Building competitive advantage through knowledge management: Pattern languages and their relationship to innovation, risk and technology transfer

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Abstract

The impact of knowledge management on competitiveness is widely acknowledged, however the method by which we choose to manage knowledge is contentious, and the pathways through which competitiveness is to be improved are often implied rather than specified. Through an analysis of the literature supporting the emergence of Alexandrian Patterns as a formalism for knowledge management, the authors relate the macroscopic factors of risk, innovation and competitive advantage to the design and in particular the specificity of the basic knowledge unit.

Keywords

Information Systems, Knowledge Management, Pattern Language, Technology Transfer, Competitiveness

INTRODUCTION

This paper reports work funded by the UK Economic and Social Research Council's (ESRC) People at the Centre of Communication and Information Technologies programme (Lloyd et al., 2000) and draws on previous work on innovation with the ESRC (Lloyd et al., 1995) and systems engineering with the United Kingdom Engineering and Physical Sciences Research Council (Pooley et al., 1998). The case of Patterns and Pattern Languages is used to explore the issue of knowledge management within an organisational context of pursuing competitive advantage through innovation: "the successful exploitation of new ideas" (ESRC, 1995).

Many organisations recognise the potential importance of knowledge management in leveraging intangible assets to improve an organisation's performance and ability to appropriate that knowledge for the future. Accordingly, many companies have created knowledge repositories of 'tried and tested' solutions that can be accessed by employees to inform decision making across a number of functions. Given the acknowledged complexity and chronically poor record of designing and implementing effective strategic information systems we examine the application of 'Pattern' knowledge repositories to this organisational process. Patterns (repeatedly observed solutions to a problem in context) have been developed to capture knowledge about the development of information and communication technology (ICT) systems that places such development in a wider socio-technical context (Lloyd et al., 2000; Lloyd et al., 1999). In this paper we consider Patterns as the primitive element of a knowledge management system. This allows us to relate their 'microscopic' design to macroscopic innovation processes, such as those described by Olivera (2000), through which we argue that their long-term impact on competitiveness could be far more significant than, for example, focussing solely on improving the reliability, availability and serviceability of the underlying system.

THE NEED FOR ALIGNMENT IN INFORMATION SYSTEMS

ICT investments are often viewed as an expense rather than a source of competitiveness and business value (Alter, 1995). There is now greater recognition of technology's impact on competitiveness, and the opportunities of increased profits when the alignment between ICT and business strategies is maximised (Papp, 1999). Within a competitive environment, information systems offer significant scope for innovation as they are core to, and connect, multiple business processes (Lloyd, 2001). Yet balancing the business and technical trade-offs at each stage of the ICT development in order to maximise the competitive impact on implementation, is widely acknowledged to be problematic (Alter, 2001; Davenport, 1994). Consequently companies that fail to innovate in this regard may find that their information systems become a competitive disadvantage (Ciborra, 1994).

The potential for improved competitiveness raises questions over the relationship between highly prescriptive knowledge management tools, which tend to replicate existing solutions, and organisational competitiveness in which the scope of activities supported by a system may be completely redefined (Venkatraman, 1994) and hence require completely novel solutions. Within such a context it seems evident that prescriptive tools will tend to favour replication over innovation.

Even where prescription is not enforced, if knowledge management tools are not used to enhance communication across and within the organisation hierarchy the responsibility for decision-making can narrow the scope of decision-making and the balance between context-specific and context-independent, or generic competitiveness considerations. While decision-making at the top of the organization accommodates company-specific considerations of competitiveness, a more generic understanding of competitiveness is often employed by system architects at lower organisational levels (Lloyd et al., 1999). This 'communication gap' between business and IT professions has been the subject of many studies and yet there is still no agreed shared framework or common language that allows a common appreciation of different disciplines' goals and assumptions (Alter, 2001).

