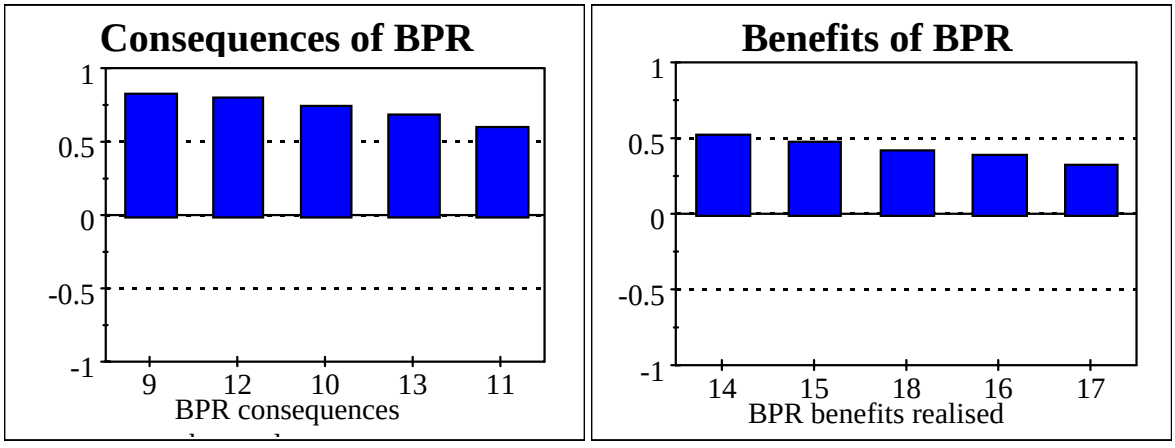

Figure 3 Consequences and Benefits of BPR

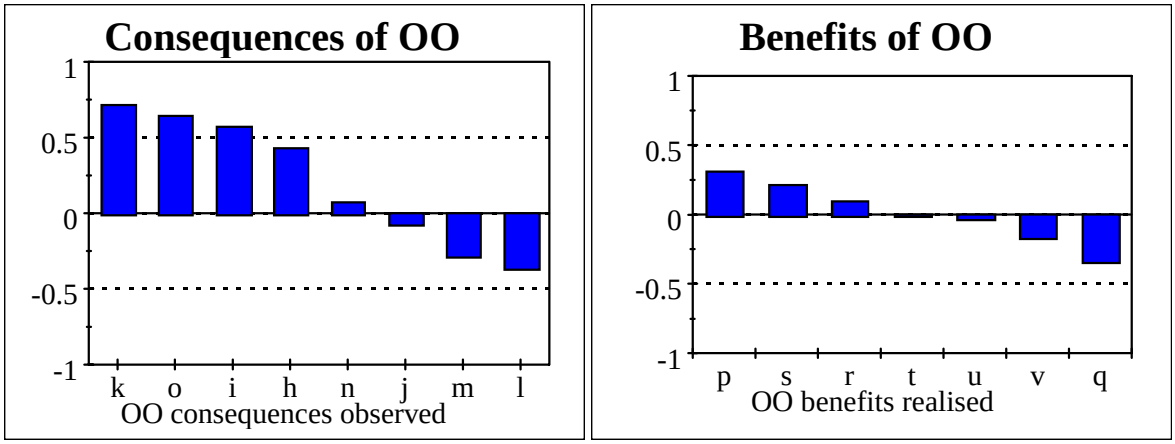

Figure 4 Consequences and Benefits of OO

Horizontal Testing

Having established the validity of the model we now move to the central thesis of this research: the existence of a synergistic link between BPR and OO. BPR respondents were asked what they required from their systems and OO respondents were asked how effective OO was in (a) meeting these system needs and (b) supporting the business needs of the organisation. OO's effectiveness in delivering system requirements was contrasted with the BPR respondents' statement of system requirements. Similarly, OO's effectiveness in supporting business needs was contrasted with the realisable BPR benefits.

This investigation of a synergistic link between BPR and OO was conducted at several levels as not all respondents had experience in both fields. The aim was to trade the generalisability of a large sample size against the degree of confidence that could be placed in the results as determined by the certainty that respondents were able to give an informed response.

Level	Sample
I	All respondents.
II	All respondents claiming to use BPR and/or OO.
III	All respondents claim organisation uses both BPR and OO.

Table 1 Levels of analysis

This approach also yielded some interesting information on trends in the strength of findings at the different levels.

