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# Digital Transformation Barriers and Their Impact on Organizational Innovation

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## Abstract

Organisations undertaking digital transformation encounter barriers of several kinds, including skills shortages, legacy systems, cultural resistance and financial constraints, and these barriers are typically catalogued as a list without attention to how they combine. This paper proposes a model in which barriers differ in their mechanism, interact with one another, and are conditioned by organisational slack, and examines the model in a simulation harness of 700 organisations whose innovation output is generated from the hypothesised process. In a linear specification, the skills barrier has the largest negative effect on innovation (−2.69 per unit of intensity), followed by the cultural barrier (−2.28), the legacy-systems barrier (−1.02) and the financial barrier (−0.72); together they explain 72.5% of the variance. Adding interaction terms raises explained variance to 76.6% and reveals that the skills and cultural barriers compound (interaction −1.89) and that organisational slack neutralises the financial barrier (interaction +1.08). A flexible learner's permutation importance confirms the dominance of skills and culture. The paper argues that barrier assessments should be configurational, that the skills–culture pair should be addressed jointly, and that financial barriers are best understood as a lack of slack rather than of budget. Implications for transformation programme design and for field research on barriers are developed.

**Keywords:** digital transformation; barriers; organisational innovation; skills; organisational culture; organisational slack.

## I. Introduction

Digital transformation initiatives fail or stall at high rates, and surveys of executives consistently attribute the difficulty to a recurring set of barriers: a shortage of digital skills, legacy information systems that resist change, organisational cultures that resist new ways of working, and financial constraints on investment [1], [2]. The barriers are real, but the way they are usually studied, as a ranked list of obstacles, obscures two things that matter for action: that barriers operate through different mechanisms and so call for different remedies, and that barriers interact, so that removing one may have little effect while another remains.

The outcome of interest in this paper is organisational innovation, understood as the introduction of new or substantially improved products, services and processes. Digital transformation is instrumental to innovation because digital technologies expand the space of feasible products and processes [3], and barriers to transformation therefore translate into barriers to innovation. The paper proposes a model in which four barrier types affect innovation through distinct mechanisms, two of them compound, and the financial barrier is moderated by organisational slack [4]. The model is examined in a simulation harness with a known process to establish its logic and estimability, and implications for programme design and field research are drawn.

## II. Literature Review

### *A. Barriers to digital transformation*

Reviews of digital transformation [1] identify inertia, in the form of existing resources and routines, and resistance, in the form of employee opposition, as the main obstacles. Skills shortages recur as the most cited barrier in practitioner surveys. Legacy systems create technical debt that raises the cost of every subsequent change. Cultural barriers include risk aversion, functional silos and hierarchical decision-making. Financial barriers are most often reported by smaller organisations.

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### B. Barriers and innovation

The innovation literature has long studied obstacles to innovation, distinguishing cost, knowledge and market barriers and finding that perceived barriers are often higher among firms that innovate more, because innovators encounter obstacles that non-innovators never reach [5]. This finding cautions against cross-sectional interpretations of barrier surveys and motivates the use of a controlled design in which barrier intensity is exogenous.

### C. Organisational slack and complementarity

Organisational slack, the pool of resources in excess of what current operations require, buffers organisations against constraints and funds experimentation [4]. Slack should therefore moderate the financial barrier: an organisation with slack can fund transformation despite tight operating budgets. Complementarity theory [6] implies that some barriers compound: skills shortages are more damaging in cultures that do not support learning, because such cultures neither attract skilled staff nor develop them.

### D. Mechanisms by barrier type

The four barrier types operate through different mechanisms, which is why their effects should not be expected to be equal. The skills barrier constrains absorptive capacity: without staff who understand digital technologies, an organisation cannot recognise, assimilate or exploit opportunities that the technologies create. The cultural barrier constrains the willingness to act on opportunities that are recognised, by penalising experimentation and failure. The legacy-systems barrier raises the cost and time of each change but does not prevent the organisation from conceiving it; it is a friction rather than a block. The financial barrier limits the scale of investment but, where slack exists, can be circumvented by reallocating resources. On this reasoning the capability barriers, skills and culture, should dominate, and the resource barriers, legacy and finance, should be smaller and more easily offset, which is the content of H4.