It is clear therefore, that decision-making at the business-strategic and the systems development-operational level could benefit from knowledge flows in both directions. The former is widely acknowledged in the technology, strategy and innovation literature (Lloyd, 2001) and the latter in foundational texts on information systems design (Benyon, 1997; Veryard, 1991). The guidelines for Microsoft Certification go even further, requiring software engineers engaged in "Analyzing Requirements and Defining Solution Architectures" to "assess the potential impact of the logical design on performance, maintainability, extensibility, scalability, availability, and security" (Microsoft, 2002). Optimising across each of these business imperatives can be shown to be dependent on microscopic design decisions. For example, flexibility reflects a business need to accommodate future, and inherently unpredictable market changes and can be achieved through architectures that partition data types according to stability (Johnston, 2001). This in turn requires an understanding of the business environment, an appreciation of the business's strategy and the role of organisational innovation.

INNOVATION IN ICT SYSTEMS

Innovation is widely perceived to be a significant element in generating and sustaining a firm's competitive advantage (Frambach, 1993; Nonaka & Takeuchi, 1995). One way in which innovation may be supported is through the adoption of new technology, either through invention or application of existing technology in a novel context – a form of technology transfer. However, "innovation is a very complex and uncertain process, requiring effective matching of market as well as technological opportunities and intelligence" (Williams et al., 1998). The history of such innovation within ICT contains many examples of super-normal profits being generated as a result, but the productivity paradox reviewed by Johannessen et al. (1999) demonstrates that such projects, like many forms of organisational change, incur substantial market and technological risk (Dos Santos, 1991; Dos Santos & Peffers, 1998; Wah, 1998).

Though the recent growth in the market for commercial off the shelf (COTS) applications might be expected to reduce both market and technical risk, it should be noted that both are present in any project with respect to budget, time and implementation difficulties. In addition, COTS applications embody the potential risks of adopting generic assumptions about competitiveness that are embedded within the software, the cost of changes required in customising the system to match existing organisational processes and the flexibility to adapt to future changes (Smith et al., 2001). More insidious than this is the fact that the set of critical skills required for COTS development projects is different to in-house systems development with a move from managing team competencies to managing supplier relations.

The timing of innovation adoption is also important, especially for a technology that may become an industry standard. For example, automatic teller machines (ATMs) in the banking sector (Dos Santos & Peffers, 1998; Davenport & Prusak, 1998), airline reservation systems (ibid.), and enterprise resource planning (ERP) systems in the petrochemicals industry (Davenport & Prusak, 1998). In these industries early adopters built and retained a long-term competitive advantage through 'first mover' and 'learning curve effects', but also incurred higher technology costs and greater risk than later adopters. Nonetheless, these costs were more than compensated by the payoffs of being a successful first mover. In the case of ATMs, once the technology was proven and established, smaller banks were forced to imitate in order to retain market share. These companies had the benefit of lower technology costs and risk, but forfeited the super normal profits generated by the initial exploiters of the innovation. In hindsight, it is clear that decision-makers with "perfect insight" would have chosen to adopt the technology in its initial stages acknowledging that the importance of strategic benefits over immediate operational benefits. This form of trade-off is explored using the Patterns framework below as an example of a knowledge unit.

Pattern Languages

Patterns and Pattern Languages were originally developed by the architect and mathematician, Christopher Alexander (Alexander et al., 1977) and have been explored as a tool for knowledge transfer in a number of domains. Alexander describes a Pattern as "a three part rule, which expresses a relation between a certain context, and problem, and a solution" that can be used "a million times over, without ever doing it the same way twice" (Alexander et al., 1977). The strength of this structure lies in the explicit documentation of the context and rationale behind the solution. Additionally, the Pattern writing process provides a framework to reflect upon, document and share experience, facilitating the conversion of tacit knowledge into explicit articulated knowledge (Taylor, 2001) and encouraging the consideration of contextual trade-offs within the design and implementation process (know-why). This procedure parallels the processes of 'externalization' (the articulation and spontaneous exchange of ideas) and 'combination' (the dissemination and adaptation of knowledge among and between groups) detailed within Nonaka and Takeuchi's (1995) model of the continuous learning process within organizations. The reuse of this articulated 'know-why', or established design concepts, can then be utilised within the wider design community to reduce costs and development time and increase quality (Beck et al., 1997; Nanard et al., 1998). At the same time, access to rich, contextual, and accurate knowledge through an organisational memory (Oliveria, 2000) is widely acknowledged as essential for improving decision-making (Marshall et al., 1996; Warkentin et al., 2001) and supporting organisational competitiveness through innovation (Drucker, 1988; Nonaka et al., 2000; Prusak, 1997).

