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Exploration, Exploitation, and Knowledge Management Strategies in Multi-Tier Hierarchical Organizations Experiencing Environmental Turbulence

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ABSTRACT

James G. March conceived organizational learning as a balance between the exploration of new alternatives and the exploitation of existing competencies. This study extends March's model to consider exploration and exploitation in hierarchical organizations. First, the effect of additional tiers is analyzed and related to March's original constructs. Second, the study evaluates additional effects of a knowledge management system that collects and shares knowledge from expert individuals in an organization. This study finds that in the absence of personnel turnover, a knowledge strategy of high exploitation and low exploration for a multi-tiered hierarchical organization reduces the veracity of average individual knowledge when compared to alternative strategies. The magnitude of this reduction in veracity increases as the number of tiers in a hierarchical organization increase; a flat organization will see less of a reduction. A weighted least-squares regression performed on a second set of data corroborates this central observation. This study is the *first* of three dissertation papers planned by the author, examining the organizational dynamics associated with knowledge management systems.

Keywords

Organizational learning, exploration, exploitation, personnel turnover, environmental turbulence, hierarchical organizations, knowledge management.

INTRODUCTION

James G. March's original model of *organizational learning* is succinct and abstract, comprising an external reality, individual knowledge/beliefs about external reality, and an organizational code representing an approximation of external reality (March, 1991). To conserve space, this paper assumes that the reader is familiar with this original model and devotes only a few paragraphs to its construction before discussing extensions. March's original model circumscribes external reality as a vector of $m = 30$ integers (either -1 or +1), each representing an independent dimension of reality. Individual knowledge comprises a similar vector of 30 integers, with the allowance of a value of 0 representing no belief. Organizational code is a similar vector of 30 integers. March defines an organization as $n = 50$ individuals (i.e., 50 vectors, each with 30 knowledge elements). March finds that the qualitative results of the model are insensitive to values of m and n . This premise similarly holds for the findings of this study; see figure 1 for details.

March defines an individual knowledge level as the proportion of external reality correctly represented by an individual knowledge vector. Separately, an organizational knowledge level is defined as the proportion of reality correctly represented by the organizational code. There is only one organizational code, hence only one organizational knowledge level. Individuals who approximate reality better than the organizational code are defined as experts in an organization.

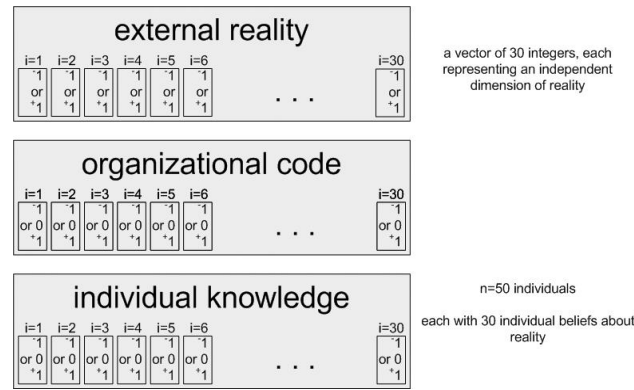


Figure 1. Three Constructs of March's Original Model

Both individual and organizational knowledge levels potentially change via organizational learning, represented as two distinct interactions among the individuals and an overarching organizational code. For each iteration of the model, every individual has the potential to change a knowledge element to conform to a corresponding knowledge element of the organizational code with (p_1) representing this probability to exploit existing knowledge; i.e., *exploitation*. This approximation of exploitative behavior serves to model individual learning from the organizational code. Equally, for each iteration, the organizational code has the potential to alter a knowledge element to match the dominant knowledge of expert individuals with (p_2) representing this probability to explore new knowledge, i.e., *exploration*. This approximation of explorative behavior serves to model organizational learning from experts; see figure 2 for details.

