Computer Modelling the Costs of Management Control in the Development of Knowledge Based SMEs.

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Abstract.

The Knowledge Based View of organizational development is based on Transaction Cost Economics involving minimizing internal transaction costs ('friction'). One source of friction is "*self-interest seeking with guile*" in management. Friction raises internal costs and Management Control (in the sense of the control of management) introduces checks and balances to limit extensive "*guile*", but control mechanisms themselves incur costs and ideally the costs for control should not exceed the costs of the friction, however quantitative measurements are lacking. To obtain these values scientific methods, including control experiments, are needed but if such estimates occur in case studies then they are seldom and often oblique. Research *in silicio* is faster and cheaper than conventional approaches and several innovative laboratory alternatives exist in computer-generated realities. One computer model explains SME development and can predict outcomes of changes within organizations. This communication reports on the costs of combinations of "*guileful*" behaviour; departmental managers restricting knowledge flow between departments do contribute to lowering company performance, but this effect is small in the

short term: One departmental manager blocking information flow reduced the financial performance organization-wide by 1.4% in the local department plus 1.2% in the remainder of the organization. Two such managers reduced overall performance by 4.1% and four such managers reduced overall performance by 6.4%. Guileful behaviour also added instability at size over 150 employees.

Keywords: Computer model, Growth of SMEs, Information Gatekeeping, Management Control, Transaction Cost Economics.

Article Classification: Research paper

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Introduction

Transaction Cost Economics (also called Transaction Cost Theory) argues that to achieve rational profit maximisation, organizations must minimise their total costs, which in turn are made up of both production costs and transaction costs. Williamson (1985) as well as Williamson and Masten (1999) stress that transaction costs are as significant as production costs. Regarding transaction costs, the Knowledge Based View of the firm (for a recent review see Amadasun, 2014) underlines that a major factor contributing to transaction costs in an organization can be the costs of internal communication, also colloquially known as information gatekeeping: It is known that unhindered knowledge flow and the rapid dissemination of incremental innovations arising from this flow is especially important in SMEs (Desouza & Awazu, 2006. Serenko et al, 2007) and this aspect has been applied to studies on management control in SMEs (for some examples see e.g. Ditillo, 2004).

In terms of management control, Williamson (1985) argues that "*self-interest seeking with guile*" (Williamson, 1985 p30, Williamson 1993, p97) is inherent in human behaviour and thus that it is difficult to identify trustworthy individuals in organizations, with the result that it is necessary for organizations to structure themselves with internal checks and balances in such a way as if individuals cannot be trusted and this 'Management Control' clearly adds a further layer to internal transaction costs. Against this background, thirty years of research has only yielded a general confirmation that "*self-interest seeking with guile*" raises internal costs and in particular quantitative measurements of this effect are

noticeable by their absence. The rise of what is popularly called ‘the knowledge economy’ has placed more attention on trust as a modulator of transaction costs in organizational economics and management, indeed over 25 years ago Donaldson (1990) pointed out that lower transaction costs should be inherent in matrix organization structures exhibiting vertical dis-integration. But again this circles back to the question; how much? Clearly trust (if not misplaced) is cheaper than control mechanisms, but by the same token the control mechanisms that are put in place should not be more expensive than what lack of trust costs.

Controversy exists as to the predominant role of middle managers within the organization: Some research, for example Kuratko et al. (2005) and Huy (2001) point to the role of middle managers in communicating information between operations and top-level management, developing tactical objectives, executing strategies and acting as important drivers of entrepreneurial initiatives within the organization. Other authors talk of the phenomena of ‘silo building’ (see e.g. Foucault, 2002) or "*counter effort*" as Guth and Macmillan (1986, p 313) succinctly put it. So while a transaction cost theory of management control is widely accepted (e.g. Spekle, 2001. Vosselman, 2002), middle managers may still not be entirely honest and truthful about their intentions, for example they might hinder the positive effects of Knowledge Management like having open information gateways or other internal communication pathways in order to ‘ring-fence’ or otherwise keep for themselves resources that are over-proportional to real or expected results, as seen on an organization-wide scale.