The Pattern Language approach has been applied to discipline 'knowledge' within a number of domains, most notably software design (for example Gamma et al., 1995). Other related applications include business process reengineering (Beedle, 1997; Lloyd et al., 1999; Falconer, 1999); systems reengineering in terms of both structure and process (Dewar et. al., 1999), e-commerce applications (Cranmore et al., 2002; Petersen, 2001) and requirements engineering (Ferdinandi, 2002). Patterns have also been adopted as a means of presenting ethnographic work (Martin et al., 2001); and studying workplace design (Erickson, 1999).

Though Patterns have been enthusiastically embraced, a review of their mixed reception in the field for which they were originally conceived, physical architecture (Lloyd & Cranmore, 2003), shows that the level of perceived prescription attached to the Patterns formalism by architects is key to determining their acceptance. Prescription, applied to the design and management of Information Systems is explored further within this paper in terms of the degree of 'specificity' and its effect on innovation, risk and competitiveness. Although the Patterns framework is used for illustrative purposes we expect the analysis to be relevant to other 'knowledge' formalisms.

Specificity

The issue of how levels of desired innovation might be reflected in the design of knowledge management systems, and the relationship between prescription and the desired level of innovation, is multifaceted. Pattern 'specificity' is one suggested design parameter to examine these issues. Its potential impact on the effectiveness of a design decision can be illustrated with an example. If a plan was to provide a description of a table, it could provide a shallow specification simply offering a description of 'a flat top with at least three legs'. Alternatively, a deeper specification might detail the types of materials to be used, the exact dimensions of the legs and table top, the types of joints to be used, etcetera. The first example provides a greater opportunity for innovation in the design and implementation process, but also offers a greater threat for both technical and market failure. The second illustration limits the scope for innovation, but reduces technical risk. We contend that the most useful form of Patterns lies between the extremes of detailing a specific project (in depth case history) and a distilled abstract rule, establishing the question: what is the optimal level of Pattern specificity?

Any attempt at answering this question requires investigation of the complex interaction and trade-offs between the issues highlighted in the preceding sections: market and technical risk, innovation, timing and specificity, within the context of strategic alignment and organisational competitiveness.

Heuristics versus Case Studies

To address the impact of specificity on knowledge transfer, the abstract rule (case analysis) versus specific (case history) dichotomy is considered. Detailed specific Patterns provide a rich narrative of information (Aamodt & Plaza, 1994) that can increase understanding of contextual interactions, while simpler, more abstracted recording may fulfil the more pragmatic concerns of the practitioner.

With case studies the reference to external frameworks and precedents allows rules to be extracted from the material. Rules may refer to procedural descriptions, based on "if then" statements; if a certain situation is identified then a solution is offered in the form of a rule- if x…then y. This level of prescription can have limited utility if the rules are presented in isolation as the user has a restricted comprehension of the sensory information, emotions, intuitions and context, that are required for accurate perception and understanding (Weick, 1985). Rules, therefore, can be argued to lack the power and impact of a case (Hoffman, 2001). People may also resist high levels of prescription due to restrictions in personal creativity and autonomy, as observed when Patterns are applied to physical architecture (Cranmore & Lloyd, 2003). At the same time however, high levels of prescription may be beneficial as a result of improved management control, faster response rates, and consistent customer service.

As cases become more detailed, larger quantities of information require assimilation by the user. Such case studies and 'storytelling' are valued in teaching as they provide a context for discussing and evaluating abstract issues thereby facilitating greater comprehension and improving retention for future applications to novel contexts (Denning, 2001). However, search and cognitive effort will only be expended if the benefits of reading and analysing the case are perceived to outweigh this effort (Payne et al., 1993). Moreover, the interpretation of case studies can result in increased subjectivity and multiple interpretations, effectively reducing the level of prescription in the documentation. Hindsight and subjectivity bias may also prejudice the case author's interpretation of events to the extent that they are no longer a fair record (Weick, 1995).