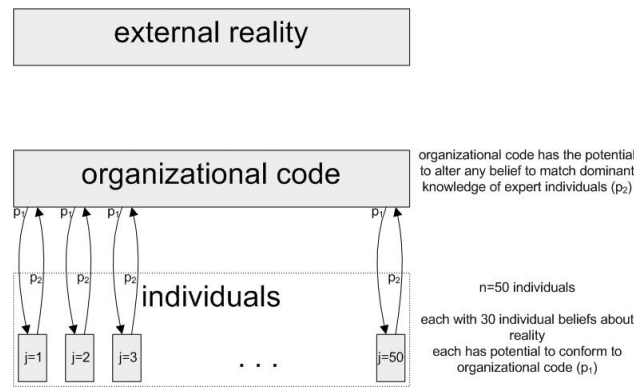


Figure 2. Core Interactions of March's Original Model

March expands his formative model to consider a more open system, comprising *personnel turnover* and *environmental turbulence*. For each iteration, every individual has the potential to leave an organization and be replaced by a new individual, with (p_3) reflecting the probability of this turnover. New individuals are replaced with randomly distributed knowledge elements. Equally, for each iteration, any dimension of external reality has the potential to flip, with (p_4) reflecting the probability of this external turbulence. March's model intentionally precludes both individuals and an organization from directly observing external reality. Instead, improvement in individual and organizational knowledge levels comes either from the organizational code adapting to the knowledge of expert individuals or from individuals conforming to the knowledge contained in the organizational code. The organizational code can only distinguish expert individuals by their optimal individual knowledge levels, and cannot pinpoint which specific knowledge elements are true or false for a given dimension of reality.

EXTENDING THE MODEL

First, an extension made to March's model considers the effect of additional tiers in *hierarchical organizations*. The original model considers all individuals as peers to each other, and hence represents a flat organizational structure. An extension positions a single boss at the top tier in the hierarchical organization with a set of direct reports (b). This boss corresponds to

the organizational code in March's reality. Multiple organizational codes are allowed to exist as different tiers in the proposed hierarchical organization with each direct report, in turn, a boss for another set of direct reports recursively until the bottom tier is reached. Individuals at the bottom tier have no direct reports. The hierarchical organization consists of a maximum of five tiers (d , where d is an integer between 2 and 5); see figure 3 for details.

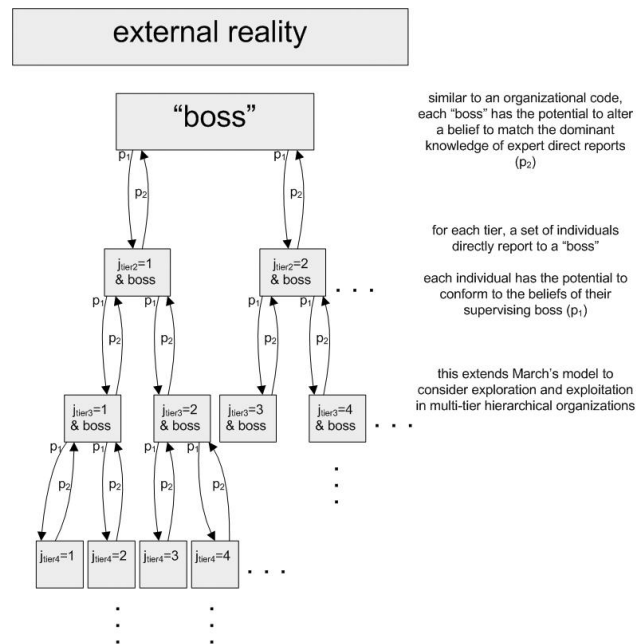


Figure 3. Extension of March's Original Model to Consider a Multi-Tier Hierarchical Organization

In this first extension, each individual retains the potential to conform to the knowledge of the supervising boss (p_1) and each boss retains the potential to match the dominant knowledge of expert direct reports (p_2). Personnel turnover (p_3) and environmental turbulence (p_4) are retained for this extension. The knowledge equilibrium of a multi-tier hierarchical organization is now best defined as the convergence of individual knowledge levels to a stable equilibrium. Such an extension to the model is simple, intuitive, and with precedent. Learning in hierarchical organizations has been considered in other models (Carley, 1992; Carley & Lin, 1997; Rivkin & Siggelkow, 2003), but no research to date has expressly advanced March's seminal model for such purposes, and only a few have considered the effect of turbulence. Kane and Prietula did make an extension to March's model, but for a two-tiered hierarchy only. Their research did not consider a multi-tier hierarchical organization, nor did their model include the effects of turnover and turbulence (Kane & Prietula, 2003; Weingart & Prietula, 2005). The proposed extension has the advantage of allowing for initial validation and subsequent extension of all constructs contained in March's model (Burton & Obel, 1995).