Results at level I

We have seen above that analysis at level I already provide some indication of synergistic link in that there was a strong correlation between the rankings of factors that affect change within the targeted organisations. However, the evidence for this link is based on the, possibly unwarranted, assumption that common change factors are behind the implementation of BPR and adoption of OO. Some other indications of a possible link at level I were:

i) 19% of BPR respondents indicated that their organisation was currently using OO, and of these, 73% used OO because it fulfilled the required systems needs.

ii) 35% of OO respondents indicated that their organisation was currently undertaking a BPR project, and of these, 89% indicated that OO helped support the business needs of the organisation.

Results at level II

A similar analysis to the above indicated a stronger correlation between change factors for BPR and OO respondents. The comparison between (a) systems needs and systems requirements and (b) the meeting of business needs produced the results shown in Figure 5.

There appears to be a continued indication of a link between BPR and OO at this level. Firstly, the change factors within the organisations continue to be similar. This is important as it supports the assumption that these factors are the main reason for adoption of BPR and OO. Secondly, OO appears to be effective in delivering the systems needs rated as most important by the BPR respondents. Finally, OO appears to be reasonably effective in supporting business needs although it is clearly more effective in supporting some than others.

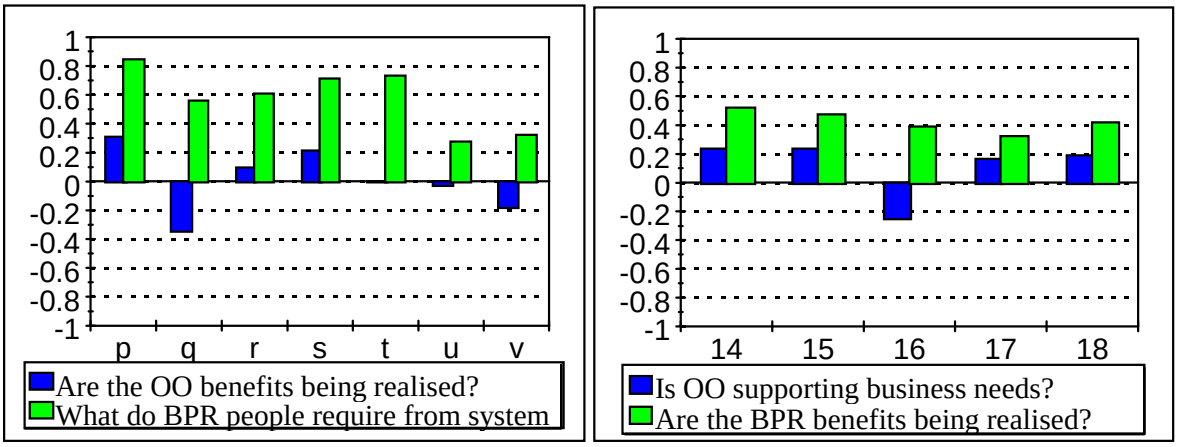

Figure 5 Results at Level II

Results at level III

The final level of analysis was conducted on two particular groups of respondents: those claiming to do BPR who have indicated that their organisation is currently using OO, and, those implementing OO and who also indicated that their organisation was conducting a BPR project. A similar analysis to level II was performed, the results of which appear in Figure 6.

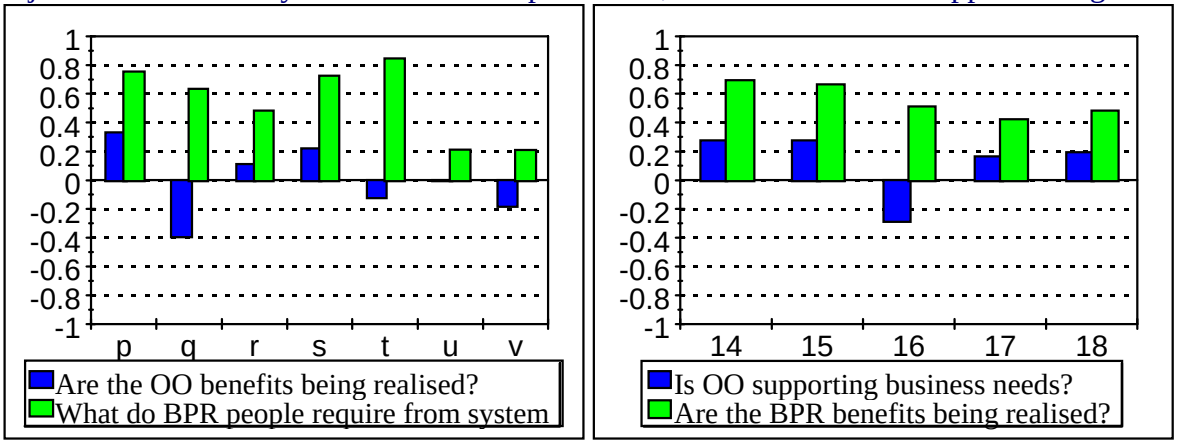

Figure 6 Results at level III

As might be expected the results are broadly in line with those of level II although some interesting differences in emphasis occur that are discussed below.