In developing 'knowledge technology' to support either of the above knowledge types, Merlyn & Valikangas (1998) argue that a knowledge management tool should be sufficiently versatile to support both abstract thinking and contextual sense making – strongly implying that some intermediate level of Pattern specificity will produce the most effective system. This echoes discussions about the optimal relationship between medium complexity and communication effectiveness noted in advertising (Morrison & Dainoff, 1972) and in web site design (Geissler et al., 2001).

Figure 1 (see APPENDIX) illustrates the optimal point of specificity. Up until this point, each marginal increase in the level of specificity makes the experience encapsulated by the Pattern more accessible and useful to others. After this point, increasing the already high degree of specificity reduces usefulness as it becomes harder to abstract issues that are relevant to both the historical as well as the target context.

To complicate matters further, the optimal point of specificity will vary depending on the application context. For example, the level of documentation specificity within medical knowledge based systems has been recognised to have an impact on the effectiveness of communication (Dampney et al., 2001); within this environment diagnostic 'success' rises as the specificity of diagnostic information increases (Lemaire et al., 1999). Here replication may be the optimal strategy to ensure consistency and high standards in the majority of situations, although doctors or surgeons with appropriate levels of expertise may innovate.

Within organisations seeking competitiveness through innovation; as specificity increases, solutions become more prescriptive and the level of innovation decreases. Rivkin (2001) and Sorenson, Rivkin & Fleming (2002) set up a similar model addressing the optimal level of strategic complexity that maximises the 'wedge' between (internal) replication and (external) imitation. Modular, low complexity strategies are easy to replicate and imitate; for example, the fast food chain *White Castle* was widely imitated in the 1920s. Highly complex strategies can be as hard to internally replicate as to imitate; for example, the British clothing and food retailer *Marks and Spencer* which had difficulties replicating its successful domestic strategy in Europe and Canada (Rivkin, 2001). They argue that moderate levels of strategic complexity offer the greatest barrier to external imitation as the original innovator has the closest proximity to the primary template and knowledge. This argument introduces the dimensions of market and technical risk for innovators and followers, which also need to be integrated into the framework.

Pattern Specificity and Risk

Recent studies indicate that IT related risks are still not well understood by the majority of organisations and are rather narrowly focussed (Wah, 1998). Risk assessment has predominantly been viewed as a financial function for calculating the variability in potential future returns. This can obscure an investment's contribution as a core infrastructure to advance the wider business strategy (Smith et al., 2001). In an increasingly competitive environment with increasing reliance on ICT systems across an increasing number of business functions, the exposure to both market and technical risk has intensified. Taking a very broad definition of risk, we can posit the following relationship:

As Pattern specificity increases from zero, technical risk reduces significantly resulting in lower levels of overall risk; however as solutions become more prescriptive, the implicit assumption that context is invariant increases market risk resulting in higher levels of overall risk. This is graphically illustrated in **Figure 2 (see APPENDIX)**, where:

Market Risk is used to describe how products and services are positioned and received within the market place. Direct imitation will not result in differentiation, and therefore will not be the source of a competitive advantage;

while differentiation may promote innovation, its success is subject to the uncertainty of the market's response to new products and services.

Technical risk is used to describe the uncertainty arising from novel processes and products as well as the potential for service or merchandise failure. Investments into novel and innovative solutions are known to incur high technical risk, as the 'performance, scalability, reliability, and stability' of the technology is not fully understood by ICT professionals and end users (Smith et al., 2001).

At low levels of specificity the technical risk of trying to implement a solution for which there are few details dominates. As specificity increases, technical risk necessarily reduces as a greater understanding of the technology and its context is provided. However as specificity increases, the increase in prescription leads to a reduction in innovation that causes market risk to increase at a faster rate than technical risk reduces. For example, market risk can increase because at high levels of specificity the company is ultimately investing in replication – for the outputs/product to be competitive the new producer must be able to operate at a lower cost and recoup its investment before the incumbent producer 'innovates'. For that reason there can be no automatic expectation of a competitive advantage to arise from that design/decision outcome alone. A succession of poor decision-making followed by investments in technology that fail to generate the anticipated benefits, not only wastes resources, but can create an impression of the company within the market that has a direct impact on shareholder value. Within the decision-making process therefore, the way that a Knowledge Management System enables different solutions to be searched, evaluated and combined also requires attention.

