

The Utility of the Hayes and Wheelwright Four Stage Model in a UK Context

Operations Strategy Track

Abstract

This paper reports on research aimed at operationalising the Hayes and Wheelwright 4-Stage model. This model has classic status in operations management but seems little tested in practice. A questionnaire derived from the model was administered in a large-scale postal survey of managers in a variety of UK manufacturing and service organisations. Analysis of the responses indicates that managers seem to have difficulty in classifying the strategic role played by their operations in an internally consistent and coherent manner. Although the questionnaire itself may have shortcomings, the results question the utility of the model and raise concerns about its validity.

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Introduction

Hayes and Wheelwright's four-stage model (1984), describing the possible strategic roles played by an organisation's manufacturing function has attained classic status (Sower, 1997). With Chase and Hayes's (1991) subsequent adaptation for service operations, the model has achieved widespread acceptance, becoming ubiquitous in the operations management curriculum. It has an attractive simplicity and high face validity. However, the empirical research from which the model was developed seems to derive exclusively from large US corporations in the late 1970s and early 1980s. There seem to have been few subsequent attempts to test its practical application. This paper reports on research aimed at operationalising the model and testing its utility in a variety of UK organisational contexts (including manufacturing and services, profit seeking and not for profits). The paper opens with a discussion of the Hayes and Wheelwright four stage model (the H & W model), identifying both its attractions and its shortcomings. The development of a questionnaire aimed at assessing an organisation's operations in terms of the H & W model is outlined and the results of a postal survey of managers in UK based organisations are then presented. Initial conclusions are drawn and future work outlined.

Background

The 1970s and 1980s were problematic for US industry. *"American society experienced a deepening sense of malaise... a series of jolts ... had eroded both its role in the world and its self-image.... In 1971, imports of manufactured goods into the United States exceeded manufactured exports for the first time in almost a century, and this imbalance persisted for 10 of the next 12 years.... Several of the country's key industries were sent reeling by the onslaught of foreign competition"* (Hayes and Wheelwright, 1984 p.1). Against this backdrop, and influenced by Skinner (1969), Abernathy (Hayes and Abernathy, 1980), and other operations management academics, Hayes and Wheelwright concluded that the root cause of the malaise was a failure to manage manufacturing strategically. Their model gave managers a *"descriptive framework for understanding how their manufacturing organisations are contributing to overall strategic goals, as well as the ... contribution those organisations could be asked to make"* (Wheelwright and Hayes, 1985, p.99). This latter point emphasises that the model is as much prescriptive as descriptive, presenting the four stages as a ladder to be ascended. The subtext underlying the H & W model was that US manufacturers needed to adopt superior Japanese management practices (Schonberger, 1983; Pascal and Athos, 1981). Only by becoming Stage 4 organisations, like their Japanese counterparts whose operations were managed strategically (Wheelwright, 1981), could US manufacturers stem the tide of foreign competition.

It is not clear precisely what empirical evidence the H & W model was based on, as no details of the "extensive field work" cited as the basis for their work (Wheelwright and Hayes, 1985 p.99) are disclosed. The organisations mentioned are large US corporations like Hewlett-Packard, McDonald-Douglas and Proctor & Gamble (Hayes and Wheelwright, 1984), General Electric, IBM, and Texas Instruments (Wheelwright and Hayes, 1985). Chase and Hayes (1991) do include both some non-US (e.g. SAS) and not for profit organisations (e.g. LAPD) examples. However their prime focus is large US profit seeking corporations, like American Airlines, J.C. Penney, and Bank of America. Neither do these works detail the methodology used in the research. Some organisations are cited as "research and test sites" (Wheelwright and Hayes, 1985 p.ix) implying the use of primary data gathering through a case study approach. However, the extensive references used, especially by Chase and Hayes (1991) indicates that many secondary data sources were also used.