Through the lens of the Knowledge Based View, perfect Knowledge Management in an organization would involve having open information and communication pathways in order both to provoke ‘mutual inspiration’ amongst the workforce, and then to promote the spread of innovations arising from e.g. ‘mutual inspiration’, rapidly within the organization. Departures from this (i.e. a form of friction) will result in companies incurring higher internal transaction costs, but again it has not hitherto been possible to put concrete financial value on this phenomenon which, by anecdote, unfortunately appears to be relatively common. Darroch (2005) reported that firms that manage their knowledge well actually do perform better. Furthermore Schmid and Kern (2014), in addition to providing an excellent overview of the literature, point out that in particular, improvements in information gatekeeping at

middle management level do indeed lead to overall improvements, but again no data has been reported on what the absolute volume involved could be. There is a real paucity of research on the impact of 'counter effort' and indeed Wang and Murnighan (2011, p. 279) state "*empirical research on greed is rare*". Much has been written on how leaders can stimulate innovation (e.g. de Jong & Den Hartog, 2007) but computer modelling allows us for the first time to investigate the converse. Therefore this communication reports the results obtained from modelling the economic impact that this 'counter effort' behaviour at departmental level has on small businesses.

Previous Research

An early theoretical framework for applying computer modelling to understanding business processes was proposed by Melão & Pidd (2000) and more particularly for business management processes by Pidd (2006). In more recent years the computer modelling of organizations has begun to make more practical advances: Yuan & McKelvey, (2004) used it to explore situated learning theory and McCarthy (2008) applied computer modelling to manufacturing strategies. More recently Keyhani et al (2015) successfully used Games Theory to model entrepreneurial processes in the marketplace. Perhaps more relevant, Mellor (2011 and 2014a) presented a 3D quantitative folded pseudo-Markov net that pertains to the knowledge-based theory of the firm and explains the growth stages of SMEs as observed in the classical SME literature (see e.g. Greiner 1972) via their knowledge assets (Boisot, 1998). The 3-dimensional computer model has also been used experimentally to predict outcomes associated with structural changes within organizations, and preliminary results that use the Knowledge Based View to model SMEs in service industries are very encouraging (Mellor, 2015b). The Mellor (2011) model has subsequently been developed and used for Markov Chain Monte Carlo simulations (see e.g. Chib and Greenberg, 1996 for a classical review of Markov Chain Monte Carlo techniques and Robinson, 2014, for a more recent overview) and this modelling revealed both the added value of financial returns upon adding innovators to middle management (Mellor, 2014b) as well as the financial value of adding "just in time knowledge" derived from external networks (Mellor, 2015a).

Previous 3-dimensional simulations (see Mellor, 2011 and Mellor, 2014a) were performed under conditions where the model assumes that the organization grows in a relatively linear fashion and, through growth in number of employees, splits into departments of up to 50 employees, splitting again in a binary fashion when this figure is exceeded and the resulting departments being joined together by a management layer of departmental managers who exhibit perfect open information gateways policies. However the computer simulation used is flexible and can be adapted, for example in this case by removing the information flow through the managerial information gateways between departments. Thus the results presented here report the situation where the departmental managers still lead departments of up to 50 individuals but are dysfunctional and impermeable regarding the flow of information, knowledge and innovation between departments.

The Model and Approach

The 3D virtual fold used is shown in Figure 1 and has previously been described in Mellor (2011) and in Mellor (2014a). Briefly the three dimensions are; (x) firm size as measured by number of employees because the number of employees is proportional to the possibility of successful recombination of knowledge to form innovation, and (y) value. Value in an organization can be measured in various ways, in Figure 1 the calculated profitability per employee is used but one could just as easily also use other indicators e.g. firm annual turnover – the amounts needed to support those employees – without significantly affecting the results. The third (z) axis represents openness to innovation on a benchmarked scale from 0 (zero resistance) to 10 (maximum resistance to change) within the relevant industry sector. This is in agreement with Melão & Pidd (2000) who specifically took business change into account in their models, albeit that they were more inclined to a Business Process Reengineering context. Within this Mellor (2011) 3D space (referred to as “knowledge valley”, Mellor 2014a) a peer-to-peer model was constructed where people in an organization are represented as nodes (the number of people being represented by the variable ‘P’, and are joined by ties. The number of links or ties between nodes is known as the Diversity Innovation (DI) number (Mellor, 2011) and as the DI number increases the potential for knowledge recombination into innovation and mutual inspiration also increases (Mellor, 2011). When two individuals enter into a communicative relationship, then a communication pathway (sometimes called a link or ‘tie’) opens, i.e. the DI number