Second, another extension is made to March's model to consider the effect of a *knowledge management* system collecting knowledge from a set ratio of experts. Organizational structure can be defined as the flow of information and the connections between individuals (Lin & Hui, 1997). This can be linked to a second perspective, where individual users can be conceptualized as social actors who interact with information systems and both influence and are influenced by social dimensions of these interactions (Cummings, 2004; Lamb & Kling, 2003). Inherent to the structure of a hierarchical organization is that individuals report to different bosses, potentially producing fragmented connections in terms of the flow of information and organizational learning (Mayer & Gavin, 2005; Singh, 2005). In this second extension, fragmented connections can be predicted to introduce a knowledge flow delay in an organization, where the time (i.e., number of iterations) required for individual knowledge levels in an organization to reach a stable knowledge equilibrium increases as the number of tiers (d) in the hierarchical organization increases (Benner & Tushman, 2003; Schulz, 2001).

In terms of cumulative research value, hierarchies remain the basic structure of most large, ongoing human organizations (Jaques, 1990; Leavitt, 2003). Similarly, collecting and sharing expert knowledge has been shown to produce a long-term competitive advantage for an organization (Alavi & Leidner, 2001; Lee & Choi, 2003; Tsai, 2001). Recent research has conceptualized varying organizational structures as different networks of social individuals whose position in the network can influence knowledge transfer and organizational learning (Hansen, Mors, Løvås, 2005; Inkpen & Tsang, 2005; Lee, Lee, & Lee, 2003). By extending March's stylized model to account for hierarchical organizations, the effect of additional tiers in

can be tested and linked to March's original constructs of exploration, exploitation, turnover, and turbulence. Additionally, this study affords for systematic examination of two dimensions of a knowledge management system: the effect of increasing or decreasing the probability of learning from a knowledge management system and the effect of collecting knowledge from a wider or narrower ratio of expert individuals.

HYPOTHESES

This study considers four experiments. The first experiment serves to verify March's original model. The second experiment evaluates the effect of additional tiers (d , modeled as a number from 2 to 5) in a hierarchical organization on the veracity of average individual knowledge levels with external reality (the outcome variable of interest). This second, novel investigation incorporates March's original constructs of exploitation ($p1$), exploration ($p2$), turnover ($p3$), and turbulence ($p4$) as defined earlier.

- H1: In multi-tier hierarchical organizations, additional tiers will decrease the veracity of average individual knowledge when an organization opts for a strategy of high exploitation and low exploration.

Justification for this first hypothesis is that a strategy of high exploitation does not consider whether the entity embodying the knowledge to be shared is an expert, only that the knowledge set of this entity should be spread. In contrast, a strategy of high exploration only considers the knowledge of the top expert(s) in a group and does not consider the knowledge of individuals who are not in the pool of experts. Thus, as the number of tiers in a hierarchical organization increase, exploration has an advantage over exploitation.

- H2: In multi-tier hierarchical organizations, increasing turnover (within the values of 0.000 to 0.040) will increase the veracity of average individual knowledge; increasing turbulence (within the values of 0.000 to 0.040) will decrease the veracity of average individual knowledge.

Justification for this second hypothesis is that hierarchical organizations are built to maintain a sense of order and internal knowledge. As such, when faced with turbulence, multi-tier hierarchical organizations (compared to flat organizations) are bad at rapidly changing their internal knowledge to match changes in external reality. In contrast, turnover can introduce new knowledge that can be incorporated to update the internal knowledge of an organization.

The third experiment evaluates the effect of increasing or decreasing the probability of learning from a knowledge management system (pKM) and the effect of collecting knowledge from wider or narrower ratios of expert individuals (rEX) on the average knowledge equilibrium. This third, novel investigation considers a knowledge management system as an organizational code containing the consensus of a number of expert individuals in the organization. Such an approach mirrors March's single organization code from which all individual can potentially learn (i.e., pKM for a flat organization is analogous to $p1$, exploitation).

- H3: Increasing the probability of learning from a knowledge management system (pKM) past the midpoint value of 0.5 will decrease the veracity of average individual knowledge.
- H4: Widening the ratio of expert individuals (rEX) whose knowledge consensus is included in the knowledge management will decrease the veracity of average individual knowledge.