Pattern Specificity and Search Overlap

A systematic approach is required to evaluate the appropriateness of alternative Patterns as a function of their impact on competitiveness. These decision variables are dependent on the perceived future changes in the market place, and require an explicit understanding of the business objectives and motivations that determined the original investment decision.

If a problem displays significant levels of overlap with two Patterns, the decision-maker is required to choose between them or use them both to synthesise a third. However if the problem significantly overlaps *a number* of solutions, a means is required to distinguish between them and to rank the most appropriate. In order to select between the alternatives, generic rules can be applied to determine if one solution offers more competitive benefits than another. For example, if Pattern One describes a viable solution that can be implemented faster than that of Pattern Two, and speed of implementation was a key consideration, then Pattern One would be selected.

In order to effectively choose between potential solutions the decision-maker needs to be conscious of both the similarities and differences between different Patterns. Contextual understanding is also essential (Drucker, 1994); the reapplication of existing solutions requires discretion in order to tailor them to a specific set of environmental circumstances which continually change. This forces reinterpretation of the pre-existing solution. In a scenario where a high overlap is observable between the problem and the Pattern solution, with respect to both the business and social contexts, the decision making process is straightforward. However, further overlap scenarios can be envisaged between the problem and the solution space (e.g. high overlap with the business context but not the social context, vice versa, and low overlap with both contexts). These in turn depend on how detailed the specification of the Pattern is – a more detailed version of the same Pattern may show a lower degree of overlap with the problem specified, and yet be no less relevant for consideration.

We argue that the level of context and detail specified in the Patterns has a significant impact on the effective selection of potential solutions, and can affect the optimal strategy for technology transfer. Figure 3 (see APPENDIX) illustrates the effect specificity and search overlap might be expected to have on the probability that a Pattern would be 'correctly' applied to a particular situation. It should be noted that case studies allow multiple interpretations whilst rules do not, increasing the opportunity for innovation but also the attendant risk. This model indicates that high specificity and high overlap result in high prescription levels, which may have an impact on innovation.

Pattern Specificity, Search Overlap and Innovation

We have already argued that Pattern specificity can affect abstract thinking and contextual sense making. If considering this from the perspective of innovation; as specificity increases, solutions become more prescriptive and the level of innovation, regardless of risk, decreases. This is not true however, if solutions are synthesised from a number of relevant Patterns, where those Patterns have been selected due to an overlap established between the problem and solution's contexts. In these cases the degree of overlap employed to make the selection is anticipated to have an impact on the level of innovation promoted, with innovation decreasing at a lower rate for low levels of selection overlap, in comparison to high levels of selection overlap (Figure 4, see APPENDIX).

In this analysis it is essential to acknowledge that innovation in any market-mediated environment cannot be assumed to be necessarily successful. The graph illustrates that when using 10% overlap in search criteria there are always higher levels of innovation than at a 100% overlap, at all levels of specificity. Innovation declines at both a 10% and a 100% overlap as specificity increases, however at a far lower rate for lower levels of overlap. These two lines set the boundaries for the next stage of analysis. Though arbitrary, a 10% overlap is used as a minimum as it is assumed that a 0% overlap is meaningless, and that a 1% overlap would assume that 99% of the detail of the Pattern is irrelevant to the current problem, which is clearly an implausible approach to generating an effective solution.

Pattern Specificity, Search Overlap, Innovation and Risk

From the relationships that have been posited in this paper so far, a number of conflicts have been identified. These constraints are summarised in Table 1 explicitly including risk:

Table 1. Summary of the major trade-offs considered in this paper that relates Patterns' database design to the promotion of competitive systems development.

