The Functionality Model

An experiment to expose paradigm formation

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Abstract

The discipline of Management of Technology must harness its epistemological assets to solve problems forthcoming from the lack of technology acuity in management circles. Set within a Kuhnian frame of reference, this paper presents an experiment that is to test the Functionality model as a particular theory of Management of Technology. Should the experiment succeed as scientific exercise, it leaves to Management of Technology a much enhanced theoretical foundation, from where to create, convey and promote technology knowledge as a commendable paradigm standard.

Key words

MOT; technological acuity; Functionality model; paradigm; theory; experiment; hypothesis; variables; validity; reliability; *t* statistic.

1. Introduction

Management of Technology (MOT) is a young and multi-disciplinary subject field, but evidence suggests that wider recognition of its bona fides, and its further development, are impeded by a lack of paradigm support. There are a number of competing theories and models in MOT with the potential to elevate the discipline into a trajectory of paradigm formation. One of these is the Functionality model, presenting the characteristics required from a paradigm construct to help MOT evolve from its current position as a fledging discipline into a prospering and generally accepted management discipline, which presents to its students and practitioners a set of exemplary practices and solutions. This paper accordingly describes a research design which intends to test the Functionality model as a particular theory of MOT. The paper subsequently shares insight into the formulation of hypotheses, it describes a methodology for empirical data collection and analysis, and concludes with a description of the statistical process seeking evidence in support of the scientific hypothesis.

2. The scientific hypothesis versus the research hypothesis

2.1 The role of theory

Does the Functionality model as depicted in Table 1 meet the requirements of good theory, so that it may help MOT evolve into a paradigm?

Table 1: The Functionality model

		Action		
		Process	Transport	Store
Output	Matter (M)			
	Energy (E)			
	Information (I)			

Source: Van Wyk, 2004:34

Kuhn (1977:321-322) states the requirements for good theory. Taken altogether, theory must help to create, maintain and expose reliable and valid knowledge of a particular intellectual domain under examination. So, the central research question pursued here is to assess whether the Functionality model succeeds to create and convey technological acuity in a manner consistent with the requirements for good theory.

The role of theory stands central in paradigm formation. According to Christensen (1997:34), facts accumulated with the scientific process must be integrated and summarized in the form of a theory to provide adequate explanation of observed behavior. Intrinsic to theory activity are models, because they show how variables interact in theory (Figure 1):

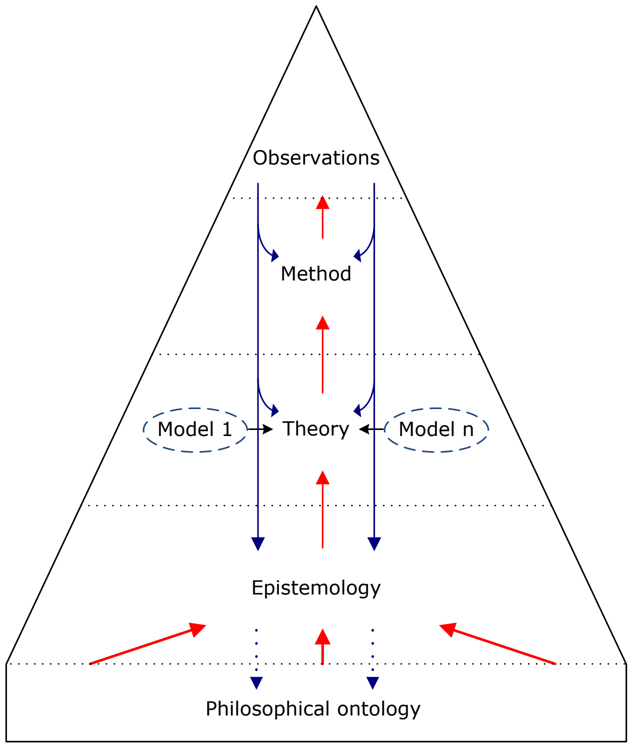

Figure 1: Paradigm structure
Source: Author's own

With the support of models, theory helps to formalize and solidify knowledge in an epistemological foundation, from where it should serve as a basis for formulation of hypotheses to be tested empirically. The outcomes of these tests reciprocate by reinforcing and building out epistemology.

2.2 Research hypotheses

Normally a null hypothesis of no difference is juxtaposed to a scientific hypothesis. The null hypothesis must meet the criterion of being able to be either refuted or confirmed. Therefore, the null hypothesis for this research is that the Functionality model makes no difference to levels of technological acuity. Against this, the scientific hypothesis is that the Functionality model does make a difference in levels of technological acuity.