Justification for this third hypothesis is that if a knowledge management system is similar to an organizational code and pKM is analogous to exploitation, then beyond a certain point additional use of a knowledge management system will hurt an organization rather than help it. Similarly, if the value of a knowledge management system is in its ability to provide expert knowledge, widening rEX to broaden the definition of expert individuals in the organization will decrease the value of a knowledge management system. A knowledge management system that simply provides the consensus of all individuals in an organization is not useful because no specific person is identified as an expert.

The fourth experiment performs two regressions on two additional sets of sample data. For each regression, 6,000 random samples are drawn from the total population of all possible organizational strategies.

EXPERIMENT 1: VERIFICATION

For the purposes of replication and validation of March's model, a two-tier hierarchical organization is generated. The simulation runs for 200 iterations for three different values of individual learning ($p1 = 0.1; 0.5; 0.9$) and for three different values of organizational learning ($p2 = 0.1; 0.5; 0.9$), similar to the original model. The absence and presence of turnover ($p3 = 0.00; 0.02$) is considered alongside the absence and presence of turbulence ($p4 = 0.00; 0.02$). Each simulation is repeated 40 times, accounting for the stochastic properties of the original model. The qualitative results of this initial scenario confirm March's original observations: there is a central dichotomy between exploitative and explorative organizational learning strategies.

An exploitative strategy (p_1) represents refinement of existing competencies in an organization, with predictable short-term returns. Conversely, an explorative strategy (p_2) represents experimentation with new alternatives in an organization, with uncertain long-term returns. Though both strategies occur independently, finding an appropriate balance between the two is a primary factor in determining the veracity of average individual knowledge with external reality. An organization with a misaligned exploitation and exploration knowledge strategy will quickly lose its relevancy. Further, under conditions of turbulence ($p_4 = 0.02$) with no turnover ($p_3 = 0.00$), the mutual learning between organizational and individual knowledge levels produces a long-term degenerative effect. Organizational and average individual knowledge levels converge to match each other, reducing the possibility for either to change to approximate external reality with greater veracity. Once a knowledge equilibrium is achieved, the probability for organizational or average individual knowledge to change becomes zero since all individuals now share the same exact knowledge. Such knowledge degeneracy can be avoided if there is turnover. Introducing naïve individuals can expose the organization to new knowledge.

EXPERIMENT 2: EXTENSION

For the purposes of extending the original model, a hierarchy of multiple organizational codes (i.e., bosses) is considered. The number of tiers (d) is an independent variable and is evaluated in tandem with the number of individuals reporting to a single boss (b). Four different hierarchical organizations are considered ($d = 2$ and $b = 132$; $d = 3$ and $b = 11$; $d = 4$ and $b = 5$; $d = 5$ and $b = 3$), each representing an organization with approximately 136 individuals. Organization size does not vary over time. For example, a three-tiered hierarchical organization with each boss having 11 direct reports represents 133 individuals in an organization $= \Sigma(b)^{k-1}$, from k to d ; k initially set to 1. Similar to March's model, initial knowledge elements for individuals without any direct reports are randomly distributed (i.e., either -1; 0; +1), whereas the knowledge elements for bosses (distinct organizational codes with direct reports) are all initially neutral (i.e., set to 0). Bosses have the possibility of exploratory learning (p_2) from an expert direct report with the highest number of knowledge elements matching that of external reality. In the event of tied experts, the boss selects one of the top individuals randomly.

On average, a knowledge strategy of high exploitation ($p_1 = 0.5$) and low exploration ($p_2 = 0.1$) in the absence of no turnover ($p_3 = 0.00$) reduces the veracity of average individual knowledge with external reality for a hierarchical organization, as compared to alternative strategies. Such a finding is significant only when a knowledge strategy of high exploitation and low exploration is considered for a multi-tier hierarchical organization. March's original model did not observe such a finding since it considered only a flat organization. For a flat organization with only one organizational code (i.e., $d = 2$), this study finds no significant difference between such a knowledge strategy of high exploitation and low exploration, compared to a strategy of either high exploitation ($p_1 = 0.5$) and high exploration ($p_2 = 0.5$) or a strategy of low exploitation ($p_1 = 0.1$) and high exploration ($p_2 = 0.5$). Such results concur with March's findings. However, for a multi-tier hierarchical organization ($d = 3, 4$, or 5), in the absence of turnover, this study does find a significant difference between such a knowledge strategy of high exploitation and low exploration, when compared to the aforementioned alternatives. High exploitation and low exploration for a multi-tier hierarchical organization *reduces* the veracity of average individual knowledge. The different studies are evaluated by employing post-hoc t-tests at the 0.05 significance level to compare average individual knowledge levels after 200 iterations; see figure 4 for details.