reaches the number 1. As long as the number of people involved is larger than 3, then the number of pathways is proportional to the number of people involved and this relationship can be expressed by a simple arithmetic equation (note that an asterisk, *, is the mathematical symbol for multiply):

$$DI = \frac{P * [P-1]}{2}$$

Using this equation the amount of potential DI (i.e. the potential for the generation of new and profitable ideas – the 'mutual inspiration' – see e.g. Belfo 2014) in an organization as it grows and acquires more employees can be calculated in a very convenient way. Unfortunately, widespread knowledge sharing and consequent recombination of diverse knowledge into useful innovation is however prevented in practice by the concomitant increase in internal transaction costs, which includes the time (and thus cost, for example as salary) taken for individuals to communicate. Furthermore as an organization grows, unfettered knowledge sharing is no longer possible because at around 50 employees, transaction costs force SMEs into a policy of departmentalization, and the effect of forming new departments is to reduce the DI number in periodic cycles in tact with each round of departmentalization (Mellor, 2011). The simple model used here assumes binary fission of the organization into departments of equal sizes as the organization grows in multiples of 50 and forms a simple hierarchical structure within the organization with departmental leaders (middle managers) acting as channels between departments and in turn reporting to the CEO, however it must be stressed that actual values for any organization can be used. To use actual data from a case organization the key values on the X and Y-axes are thus number of employees (X axis) and some measure of financial performance (Y axis) whereas the Z axis would be a benchmarked scale of where an organization can be placed on a 1-10 scale, the maximum (10) being calculated using the DI equation for that organization. The three dimensional space of the model is occupied by a fold representing the fluctuating DI number with time and a J-curve which in turn uses values taken from the literature on Business Process Reengineering (Pidd, 2006; and for the actual values used see Mellor, 2011, table 14.1 and for an at-length discussion of these, see Mellor 2011 and 2014a). Thus taking a

low-innovation company as a starting point it is assumed that successfully transforming it into a high-innovation company will initially decrease its value but upon successful completion will approximately triple its value and profitability. Thus the 3D fold allows the benchmarked use of innovation to be plotted against projected financial performance starting from low-innovation organizations (the "Dickensian" side of the fold) on the left, to a high-innovation state (the "Schumpeterian" side of the fold) on the right; the inhabitants of the Schumpeterian side represent the "gazelles" of the sector (for illustrations of this effect, see Mellor, 2011).

Modelling was carried out in Maple 18 (www.maplesoft.com).

Analysis and Results

The control simulation was run exactly as before (Mellor, 2011) with the exception that Maple 18 was used in place of Maple 14, which is now outmoded. The model referred to as above, when completed, results in the 3D fold shown in Figure 1A. The simulation was then run again and Figure 1B shows the results obtained when the simulation was repeated but with the connections between nascent departments severed, emulating dysfunctional and impermeable barriers regarding the flow of information, knowledge and innovation between departments. Each simulation was run ten times and the overall standard deviation (SD) observed was less than 0.01.