3. Defending variables

3.1 Selecting variables

Having stated the research question and having subsequently specified a null hypothesis, the researcher is logically led to selection of a set of variables to serve in the intended research experiment. Typically, an independent variable of which the effect is observed is stated against a dependent variable - the variable which measures the effect of the independent variable. According to Christensen (Ibid.:193) the independent variable is to be manipulated by the researcher, because it is postulated to be a cause of the presumed effect on the dependent variable. In its turn, and given its task to measure the presumed effect of the variation of the independent variable in this particular research project, the dependent variable is metric, so it can vary in its amount; and it is continuous, so it can be represented by whole and fractional units on an interval or ratio scale. Consequently, the independent variable for this project is the *Functionality model*, whereas the dependent variable is *technological acuity*, with the postulated relationship depicted below:

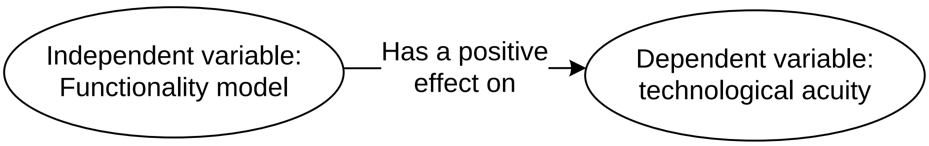

Figure 2: The scientific hypothesis
Source: Author's own

Given a corpus of research material on the Functionality model as construct, the obvious mechanism to translate it into concrete operational terms is a formal lecture about its philosophical roots, theoretical base and practical MOT applications.

3.2 A control group experiment

The selected technique to induce variation in the independent variable is *Presence versus Absence* (Christensen, IBID.:194), which means that one group of randomly selected research participants will receive the formal lecture about the Functionality model, whereas a second group will not. Both groups are then evaluated on their technological acuity, so as to assess whether the experimental group which did receive the lecture achieves results that differ statistically from the control group which did not receive the lecture.

3.2.1 *Construct validity of the independent variable*

Will the two levels of variation in the Functionality model lead participants in the experiment to exhibit different levels of technological acuity as postulated in the scientific hypothesis? Christensen (Ibid.:207) defines construct validity as the "…extent to which the…conceptual variable of interest can be inferred from the operational definition of that construct." To achieve construct validity, the Functionality model must be clearly defined, structured and presented in the lecture, and the lecture must be validated by a suitably qualified panel of experts. This should ensure that the learning event as operational definition of the Functionality model optimally achieves the variation anticipated in the dependent variable.

3.2.2 *Reliability and validity of the dependent variable*

Christensen (Ibid.:217) refers to reliability as consistency, and to validity as measuring what is in fact intended to be measured.

Reliability of the dependent variable is established by determining the consistency with which responses are made on the dependent variable. This experiment is planned as a single-occasion event, but the lecture about the Functionality model will be presented as a pretest, and the results will be analyzed with Cronbach alpha, as will be the results of the formal learning event. According to (1999) and Welman and Kruger (2001:141), Cronbach's alpha is a widely used statistical test for reliability of a measurement tool. Cronbach's alpha ranges in value from 0 to 1, and the rule of thumb is that a measurement tool should only be used if an alpha value of 0.70 or higher is obtained. According to Garson (2005) though, a lenient cut-off of 0.60 is common in exploratory research.

Is the dependent variable valid? Does it measure the construct intended to be measured? Does the dependent variable embody an answer to the question of *what is technological acuity*? Most opportune to this study, Van Wyk (2008b:8) presents a theoretically sound architecture for the MOT body of knowledge (MOTBOK). Lochner and Wyk (2009) confirms the epistemological bona fides of this very first conceptualization of MOTBOK, demonstrating that it is and acts as epistemology proper, focusing on two substantive issues at the heart of MOT problem solving, i.e. what MOT practitioners do; and what they need to know as practitioners (Figure 3).

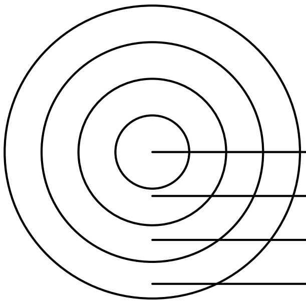

Figure 3: The MOT body of knowledge
Source: Van Wyk, 2008b:8

The Functionality model and the insights it generates about technology are found at the centre. From here, its repeated application as model solution projects knowledge about the technology landscape to MOT practitioners. This overview confirms that technological acuity indeed has an ontological foundation with argued intellectual substance. It is confirmed to represent the dependent variable.

3.2.3 *Internal validity of the experiment*

The influence of variables such as *intelligence, interest, learning ability, fatigue* and *motivation* cannot be removed from this experiment, nor can they be kept constant across the two levels of the independent variable. To ensure that the independent variable produced the observed effect as shown by the dependent variable (Christensen, OP CIT.:229), the potential confounding influence of these extraneous variables are to be controlled with the random assignment of participants into the two groups in this experiment. To control for experimenter effect, a computerized evaluation to measure technological acuity is considered. This should improve control, ensure data integrity and minimize participant-experimenter interaction during evaluation.