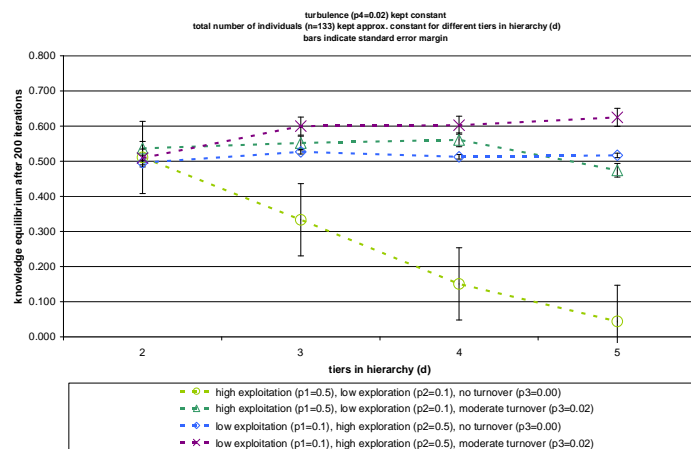


Figure 4. Effect of Tiers in a Hierarchy on Organizational Knowledge Equilibrium; Constant Turbulence

Curiously, keeping all other variables constant, increasing the number of tiers in a hierarchical organization *increases* the reduction in veracity. In the absence of turnover, a five-tiered hierarchical organization ($d = 5$) will see a greater reduction in veracity from a knowledge strategy of high exploitation and low exploration, compared to a three-tiered hierarchical organization ($d = 3$) with approximately the same number of individuals employing the same strategy.

EXPERIMENT 3: KNOWLEDGE MANAGEMENT

For the purposes of evaluating knowledge management strategies, two variables are examined: the effect of increasing or decreasing the probability of learning from a knowledge management system (pKM), and the effect of collecting knowledge from wider or narrower ratios of expert individuals (rEX). Three probabilities are considered for the likelihood of individuals learning from a knowledge management system (pKM = 0.01; 0.05; 0.09). These values represent low, moderate, and high values of reliance on a knowledge management system and are similar to values chosen by March to test differences between exploitation and exploration in his original model. Three different ratios of expert knowledge collected also are evaluated (rEX = 1%; 10%; 100%). As before, the different studies are evaluated by employing post-hoc t-tests at the 0.05 significance level to compare average individual knowledge levels after 200 iterations.

On average and keeping all other variables constant, increasing the likelihood of individuals learning from a knowledge management system (pKM) increases the veracity of average individual knowledge in the presence of turnover ($p3 = 0.02$) when combined with a strategy of high exploitation ($p1 = 0.5$) and low exploration ($p2 = 0.1$). Notably, this is the only instance where an increase in pKM improves the veracity of average individual knowledge. In contrast, increasing pKM reduces the veracity of average individual knowledge in either the presence or absence of turnover when combined with a strategy of low exploitation ($p1 = 0.1$) and high exploration ($p2 = 0.5$). Increasing pKM also reduces the veracity of average individual knowledge in the absence of turnover when combined with a strategy of high exploitation and low exploration; see figure 5 for details.

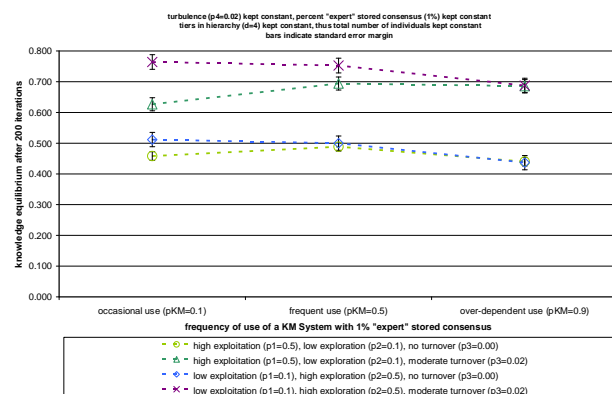


Figure 5. Effect of Frequency of Use of a KM System on Organizational Knowledge; Constant Turbulence

Perhaps predictably, on average and keeping all other variables constant, increasing the ratio of expert knowledge collected (rEX) reduces the veracity of average individual knowledge in an organization. Attempting to discern true knowledge through majority consensus results in all knowledge strategies converging to 0.500 (i.e., only half of the knowledge elements held are correct).