Additionally, it is unclear how an organisation's operations are classified in accordance with the four-stage model. The introduction of the now influential categorisation of *structure* - capacity, facilities, technology, vertical integration, and *infrastructure* - workforce, quality, production planning and organisation (Hayes and Wheelwright, 1984 p.31) recognises the complexity of manufacturing strategy. Wheelwright and Hayes (1985) go on to acknowledge the difficulty of assessing an operation's level in accordance with the model by declaring, "A given operation may be - and often is - composed of factors that are themselves at different levels of development. What determines the overall level of the operation is where the balance among these factors falls" (p.100). How this "balance" between the factors is determined is not explained. Is it on the basis of whatever stage had the majority of the factors, or are some factors more important than others are? It seems that the H & W stage for an operation must be determined subjectively. Given this basis, it is surprising that the model has not been subject to much academic criticism within a subject with a strongly positivist methodological tradition. However, anecdotal evidence from operations management teachers suggests the model is particularly attractive to practitioners, who usually find it easy at a conceptual level to assign an H & W stage to their own organisation.

To be useful at more than a high level of abstraction, and especially if it is to be used to move to a higher strategic level, managers need an instrument to diagnose their operation's position on the model at a more detailed level. Such an assessment of the operation's position in a range of factors (e.g. quality, technology, etc) could then be used as the basis for setting specific improvement priorities. Thus, the first objective of this research was to operationalise the H & W model by developing a questionnaire to assess the strategic role of an operation, overall and also to assess specific operational factors.

Literature

There have been few reported attempts to empirically test the H & W model. In work exploring links between manufacturing strategy and organisational culture (Mistereck et al, 1992; Bates et al, 1995), a Likert type questionnaire was used to categorise 41 US manufacturing plants according to the H & W model, using multiple respondents in each plant. In an attempt to operationalise the H & W model as a manufacturing audit tool, Hum and Leow (1996) developed a questionnaire (using a five point rating scale) based on Hayes et al's (1988) manufacturing strategy decision areas. This questionnaire was then applied to 55, mostly large (over half with over 500 employees) Singaporean electronics companies. Newman and Hanna (1996) employed the four-stage concept to investigate the linkages between environmental management and manufacturing strategy. They report the results of an exploratory survey, in which 19 (presumably US) respondents indicated which stage of the H & W model best described their company through "mostly open-ended questions". Hum (2000) extends and applies the H & W model to a service context (a Singaporean third party logistics company) in a single case study based on an interview with its Managing Director. For a 'classic' model, these are a very limited data set, few in number, and restricted in their contexts.

Methodology

Of the three possible purposes for a research study - description, explanation and testing (Meredith et al, 1989), this work falls within the latter category. The research seeks to test the utility of the H & W model in a large number of different organisational contexts. A self-administered questionnaire is an appropriate method of capturing data from large numbers of respondents and facilitates the use of statistical analytic techniques. This type of research is firmly in the rationalist paradigm, which is appropriate for testing or verifying existing theory

(Meredith, 1998). Calls for more empirical research in operations management have led to an upsurge in the use of questionnaire-based survey methodologies over the last decade (e.g. Filippini, 1997; Scudder and Hill, 1998; Malhotra and Grover, 1998), and this is now the most commonly used methodology in empirical operations management research.

To remain true to the spirit of the H & W model, the questionnaire developed 33 statements from the original texts (Hayes and Wheelwright, 1984; Wheelwright and Hayes, 1985; Chase and Hayes, 1991). Wording was screened to ensure maximum acceptability within the UK context, especially for services, not-for-profits (NFP) and public sector organisations, incorporating terminology and language that would be as context-neutral as possible. The statements, requiring an *agree*, *disagree* or *uncertain* response, were presented in a random order. The questionnaire was piloted with a sample of twenty middle managers drawn from a variety of British organisations and amendments made as a result of their comments.