4. Research design

Given the aforementioned considerations, the *After Only* research design (Christensen, Ibid.:323) is proposed as the optimal mechanism for data collection. Also known as the *two-group post-test only randomized* experiment, this design plays a major role in various research applications where comparison is required after an intervention. Participants are first randomly assigned to two groups, after which the independent variable is administered to the experimental group. Both groups are then post-tested on the dependent variable. The differences between the means for the experimental and the control group are tested statistically to assess the impact of the independent variable. This design is depicted in Figure 4:

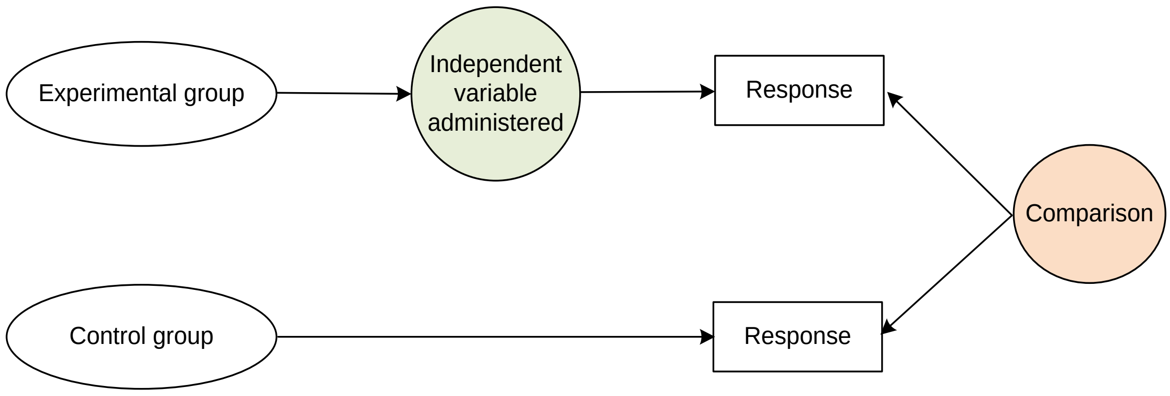

Figure 4: The before-after research design
Source: Adapted from Christensen (IBID.:323)

5. Data collection

5.1 Sample size

What is the minimum sample size to obtain results with an acceptable degree of confidence for an experiment testing the knowledge creating and learning power of an evolving theory such as the Functionality model? Given limited resources, the goal is to achieve a needed level of precision with least cost, framed within the recommended sample size for experimental research. A general approach would be to follow Christensen (IBID.:417) and Thiétart (2001:187) in their recommendation for a small sample given the preliminary and experimental nature of this research. A key requirement hereto is however to aim for homogeneity in the sample, since more variance necessitates larger samples. At the same time, however, it reduces external validity and freedom to generalize the results, even if internal validity remains a priority for experimental research. An economic approach still meeting requirements for internal and external validity suggested by Thiétart (IBID.:164) is to do a small sample first and test for significance, and to follow up with more small samples, as long as either location or population changes. The focus will however remain on internal validity for the PhD phase of this research.

5.2 Selection and assignment of participants

Evidence suggests there is an embedded need for MOT in MBA courses as well as in management as organizational process. Therefore, the designated sample population is the global pool of MBA students, but they are not the experimentally accessible population. The best response to this built-in bias is to stratify by selecting the total collection of full-time MBA's at a particular business school, or selection of business schools, and to randomly assign participants from this sampling frame to respectively the experimental and control groups. Should a significant effect from a management science point of view not be found, the option remains to expand the same experiment to other business schools.

6. Data analysis and hypothesis testing

At this point in the research, the collected data must be processed and analyzed to test the scientific hypothesis with an appropriate statistical test. According to Christensen (IBID.:448) and Cryer and Miller (1994:485), the Two-Sample *t* Statistic is most appropriate for analysis of test data obtained from two different groups. This test determines whether the difference in the group means is so large that it cannot reasonably be ascribed to chance. This requires that the experiment be designed so as to deliver metric data on statistics such as the median, mean and standard deviation. Should a significant difference not be found, the experiment will have failed to reject the null hypothesis. Such an outcome must however be judged within the criteria set for a null conclusion. Conversely, the null hypothesis may have to be rejected in favour of the scientific hypothesis, which would mean that the Functionality model does have an effect on technological acuity. In the hypothetical deductive method this increases the probability that the Functionality model may be ready to take its place in MOT as a paradigm-supporting theory, but it is a result which remains subject to further tests with alternative hypotheses which are more likely to be true and to provide better support for the Functionality model as a theory of MOT.

7. Conclusion

This research project is designed to show how the Functionality model leverages theory dynamics to help with paradigm formation for MOT. This will help to propel MOT into a trajectory of wider appeal and wider management application, which again may lead the discipline's methodologies and tools to be accepted as a set of standard and exemplary solutions by the MOT community of practitioners. This, according to the Kuhnian understanding of scientific revolutions, may help MOT to achieve paradigm status.

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