EXPERIMENT 4: REGRESSION

To alleviate concerns that the findings of this study could be a result limited to its definition of low, moderate, and high levels of different constructs, a fourth experiment is performed in which 6,000 random samples are drawn from the total population of all possible organizational strategies. Exploitation ($p1$) and exploration ($p2$) are random numbers ranging from 0.1 to 0.9. Turnover ($p3$) and turbulence ($p4$) also are random numbers ranging 0.000 to 0.040 (to three decimal places). The number of tiers (d) for different hierarchical organizations varies, with the veracity of average individual knowledge (Y) as the dependent variable.

Prior to performing the first regression, normality of the data is assessed by observing plots of the variables $p1$, $p2$, $p3$, $p4$ vs. Y . After performing the regression, the normality assumption is rechecked by observing a plot of the residuals (expected Y - predicted Y) and a Q-Q plot of standardized residuals. All plots indicate normality. The effects of the different variables are approximately linear. No auto-correlation to the residuals is observed.

A weighted least-squares regression is performed. Justification for this approach stems from the standard errors observed in Experiment 2, where the variance of the residuals increases as the number of tiers (d) increase. A plot with the number of tiers on the X-axis and the standardized residuals on the Y-axis provides additional justification: variance in the error term increases as the number of tiers increase. It should be noted that such heteroscedasticity is expected. As the number of tiers increase in an organization, so do the number of bosses with direct reports. Additional bosses result in additional fragmentation of knowledge with an organization, leading to increased variation of knowledge throughout the organization; see figure 6 for details.

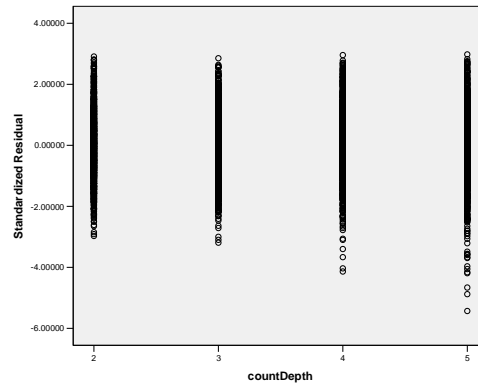


Figure 6. As Expected, Variance of the Standardized Residuals Increases with Number of Tiers (d)

The observed heteroscedasticity is adjusted by performing a weighted least-squares regression with the number of tiers (d) as the weight, thus adjusting the variance of the residuals to be approximately equal.

The first regression does not consider the effect of a knowledge management system, only the effect of the number of tiers in the hierarchical organization. An interaction term is included between exploitation (p1) and the number of tiers in the hierarchical organization (d), based on the results of Experiment 2. The resulting first regression produces an adjusted- R^2 of 0.376 with all coefficients highly significant at p-values < 0.05, including the interaction term. Checking the variance inflation factors for the regression demonstrate some correlation between (p1) and the interaction term (p1 times d), which is expected but not alarming as the diagnostics are below the critical value for concern. The main effects of exploitation (p1) and exploration (p2) are both positive, with exploitation somewhat greater in magnitude. The main effect of turnover (p3) is positive, while the main effect of turbulence (p4) is negative. These observations are consistent with March's original observations and support hypothesis H2.