	Specificity	***Competitive optimal relationship***
1. Risk	Risk is minimised between the extremes of high and low specificity	Risk favours *moderate specificity*
- Market Risk	As specificity increases, market risk increases and dominates total risk	Market risk is *minimised with lower levels of specificity* (as context is less invariant)
- Technical Risk	As specificity decreases, technical risk is increases and dominates total risk	Technical risk is *minimised with high levels of specificity*
2. Innovation	As specificity increases, the scope for innovation decreases	Innovation *favours low specificity*
3. Probability of correct application/ level of prescription	As specificity increases, the probability of correct application increases	Prescription *favours high specificity*

As the level of specificity increases, technical risk is reduced, but the scope for innovation is restricted, resulting in higher market risk arising from imitation. Conversely, as specificity is reduced, technical risk increases, but the scope for innovation increases providing opportunities for gaining competitive advantage. High specificity and high overlap result in higher prescriptive application of Patterns to new contexts, however low specificity and low overlap promote innovation. Therefore the optimal level of specificity is firm specific and is dependent on the competitive strategy of the firm, which in turn dictates the desired relationship between innovation and prescription. These conflicting trade-offs are overlaid in Figure 5 (see APPENDIX). The levels of innovation and risk (including both technical and market) at 10% and 100% overlap define the boundaries of a viable domain (delineated by the dotted line).

Specificity, Overlap, Innovation, Risk and Competitiveness

Within this 'viable' domain, the relationship between Innovation, Risk and Competitiveness is complex, especially if attempting to account for the timing of competitive benefits. If we consider only long-term competitive advantage, then some guidance is provided by considering 'Innovation less Risk', which is overlaid in Figure 6 (see APPENDIX). If construction lines are chosen from the points at which Innovation exceeds risk, posited to produce long-term competitive advantage, three sub-domains are defined within the viable region.

The first of these, 'Maverick', defines an area where an investment is made into new and unproven technology that has not been applied in any field or organisation previously. Both market and technical risk are high. 'Me too' describes the situation where a company invests in a technology that has been established by the market leader. The company may hope to retain or improve its competitive position but is unlikely to achieve any differentiation as the 'first mover' company continues to move up the learning curve. The technology may become an entry requirement for the market but it is not a source of competitive advantage if the implementation is prescribed precisely by what has already been demonstrated elsewhere. It is important to appreciate, however, that later entrants can move up the learning curve faster than the first-mover in later iterations.

Between these two regions, long-term competitive advantage is shown as net positive, where intermediate levels of Pattern specificity promote innovation, but provide enough guidance and forced reflection to significantly reduce technical risk. Within this area of 'Technology Transfer', however, there is still a very wide scope of technology strategies that can be followed. For example, proven technology can be transferred from other (non-competing) domains or business units, reducing technical risk, but still incurring high market risk as the full applicability and appropriateness to the specific context is unknown. Given these boundaries, further subdivision of the Technology Transfer region is possible. In the following example, we show how different areas of this viable region can be related to generic business strategies.

THE TECHNOLOGY TRANSFER MATRIX

In exploring the impact of specificity on the representation of knowledge it is suggested that the optimal level of prescription will differ for different company strategies and market circumstances. Opportunities for knowledge transfer may exist within intangible interrelationships through the movement of management know-how across separate value chains (Porter, 1985). Although a business may operate in different industries they may have generic strategies in common, such as cost leadership or enhanced differentiation. Philip Morris, for example, in the 1980s successfully applied its know-how in advertising, product management, and branding for cigarettes to the Miller beer brand. Emerson Electric and H.J. Heinz use cost leadership strategies within a number of their business units which share low cost know-how. Smaller companies, however, following a strategy of organic growth may need to introduce a higher degree of innovation in order to gain market share and serve niche markets. Possible market scenarios drawing from generic strategies, for example Ansoff's (1957) classical matrix for strategic diversification, which focussed on technical innovation, and the corresponding optimal levels of prescription are suggested in Table 2.

Table 2. Example market scenarios and suggested levels of prescription within 'Technology Transfer' domain.