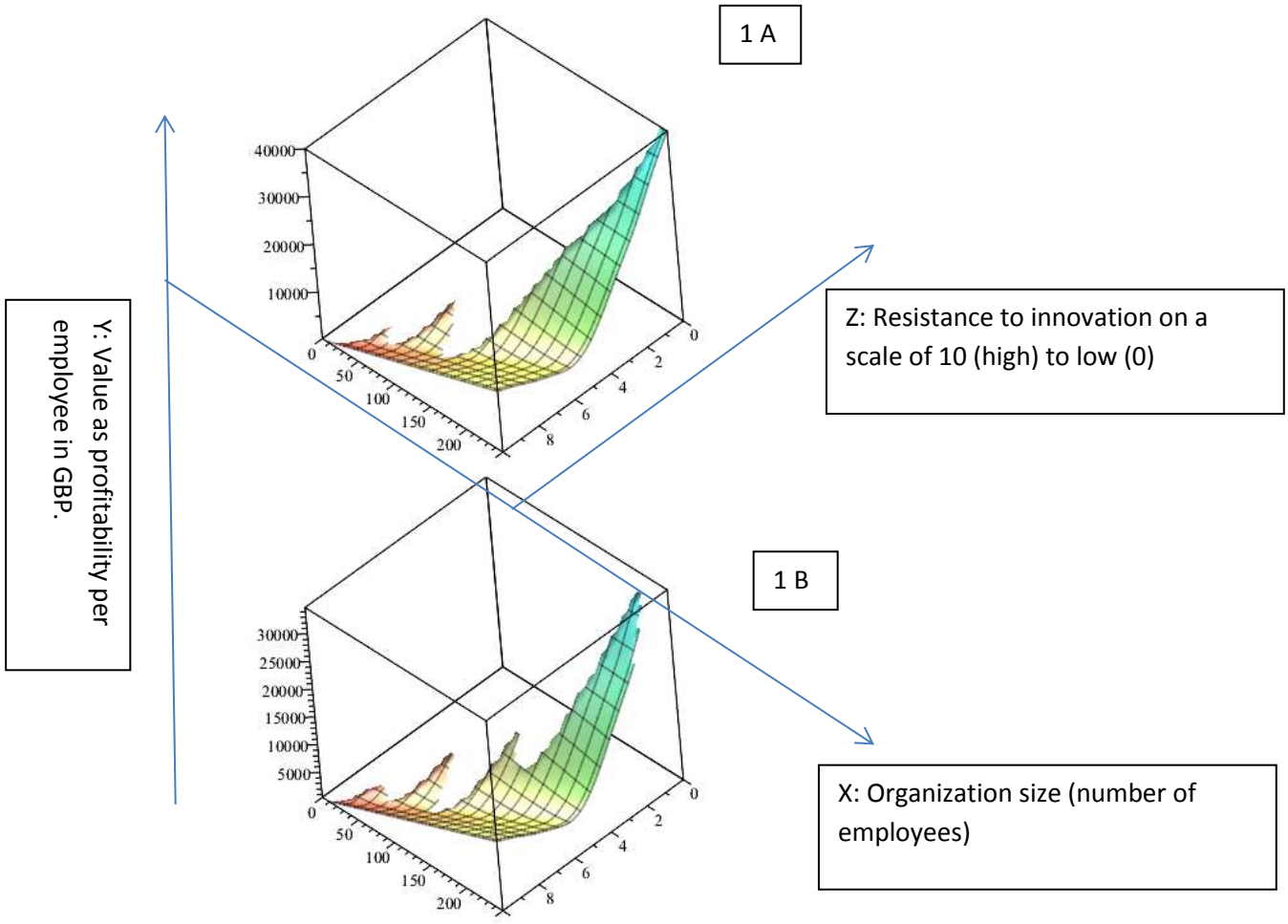

Figure 1A and 1B: The 3D fold with open information gatekeepers (1A) as control simulation, and with blocked ('counter effort') information gatekeeping (1B). Both Figure 1A and Figure 1B exhibit dips at employee number 50 and 100 where rounds of departmentalization take place, but only 1B exhibits a further dip at further departmentalization (150 employees).

The situation modelled in the case of closed information gates reveals two differences; a pronounced third ‘dip’ in the financial performance of the organization at around size 150 employees and an overall lower performance during all growth phases above 50 employees. It is not clear why the closed information gates scenario involves a crisis at the third round of departmentalization, which is not so clear or even lacking in the open gatekeeping simulation, but one could speculate discord amongst uncommunicative managers affecting overall performance, a phenomenon which would not be found in the control experiment, which also showed a generally higher background performance which in turn could mask any negative effects in that scenario.

At organization size over 50 employees, general financial performance was less in the simulation with closed information gates (Figure 1 B) than in the control simulation (Figure 1 A). However at the peak of performance, the point where the most difference would be found, overall performance was down by a mere 6.4% (SD 0.05, n=10). As an across the board rule and subject to some variation (within the constraints given in real life like the vagrancies of exactly how poor the information gatekeeping is) then this percentage of financial under-performance will apply to organizations generally having four departments. Predictions for organizations with different number of departments may be derived from Table 1 (below).