More importantly, the interaction term (between p1 and d) is negative, with a magnitude roughly one-third the value of the main effect of exploitation. The effect of exploitation on the veracity of average individual knowledge depends on the number of tiers in an organization. This is consistent with Experiment 2 and hypothesis H1, where *increasing exploitation has negative consequences for multi-tiered organizations, but not for flat organizations* (d = 2); see figure 7 for details.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.658	.006		117.572	.000		
	probP1	.170	.014	.300	12.330	.000	.176	5.688
	probP2	.124	.006	.215	21.039	.000	1.000	1.000
	probP3	2.118	.118	.182	17.875	.000	1.000	1.000
	probP4	-5.646	.118	-.488	-47.876	.000	.999	1.001
	interactP1Depth	-.055	.003	-.446	-17.104	.000	.153	6.549
	countBreadth	-.001	.000	-.297	-21.028	.000	.520	1.922

a. Dependent Variable: corrOrgCMatch

b. Weighted Least Squares Regression - Weighted by countDepth

Figure 7. First Regression; Y = Veracity of Individual Knowledge; Number of Tiers (d) as Weight

A second regression is performed to consider the additional effects of increasing or decreasing the probability of learning from a knowledge management system (pKM) and the effect of collecting knowledge from wider or narrower ratios of expert

individuals (rEX). Again, normality of the data is assessed by observing plots. The observed heteroscedasticity in the error term is adjusted by performing a weighted least-squares regression with the number of tiers (d) as the weight.

The second regression considers the effects of a knowledge management system. Again, an interaction term is included between exploitation (p1) and the number of tiers in the hierarchical organization (d), based on the results of Experiment 2. The resulting regression produces an adjusted- R^2 of 0.165 with all coefficients significant at p-values < 0.05. The variance inflation factors are below the critical value for concern.

Importantly, pKM and rEX are both negative as predicted by H3 and H4. On average, increasing either pKM or rEX decreases the veracity of average individual knowledge. Though smaller than the coefficients reported in the first regression model without a knowledge management system, p1 and the interaction term (between p1 and d) are similar and sign and approximate scale compared to one another, consistent with Experiment 2 and the first regression. Equally, the coefficients for p3 and p4 are now smaller; supporting the idea that *a knowledge management system both lessens the negative effects of turbulence, but also replaces the positive effects of turnover in an organization*; see figure 8 for details.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.656	.007		94.340	.000		
	probP1	.050	.014	.099	3.510	.000	.177	5.650
	probP2	.031	.006	.061	5.185	.000	.999	1.001
	probP3	.260	.124	.025	2.096	.036	.999	1.001
	probP4	-2.675	.124	-.254	-21.504	.000	.998	1.002
	interactP1Depth	-.007	.003	-.066	-2.183	.029	.154	6.499
	countBreadth	.000	.000	-.052	-3.165	.002	.519	1.926
	probKM	-.068	.006	-.133	-11.230	.000	.998	1.002
	ratioExperts	-.111	.005	-.265	-22.464	.000	.999	1.001

a. Dependent Variable: corrOrgCMatch

b. Weighted Least Squares Regression - Weighted by countDepth

Figure 8. Second Regression; Y = Veracity of Individual Knowledge; Number of Tiers (d) as Weight

CONCLUSIONS

This study extends March's stylized model to account for hierarchical organizations. In the absence of turnover, a knowledge strategy of high exploitation and low exploration reduces the veracity of average individual knowledge for a multi-tier hierarchical organization. Keeping all other variables constant, increasing the number of tiers increases this reduction in veracity. This study potentially is limited in its approach by considering simulated data, however this is in alignment with March's original model and perhaps the only way to consider the consequences of different exploitation and exploration strategies for more than 6,000 different organizations. Two additional approaches are planned by the author: a survey and an experimental investigation as to the variables influencing knowledge management success.

From this study, a theoretical implication is that multi-tier hierarchical organizations that rely on a heavy "top-down" exploitative strategy, combined with little or no turnover, may not be ideal for adjusting to turbulent environments. Traditionally, such organizations have been justified as being best suited for maintaining their own internal knowledge or organizational code (e.g., or most military or government institutions). This study supports such a premise, but also demonstrates that when confronted with a rapidly changing external reality, heavy "top-down" exploitative hierarchical organizations may not be sufficiently agile to maintain their veracity with a changing, external reality.

Moreover, increasing the likelihood of individuals learning from a knowledge management system has value only in the presence of turnover combined with a strategy of high exploitation and low exploration. In all other instances, increasing the likelihood of individuals learning from a knowledge management system reduces the veracity of average individual knowledge. Likewise, increasing the ratio of expert knowledge collected produces a similar reduction. Thus, another implication is that knowledge management efforts should seek to collect and share expert knowledge only from the top 1% of individuals, and organizations should employ a knowledge management system for selective cases vs. moderate or frequent use. If overused, a knowledge system can preclude exploratory organizational learning. An exception occurs when a hierarchical organization relies on a heavy "top-down" exploitative strategy with little exploratory learning. In such a case, one method to counteract the negative consequences of heavy exploitation is to encourage personnel turnover coupled with balanced use of a knowledge management system providing expert insights of the top 1% of individuals.