With hindsight a number of criticisms can be levelled at the questionnaire. Firstly, there is an imbalance of the number of questions per stage. It would seem neater, and more logical, to have a statement on each operational topic for each stage of the model. This would also have made subsequent data analysis easier. In defence, it can be argued that this imbalance arises from attempting to reflect both the letter and the spirit of the original texts. A second criticism is that the question topics do not cover the full range of Hayes and Wheelwright's (1984) own manufacturing strategy decision areas. However, the original articles do not attempt to equate the various operational factors to these strategic decision areas in any systematic way. Finally, a more sophisticated response mechanism, such as a 5 or 7 point Likert scale might have been used. This was rejected to remain true to the spirit of the original articles and to simplify a respondent's task to encourage a high response rate.

The main motivation in the design was to create a self-diagnosis instrument for practising managers. External analysts (e.g. management consultants) can offer detachment and objectivity, but they can be prohibitively expensive. The questionnaire tries to strike a balance between simplicity and sufficient detail than that offered by a "You'll know it when you see it" overview, to enable reasonably well informed managers to systematically assess the strategic contribution of their own operations, overall and in detail.

Results

460 responses were received from a sample of 1356 students (a response rate of 34%) on executive education programmes at the researchers' universities. These were typically mid-level operational managers, arguably well placed to provide information about their organisation's operations. Of the 390 mostly UK based organisations represented: 66% were commercial service providers, 19% were manufacturers and 15% were NFPs, 47% had annual sales of over £100million, 56% had more than 1000 employees, 76% were multi-site operations. Data was analysed using SPSS, supplemented by EXCEL. Initial examination of the data revealed that no respondent totally agreed with all the statements in only one stage. Only 15 respondents agreed with all the statements in any one of the four stages. Responses were usually spread across all four stages. Many respondents revealed inconsistencies by having, for example, an 'agree' response to more than one statement on a single factor (e.g. technology). Cluster analysis failed to reveal any significant underlying clusters in the data.

To advance the analysis some broad, inevitably subjective, decision rules, were developed to enable each respondent's organisation to be assigned to one 'dominant' stage. Firstly, it was decided to require the minimum number of positive responses required to classify a

questionnaire in a particular stage to be between 50% and 60% of the total statements for that stage. Secondly, as it was felt that some statements were more significant than others, one or two 'acid test' statements were identified for each stage. Thus, in order to classify a questionnaire in one of the H & W stages required a positive response to the relevant acid test statement, and an additional minimum number of positive responses for the relevant stage. This methodology enabled 36 organisations to be classified as Stage 1, 27 as Stage 2, 112 as Stage 3 and 71 as Stage 4. Thus, it was only possible to classify 246 responses (out of 460). Since each data sub-set was analysed separately it was possible for an individual questionnaire to appear in more than one stage. In this way, 42 respondents could be classified into two stages and 5 into three stages. Alternative decision rules could be adopted. However, if any of these different decision rules require positive responses to only one acid test statement, the number of organisations classified according to the H & W model is bound to be reduced to less than the 246 obtained under the existing methodology.

The main finding from this analysis was therefore problematic. Using relatively relaxed criteria in the decision rules only just over half of the respondents had provided sufficiently consistent responses to enable their organisations to be classified into only one dominant stage of the H & W model. So, although there is some evidence of a dominant stage as predicted by the model, there is a high level of ambiguity and inconsistency amongst the responses. In particular, many of the respondents exhibit patterns of inconsistency with regard to other stages. For example, a respondent in a Stage 1 organisation can still offer a number of responses that place the organisation, not in an adjacent category, but in Stage 3 or 4.

Discussion

Data analysis is continuing, but the results to date raise questions about the model. The key issue is why can only around half of the sample be categorised according to the H & W model? Conversely, why do the other half of the sample exhibit no underlying pattern of response within the H & W framework? Possible answers might arise from:

Problems with the questionnaire: As discussed above, the design of the questionnaire can be criticised. Terminology could have been problematic for some respondents leading to ambiguous responses. However, considerable care was taken to make the questionnaire as suitable as possible for a British audience whilst remaining true to the original articles.