CONCLUSIONS

The Results Versus The Model

i) **Vertically** - the BPR aspect of the model is validated as there is strong evidence that the consequences cited are observed and the resultant benefits realised (see Figure 3). The OO aspect of the model however appears validated only to a degree. Certain consequences, such as reduced errors and more robust systems, were not observed and certain benefits, such as reduced system development costs, were not realised (see Figure 4). It can be argued however that the model does not necessarily misrepresent OO. Several explanations can be identified in the literature for this apparent failure.

a) The immaturity of the technology. Although OO is not new, it is still not a stable technology; working systems may need to be modified to take advantage of developments in the technology. Taylor (1990); Price Waterhouse (1995).
b) The initial set-up costs. There are major costs associated with the transition to object-oriented technology, e.g. the investment in new languages, databases and tools; the minimal level of reuse if an organisation is using OO for the first time and the education and training of staff. Booch (1991).
c) The lack of standards. A lack of common standards means that it is difficult for technologies from different manufacturers to co-operate effectively. Taylor (1990); Rockwell (1994).
d) The level of expertise. There are few people in the commercial arena that understand how to use object-oriented technology effectively. To derive maximum benefit requires excellent technical management with a clear awareness of its capabilities. Taylor (1990); Wilkie (1993).
e) The required paradigm shift. The change of mind-set, from the traditional structured way of doing things, to the novel concepts of OO, is put forward as one of the major barriers to successful widespread adoption of the OO techniques and technology. Wilkie (1993).

A follow-up interview with one of the respondents in the survey provided two other possible explanations for these findings. The first was that many projects are in the early stages of implementation: projects need to be well advanced or even completed before benefits are realised. The second was that OO had been used in areas, such as transaction processing systems, where the extra capability provided by an OO system was not required but still had to be paid for.

ii) **Horizontally** - having accepted the validity of the vertical aspect of the model the horizontal aspect highlighted the existence and nature of the supposed synergistic link. It appears that the mappings relating to flexibility in organisations are validated. There is evidence that OO is effective in supporting the following BPR benefits:
a) Increased flexibility of organisations to meet customer requirements;
b) Improved responsiveness of the organisation to meet changing customer requirements quickly and to keep abreast of competitors.

Certain mappings however did not appear to be validated.

Mapping 2 - identifies BPR and OO working together to reduce costs. This link is not confirmed as there is no conclusive evidence to suggest that OO is effective in reducing costs. However, as suggested previously, there are factors that could reasonably be attributed to this result, e.g. a first project will always have a high initial investment cost. This does not therefore rule out the possibility that this link may be realised.

Mapping 5 and Mapping 6 - identify OO's facilitation of distributed systems. The results indicate that OO is ineffective in this area, although it should also be noted that BPR respondents did not identify this as an important systems requirement. Reasonable explanations for the apparent poor performance could include the following:

- The lack of robustness and reliability of client-server platforms due to the immaturity of the technology;
- The level of complexity and effort required managing and supporting such an environment.

These mappings are not validated but, with the maturation of the technology, a synergistic relationship could be realised.

Mapping 4 - identifies OO as contributing to the business need of quick response, specifically in terms of a rapid system development. Although inconclusive, the results appear to indicate that OO is lacking in this area. However, again, there are factors, such as the learning period of the organisation, which could cause this. Further analysis revealed that when OO was used in the analysis and design stage of a project, rather than just for implementation, this particular mapping did appear to be more valid. It is possible that the promise of OO is not empty, and that it is only a matter of time before this benefit is realised.

Is there a link?

There is clear evidence of a link regarding the factors that influence change and the realisation of business needs. Furthermore, OO appears to enhance the capability of organisations to achieve some of the objectives of BPR, such as flexibility. There is however insufficient evidence to indicate a synergistic link between BPR and OO regarding the systems requirements of the organisation. Whilst OO was seen to deliver some benefits in certain organisations, there still appears to be considerable risk associated with its use. The implication for organisations considering the use of OO as a technology is that they should view it in terms of the expected long term benefits and that non-strategic applications be identified to develop expertise in the use of OO.

BPR, and to a lesser extent OO, appear to be responses to the external environment, as common factors appear to influence the adoption of both. There is however some evidence of a synergistic link: OO facilitates flexibility and process analysis and design in BPR. OO however does not necessarily produce the systems required. As we have suggested, this may be due to a lack of maturity in the technology or to lack of experience in the people who use it.

Neither BPR nor OO is a panacea, but both appear to deliver benefits to those organisations that are clear about what they wish to achieve. Ultimately, the benefits to be gained from the synergistic relationship between BPR and OO will depend upon an organisation extracting those aspects of the approaches that will make it work for them.

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