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REFERENCES

1. Alavi, M. and Leidner, D. (2001) Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues, *MIS Quarterly*, 25, 1, 107-136.
2. Benner, M. and Tushman, M. (2003) Exploitation, Exploration, and Process Management: The Productivity Dilemma revisited, *Academy of Management Review*, 28, 2, 238-256.
3. Burton, R. and Obel, B. (1995) The Validity of Computational Models in Organization Science: From Model Realism to Purpose of the Model, *Computational and Mathematical Organization Theory*, 1, 1, 57-71.
4. Carley, K. (1992) Organizational Learning and Personnel Turnover, *Organization Science*, 3, 1, 20-46.
5. Carley, K. and Lin, Z., A Theoretical Study of Organizational Performance Under Information Distortion, *Management Science*, 43, 7 (1997) 976-997.
6. Cummings, J. (2004) Work Groups, Structural Diversity, and Knowledge Sharing in a Global Organization, *Management Science*, 50, 3, 352-364.
7. Hansen, M., Mors, M., and Løvås, B. (2005) Knowledge Sharing in Organizations: Multiple Networks, Multiple Phases, *Academy of Management Journal*, 48, 5, 776-793.
8. Inkpen, A. and Tsang, E. (2005) Social Capital, Networks, and Knowledge Transfer, *Academy of Management Review*, 30, 1, 776-793.
9. Jaques, E. (1990) In Praise of Hierarchy, *Harvard Business Review*, 68, 1, 127-33.
10. Kane, G. and Prietula, M. (2003) Influence and Structure: Extending a Model of Organizational Learning, *Proceedings of the North American Association for Computational Social and Organizational Science*, Pittsburgh, PA.
11. Lamb, R. and Kling, R. (2003) Reconceptualizing Users as Social Actors in Information Systems Research, *MIS Quarterly*, 27, 2, 197-235.
12. Leavitt, H. (2003) Why Hierarchies Thrive, *Harvard Business Review*, 81, 3, 96-102.
13. Lee, H. and Choi, B. (2003) Knowledge Management enablers, Process, and Organizational Performance: An Integrative View and Empirical Examination, *Journal of Management Information Systems*, 20, 1, 179-228.
14. Lee, J., and Lee, J., and Lee, H. (2003) Exploration and Exploitation in the Presence of Network Externalities, *Management Science*, 49, 4, 553-570.
15. Lin, Z., and Hui, C. (1997) Adapting to the Changing Environment: A Theoretical Comparison of Decision Making Proficiency of Lean and Mass Organization Systems, *Computational and Mathematical Organization Theory*, 3, 2, 113-142.
16. March, J. (1991) Exploration and Exploitation in Organizational Learning, *Organization Science*, 2, 1, 71-87.
17. Mayer, R. and Gavin, M. (2005) Trust in Management and Performance: Who Minds the Shop While the Employees Watch the Boss? *Academy of Management Journal*, 48, 5, 874-888.
18. Rivkin, J. and Siggelkow (2001) N., Balancing Search and Stability: Interdependencies Among Elements of Organizational Design, *Management Science*, 49, 3, 290-311.
19. Schulz, M. (2001) The Uncertain Relevance of Newness: Organizational Learning and Knowledge Flows, *Academy of Management Journal*, 44, 4, 661-681.
20. Singh, J. (2005) Collaborative Networks as Determinants of Knowledge Diffusion Patterns, *Management Science*, 51, 5, 756-770.
21. Tsai, W. (2001) Knowledge Transfer in Intraorganizational Networks: Effects of Network Position and Absorptive Capacity on Business Unit Innovation and Performance, *Academy of Management Journal*, 44, 5, 996-1004.
22. Weingart, L. and Prietula, M. (2005) An Exploration-Exploitation Model of Negotiation, *Proceedings of the Annual Meeting of the Academy of Management*, Honolulu, HI.