MARKET CONTEXT	DESIRABLE INNOVATION LEVEL
New Product – New Market	High Innovation – Low Prescription
New Product Development (Existing Market)	Medium Innovation – Low Technical Prescription
New Market Development (Existing Product)	Low Innovation – High Technical Prescription
Existing Product – Existing Market	Minimal Innovation – High Prescription. Focus on replication

1. *New Product – New Market*, for example within a Design Agency environment replication may be undesirable while high innovation is essential in creative output.
2. *New Product Development,* moderate levels of innovation may be required for the launch of a new product offering in order to ensure differentiation from competing companies. Here the focus will be on promoting technical innovation in order to generate new product qualities.
3. *New Market Development*, such a strategy may favour lower levels of innovation if the company's core competency lies in the existing product technology and the objective is to increase existing production volumes rather than increase niche customisation. Here the focus will be on communicating different product qualities rather than creating new product capabilities.
4. *Existing Product – Existing Market*, companies undergoing consolidation may elect to retain existing products and markets, while changing the production process in pursuit of a competitive cost structure arguably promoting incremental improvement rather than innovation. Likewise, companies undergoing horizontal diversification, for example through a merger and acquisition, may favour a prescriptive approach to ensure that the knowledge transferred is implemented in a consistent manner.

POTENTIAL LIMITATIONS

While this may provide a useful framework to guide decision-making, such planned outcomes from the design of a Pattern Language are not automatic. For instance, Porter (1985) notes that in order to improve competitiveness it is imperative that the benefits of know-how transfer exceed the costs of the implementing the transfer. Assimilating new technology, for example through the acquisition of another firm, has been recognised as being especially problematic, potentially inducing reduced employee commitment and productivity, higher levels of dissatisfaction, and greater turnover (Buono, 1997). Within this context, Porter (ibid.) highlights numerous impediments that hinder efficient know-how exchange. These include the perception of asymmetric benefits, loss of autonomy and control, biased incentive schemes, differing business unit circumstances and cultures, and managerial fear of tampering with decentralisation. The process of transfer is dependent on the interactions between people and the availability of resources overcoming any barriers that arise from specific company cultures, norms and structures. Knowledge management using Pattern languages has a contribution to make in all these respects, but the design considerations above are not sufficient for these to follow necessarily.

Furthermore, whilst a link can be identified between technology and its impact on the business process, the relationship between the business process and competitiveness is more complex. The relationship in turn with competitive advantage is so heavily dependent on exogenous factors that any ex ante claim that one is necessarily related to the other is indefensible. This in part contributes to the unresolved debate surrounding the 'IT productivity paradox'.

CONCLUSION

In this paper we have built a model that posits a number of relationships between Pattern design and the competitive benefits that may arise as a consequence of managing information using a Pattern language or knowledge repository. We have examined one aspect of Pattern design, specificity, and built a model that relates microscopic structure to the process of searching and relating Patterns, the promotion of innovation, the alignment of technology and business strategy, and the reduction of risk.

Once a design has been chosen a number of potentially irreversible constraints may be introduced restricting the knowledge management system's impact on competitiveness. Although the Patterns framework is used for illustrative purposes the analysis is relevant to any type of knowledge documentation and the design of the basic knowledge unit. It is suggested that different market scenarios may require different levels of prescription in order to achieve the desired organisational outcome. The desirable level of prescription needs to be defined and supported within the specific technology transfer context. For example in the application of information technology to business problems in the pursuit of competitiveness know-why is essential to facilitate innovation; pure replication is inadequate and is unlikely to be manifested as an advantage in the market place.

The model presented has been justified with reference to established literature in a number of relevant fields and the underlying hypotheses are currently being examined as part of an Economic and Social Research Council study of knowledge management within financial services organisations. Neither the model, nor the literature on which it is justified are complete and are expected to develop as the research progresses. However, it is clear that the specific design of a Pattern formalism for the creation of a Patterns database has far-reaching consequences for the success of the venture and, once fixed, may not be reversible. Through analysis of the literature supporting the emergence of Alexandrian Patterns as a formalism for knowledge management, the we have related the macroscopic factors of risk, innovation and competitive advantage to the design and in particular the specificity of the basic knowledge unit. In terms of the design of the Patterns formalism, we contend that high levels of prescription could constrain innovation processes within an organization, reduce strategic alignment and consequently reduce an organization's competitiveness.