Problems with respondents: There are three issues here. Firstly, may be some respondents did not fully understand the questionnaire. However, as middle managers and management students who had been exposed to the H & W model, they ought to have a good understanding of the terminology used. Secondly, may be some respondents did not have an adequate level of knowledge of operations to be able to answer adequately. However, the 'uncertain' response provides for this eventuality. (The level of uncertain responses was typically around 10%). Thirdly, may be some wanted to present their organisation in the best possible light. As such, they may have offered 'aspirational' responses, that is telling it like they think it should be or how they expect it to be rather than how it is. There is a caution not to do so in the questionnaire rubric, but the relatively high number of Stage 3 and 4 responses obtained does raise suspicions in this respect. Any of these three cases raises questions about the usefulness of the model to practising managers.

Problems with their organisations: It may be that some organisations are 'unusual', making it difficult to apply the underpinning H & W concepts. After all, the model seems to have been

developed within the context of large US profit seeking manufacturers. Although the organisations are diverse in many respects, they do not seem atypical of UK organisations more broadly. Also, the H & W model, especially as modified by Chase and Hayes (1991), should be relevant to all organisations. Thus any problems arising from the characteristics of the organisation may say more about the applicability of the model to the UK context rather than the organisations themselves.

Problems with the model: Analysis to date suggests a number of possible problems with the model itself. Firstly, a significant number of respondents agreed with more than one 'acid test' statement. This should not be possible if the model is meaningful to managers. Secondly, there is a high level of inconsistency across operational factors, with respondents assigning different factors (e.g. technology, quality) to different stages. Whilst the H & W framework predicts this, the extent to which it might occur and still permit one dominant overall stage classification is unclear. Thirdly, there is a high level of inconsistency within the operational factors. In some instances it is logically inconsistent to agree with more than one statement. For example, you can not logically agree with the statements "Our quality is highly variable because we concentrate on cutting costs" and "We continually improve our quality and so we raise the expectations of our customers". However, in other instances there is scope for more ambiguity. For example it might be possible to agree with both the statements, "We expect our operations workforce to maintain efficiency by following set procedures" and "We look to our operations workforce to develop innovative new ways of working". A number of such ambiguities can be identified. These strike at the heart of attempts to operationalise the H & W model, at a detailed level. Without detail, the model is only useful at a conceptual level, potentially appearing superficial to practising managers, who need to consider operational detail if they are to develop practical improvement plans. This all raises serious doubts about the utility of the model as a practical tool for operational analysis.

It may be possible to address these concerns by, for example, further development of the questionnaire. However, the analysis raises doubts about the validity of the model. As discussed above, the model was originally developed from data from large US profit seeking manufacturing organisations in the 1980s. It is unclear if the model has been validated outside of that context. With the changes taking place over the past twenty years, it seems opportune to re-examine the model. This research suggests that, in a UK context at least, there are serious doubts about the utility and possibly the validity of the model.

Next Stages of the Research

These preliminary conclusions need to be treated cautiously as further detailed analysis of the data is still being carried out. This will include investigating the impact of using other sets of decision rules. For example, the 'acid test' statements could be used as the sole test for assigning questionnaires to particular stages, with questionnaires remaining in the stage in which they were first filtered out. However, for respondents agreeing with more than one acid test statement, the order in which this analysis is performed is crucial (i.e. it could be done in 1-2-3-4 stage order or 4-3-2-1). The analysis will also investigate whether the model works best for certain types of organisation by testing for correlation with various organisational factors (services or manufacturing, size, structure, customer type, and so on). Patterns of inconsistencies can be explored, for example investigating responses that categorise an organisation in one dominant stage, but with some responses in non-adjacent stages. A series of follow up interviews with respondents from three organisations with multiple respondents are also being conducted. These will enable any inconsistencies

between respondents from the same organisation to be explored, together with any difficulties with terminology, ambiguities or misinterpretations in individuals' responses. Managers' competencies to answer questions on specific aspects of operations will also be explored.

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