Using the model provided of linear growth, regular departmentalization and turnover covering costs and the data presented, the amount of actual value in annual turnover lost due to under-performance was calculated to range from £3.8 million per annum for very high value organizations (“gazelles”) of size 200+ employees down to £530.000 per annum for low value organizations of similar size. Clearly unlike percent values, these figures are not subject to generalizations and probably will not apply exactly to any existing organization. None the less, the actual amount for any particular organization will most probably fall within that range and furthermore can be relatively simply calculated by entering the specific data for that organization into the computer model and deriving a simulation.

The 6.4% drop in annual performance observed was due to 4 information gatekeepers (middle managers as heads of the four newly formed departments) each being completely closed. It would be an extreme situation if all departmental heads in an otherwise high-value, high-innovation environment refused to communicate with each other at all on what was happening within their respective departments, nonetheless it only represents an average of 1.5% drop in profits per gatekeeper per annum, so serious detrimental effects of departmental leaders acting within the term "*self-interest seeking with guile*" or with other guileful fashion by restricting information gatekeeping, can reasonably only be expected to be significant and provoke remedial action after several years of this behaviour, e.g. building up to 15% after 10 years.

In order to test the effects relating to departmentalization further, a scenario was adopted where not all four, but only two, departmental heads behaved in a guileful fashion. In this modelling any two departmental heads behave in guileful fashion but communication is unhindered between the others. The results were an overall decrease in performance of 4.1% with a deviation from 10 repeats of 0.05. This figure was rather higher than expected because information can still reach all four departments by tricking through roundabout routes. Due to this seeming discrepancy the simulation was repeated with only one guileful manager; as before the model assumes that communication is unhindered between the non-guileful. The other assumptions in this particular scenario are; (a) leaders in a department cannot change with time i.e. the model does not deal with a mix of long-established managers and new managers but all of a similar length of service, and (b) that no department is functionally dependent upon another i.e. there are knock-on effects related to e.g. production bottlenecks. The results are shown in table 1.

	Manager 1	Manager 2	Manager 3	Manager 4
Department 1	A	B	B	B
Department 2	B	A	B	B
Department 3	B	B	A	B
Department 4	B	B	B	A

Table 1: Showing loss of performance in departments according to guileful behaviour at managerial level. These were e.g. Manager 1 of Department 1, or Manager 2 of Department 2, etc. Results were found to belong to two categories (A and B) where category A was minus 1.4% with SD of 0.05 and category B was minus 0.4% with SD of 0.05. In all cases n=10.

The results summed up in Table 1 show that one departmental manager blocking information and knowledge flow to other departments reduced the financial performance of an organization by 1.4% in the local department and a further 1.2% spread across the remainder of the organization. Two such managers reduced overall performance by 4.1% and this should be seen in the light of the results from Figure 1 that four such managers of all four departments reduced overall performance by 6.4%. The situation of three departmental managers blocking information flow was not modelled because three withholding information from the fourth is functionally alike to all four blocking communication with each other.

Discussion

The simulations illustrated in this communication show the quantitative effects of a dysfunctional lack of information gatekeeping (non-communication with consequent restriction of diffusion of innovation) between departmental managers. This is not the only 'counter effort' that can exist, but in this report other instances on a spectrum from Human Resources issues like neglecting duties, anti-social behaviour and bullying etc to actual criminal issues like fraud and embezzlement to outright stealing are not considered, rather left to internal or official investigation. Taken together, the results illustrated in this report do show without doubt that guileful information gatekeeping ('counter effort') at departmental manager level in SMEs is detrimental to overall organizational performance in two ways:

1. Firstly the development of the organization is not smooth and modelling showed growth and performance to be significantly hindered at around size 150 employees, which perhaps indicates the consequences of managerial non-cooperation e.g. the departmental managers squabbling over the division of budget and assets as the organization grows from three departments to four departments.
2. Secondly the overall financial performance of an organization is negatively affected. That said, the effect is relatively minor and it may in fact take several years for the effect to attain the magnitude needed to attract attention and provoke remedial action by the other stakeholders involved (e.g. the owner or CEO) especially because,

as the word '*guileful*' implies, the behaviour is artfully deceptive and thus probably not consistent. In addition to this, not all effects may be immediately localized and thus point at the individual involved; one guileful manager attracted a deficit of 1.4% in their own department, but four times this is 5.6, not the 6.4 that all four acting together provoked, implying that the effects of 'counter effort' by one manager will be felt in several other departments so one may not immediately be able to locate the source of the friction.