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APPENDIX: FIGURES

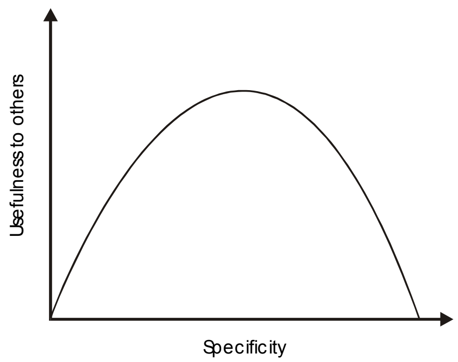

Figure 1. Depth of Pattern specification 'specificity' versus the usefulness of the Pattern in generating an innovative solution to a similar problem in a new context.

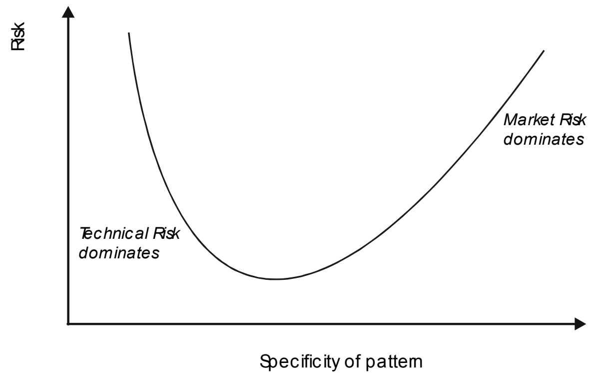

Figure 2. Relationship between RISK and Pattern specificity. Note that different levels of overlap are incorporated into the level of risk illustrated.

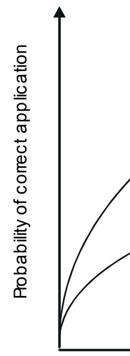

Figure 3. G correct appli

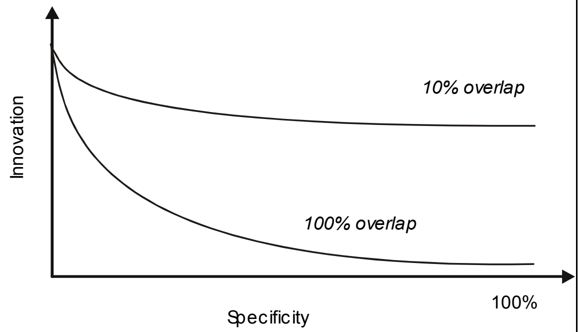

Figure 4. INNOVATION as a function of Pattern SPECIFICITY and selection OVERLAP.

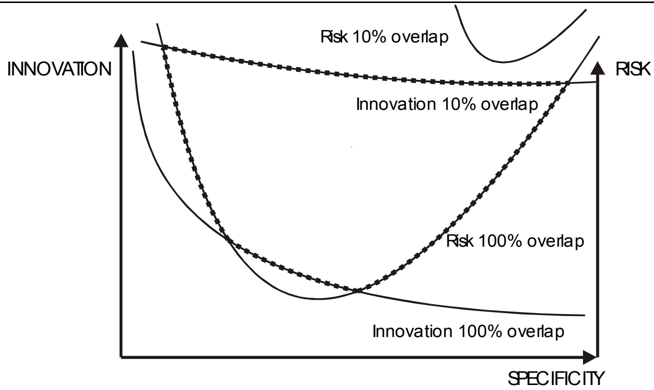

Figure 5. Graph combining Innovation, RISK and Specificity. These bound a region (delineated by the dotted line) for which a Patterns Catalogue might sensibly be designed.

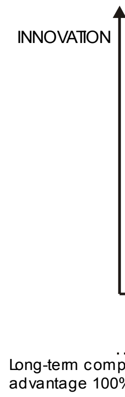

Figure 6. Gra Long-term C