## III. Research Model

Innovation output $I$ is modelled as a function of four barrier intensities, skills ($S$), legacy systems ($L$), culture ($C$) and finance ($F$), each on a 0–1 scale, and organisational slack ($K$):

$$I = \beta_0 - \beta_S S - \beta_L L - \beta_C C - \beta_F F (1 - K) - \beta_{SC} S \times C + \varepsilon. \quad (1)$$

Hypotheses: H1, each barrier reduces innovation; H2, the skills and cultural barriers compound ($\beta_{SC} > 0$); H3, slack attenuates the financial barrier; H4, the skills and cultural barriers have larger effects than the legacy and financial barriers, because they constrain the capacity to use technology rather than the technology itself.

## IV. Simulation Design

The harness generates 700 organisations with independent uniform barrier intensities and slack on [0, 1], and innovation from Equation (1) with $\beta_0 = 5$, $\beta_S = 2.0$, $\beta_C = 1.5$, $\beta_L = 1.0$, $\beta_F = 1.2$, $\beta_{SC} = 1.5$ and noise SD 0.6. Three analyses are run. A linear regression of innovation on the four barriers estimates main effects. A regression adding the skills–culture product, the finance–slack product and slack estimates the interactions. A gradient-boosting model with permutation importance provides a specification-free check on which inputs matter. Parameters are design values that encode the hypotheses; the harness establishes that the model's structure is recoverable from data of plausible size.

## V. Results

### A. Main effects

Table I reports the linear estimates. All four barriers reduce innovation (H1). The skills barrier has the largest coefficient (−2.69), followed by culture (−2.28), legacy (−1.02) and finance (−0.72), supporting H4. The linear model explains 72.5% of the variance. The skills and culture coefficients exceed their design values of 2.0 and 1.5 because the omitted interaction term loads onto them, which is what a linear specification does when barriers compound.

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### B. *Interactions*

Adding interactions raises $R^2$ to 76.6%. The skills–culture interaction is −1.89, confirming H2: the marginal damage of a skills shortage grows with cultural resistance. The finance–slack interaction is +1.08, confirming H3: slack offsets most of the financial barrier. Figure 1 shows the compounding visually. Innovation declines with the skills barrier in both cultural conditions, but the decline is far steeper when the cultural barrier is high, and at high skills-barrier intensity the gap between cultural conditions is roughly twice its size at low intensity.

TABLE I. LINEAR AND INTERACTION ESTIMATES OF BARRIER EFFECTS ON INNOVATION OUTPUT (700 SIMULATED ORGANISATIONS).

| **Term** | **Linear model** | **Interaction model** |
|---|---|---|
| Skills barrier | −2.69 | included |
| Legacy-systems barrier | −1.02 | included |
| Cultural barrier | −2.28 | included |
| Financial barrier | −0.72 | included |
| Skills × culture | — | −1.89 |
| Finance × slack | — | +1.08 |
| $R^2$ | 0.725 | 0.766 |

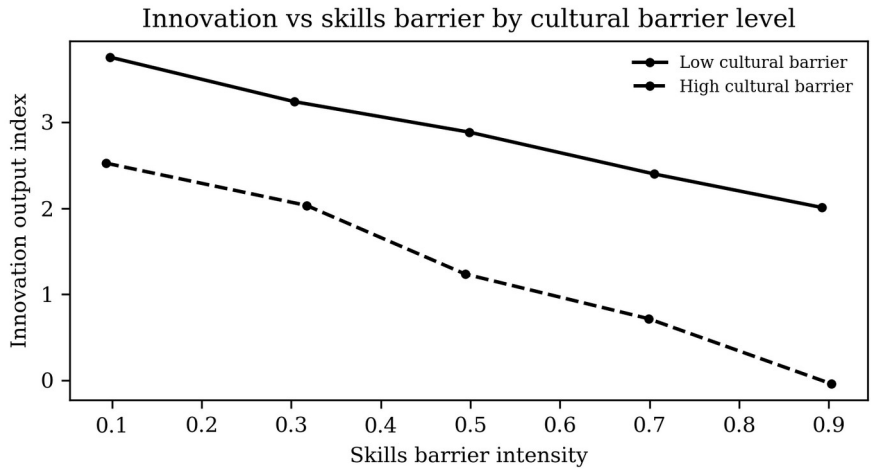


Fig. 1. Innovation output against skills-barrier intensity in organisations with low and high cultural barriers.