This is clearly of interest for the strategic aspects of management control and the management of SMEs generally, because it shows for the first time the cost ceiling for Management Control operations.

The measurements taken in the modelling presented here took place at the highest point in order to have the largest possible measurable differences and thus the actual financial figures may well not be applicable to other organizations (although specific cases can be modelled as well), but the percent differences are very much applicable to both low-innovation and high-innovation organizations of any size below 250 employees. It is worthy of note that while concrete data is not available, organizations with less than 200 employees but five or more departments can presumably and at a conservative estimate attain 6.4% losses (from Figure 1) plus a minimum of 1.4% (from Table 1) for every department above four; so the larger the number of departments and thus departmental managers, the larger the potential inefficiency. Nonetheless having non-communicative middle managers in high-innovation environments does seem somewhat paradoxical and it is tempting to speculate that there may be fewer knock-on effects in high-innovation environments, in other words that a guileful manager that provokes larger losses by e.g. demotivating the workforce in their department may be more characteristic of low-innovation environments. This speculation is in line with the classical findings of Bracker and Pearson (1986) whose said it is *"… the process, not the plan itself*, (that) *is a key component in performance*." (Bracker and Pearson, 1986, p312) as well as the more contemporary findings in a similar vein, e.g. Desouza & Awazu (2006, p32) who stress "*Organizational knowledge is the most salient resource at the disposal of SMEs …* (and) *… successful SMEs are those who can leverage their knowledge in an effective and efficient manner*" which indeed would imply that 'counter effort' may well act differentially in high- and in low-innovation environments.

Transaction Cost Theory assumes that commercial organizations (firms, companies, etc) are profit maximising, and that profit maximisation involves costs minimisation. Furthermore it assumes rationality on the part of owners and also the middle managers. This is a dangerous assumption and may well be at variance with reality when considering the amount of literature mentioning the 'counter effort' (e.g. Foucault, 2002) behaviour exhibited by middle managers (see also Guth and Macmillan, 1986). Consider that in the 1970s, smaller companies were held up as being viable alternatives to larger companies, but the 'happy ship' scenario developed by Ingham (1979) and others has since been questioned by academics whose research included not only the managers, but also the managed (e.g. Ram, 1994). This led to the 'bleak house' scenario, which is supported by Earnshaw, et al (2000) who used statistics from e.g. work tribunals for unfair dismissal etc. and generally exposed widespread poor employee relations, although Earnshaw, et al (2000) did not provide information about the innovation level of the "bleak house" companies involved.

Conclusion

SMEs are very important in the global economy and especially those in the growing service sector undergo a knowledge-based development that it is paramount to understand properly.

These results confirm that the dissemination of incremental innovations is important in SMEs (Desouza & Awazu, 2006. Serenko et al, 2007) and confirms Darroch (2005) findings that firms that manage their knowledge well do perform better, and in particular the assertion of Schmid and Kern (2014) is supported in that improvements in information gatekeeping at middle management level do indeed lead to overall financial gains.

Briefly; the 3D computer model has shown for the first time that the real transaction costs for poor knowledge management and guileful behaviour in the sense of blocking information gatekeeping and the spread of innovation in the organization can be up to 6.4% of overall annual financial performance and this figure represent the first quantitative estimation of the maximum costs for Management Control in SMEs.

Anecdotally stories of poor departmental leadership abound and thus of interest to strategic knowledge management (and Business Consultants) is the question; what actual effect does

the “bad boss” have on “the bottom line”? Here it is shown that in high-innovation environments these costs are not sufficiently high to attract much attention and attendant preventative measures in the short-term provided that the workforce in the department affected remains motivated and innovative. However, if the workforce attached to that departmental manager becomes demotivated – a scenario that may be more common in low-innovation work environments – then costs can be expected to increase significantly. Does this imply that bureaucratic controls on management are more justified and should be of higher magnitude when the organization involved is a low-innovation organization? Unfortunately it is beyond the present capacities of this computer model to anticipate these extra costs with any reasonable accuracy. In order to resolve this question, future work will be aimed at investigating this area further and will involve the modelling of actual case organizations, contrasting high-innovation with low-innovation organizations and organizations which contain various numbers of departments.

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