### C. *Specification-free check*

Permutation importance from the gradient-boosting model ranks skills (0.86) and culture (0.65) far above legacy (0.15), finance (0.09) and slack (0.07). The ranking agrees with the regression results and confirms that the dominance of the two capability-related barriers is not an artefact of the linear functional form.

### D. *Model comparison*

The improvement in $R^2$ from 72.5% to 76.6% when interactions are added is modest in absolute terms but substantively important, because the interaction terms change the interpretation of the main effects. In the linear model, the skills and culture coefficients absorb the compounding effect and appear larger than their design values; in the interaction model, their main effects return toward the design values and the compounding is attributed to the product term. A researcher relying on the linear model would conclude correctly that skills and culture matter most but would miss that they are jointly, not separately, the problem.

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## VI. Discussion

### A. Barriers as configurations

The results argue for assessing barriers as a configuration rather than a list. An organisation with a moderate skills barrier and a low cultural barrier is in a different position from one with the same skills barrier and a high cultural barrier, even though a ranked list would score them alike on skills. Programme design should begin by mapping the barrier profile and identifying compounding pairs.

### B. Addressing skills and culture jointly

Because the skills and cultural barriers compound, remedies that address one without the other underperform. Hiring digital talent into a culture that does not support experimentation leads to attrition of that talent; culture-change programmes without skills development produce enthusiasm without capability. Integrated interventions, such as cross-functional digital teams with protected time for learning and visible executive sponsorship, address both.

### C. Financial barriers as slack deficits

The moderation result reframes the financial barrier. Organisations report it as a lack of budget, but the model locates its effect in the absence of slack, that is, of resources that can be redirected without disrupting current operations. Remedies include ring-fenced transformation funds, staged investment with option value, and partnerships that provide capability without capital outlay, all of which create slack rather than budget.

### D. Implications for field research

Field studies should measure barriers as intensities rather than presence, include slack as a moderator, test the skills–culture interaction explicitly, and address the endogeneity noted in Section II-B by using panel data or by measuring barriers before innovation outcomes are observed. The simulation indicates that the hypothesised interactions are detectable with several hundred organisations.

### E. Sequencing barrier removal

The compounding structure suggests an order for barrier removal that differs from the order in which barriers are usually reported. Because the marginal effect of reducing the skills barrier is larger when the cultural barrier is high (the interaction term), and vice versa, an organisation facing both should expect the first intervention to show modest returns and the second to show larger ones. Programme sponsors who evaluate interventions one at a time will therefore underestimate the first and may abandon it prematurely. Evaluation should be planned over the pair rather than the individual intervention.

### F. Barriers over the transformation lifecycle

Barrier salience changes as transformation progresses. Early stages encounter financial and legacy barriers most visibly, because initial investments and system replacements dominate the agenda; later stages encounter skills and cultural barriers, as the organisation attempts to exploit what it has built. The simulation is cross-sectional and cannot show this progression, but the model's structure is consistent with it: the resource barriers determine whether transformation starts, and the capability barriers determine whether it produces innovation.

### G. Measurement of barrier intensity

Translating the model into a field instrument requires that each barrier be measured as an intensity on a common scale. Skills can be measured as the gap between required and available competencies across a defined set of digital roles; legacy as the share of core processes dependent on systems that cannot be modified without vendor involvement; culture through validated scales of risk tolerance, cross-functional collaboration and learning orientation; finance as the share of transformation needs that cannot be funded from approved budgets; and slack as the proportion of resources that could be redirected within a planning cycle. Multi-informant measurement is advisable, since barriers are perceived differently by executives, IT staff and line managers, and the perception gap itself may be informative about the cultural barrier.

## VII. Limitations

The harness generates innovation from the hypothesised model with independent barrier intensities, so it demonstrates recoverability rather than testing the hypotheses, and it abstracts from the endogeneity that affects real barrier surveys. Only one compounding pair and one moderation are modelled. The coefficients and $R^2$ values are simulation outputs and should not be read as empirical estimates.

## VIII. Conclusion

Digital transformation barriers differ in mechanism and interact. In a controlled simulation of the proposed model, skills and cultural barriers dominated innovation outcomes, compounded one another, and were only partly captured by a linear specification, while organisational slack neutralised the financial barrier. Transformation programmes should assess barrier configurations, treat skills and culture as a joint problem, and create slack rather than merely budget. Field research should adopt interaction-aware designs to test these propositions.

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