THE MEASUREMENT OF QUALITY MANAGEMENT LEVELS WITHIN UK CONSTRUCTION SME'S: DEVELOPMENT AND VALIDATION OF TQ-SMART

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Manufacturing and service industries have developed and validated techniques for identifying critical success factors related to the measurement of deploying quality initiatives. However, little research has been undertaken to examine if these techniques can be applied to UK Construction related SMEs. This noted omission has been the motivation for this research project. The main aims of this paper are twofold; firstly, to identify the major constructs of Total Quality Management (TQM) and refine the scales for measuring the constructs, secondly to empirically validate these revised scales. Through a survey of 63 UK Construction related SMEs, this study empirically refines and validates 10 constructs for TQM in construction. The constructs refined in this study are compared with other major quality measurement instruments. The study reports on the operational framework of Total Quality-Self Monitoring and Assessment Rating Tool (TQ-SMART) which can be used to examine the levels of quality management initiatives within UK construction related SMEs. The findings indicate that TQ-SMART is both reliable and valid. This paper concludes by presenting the refined instrument which contributes to the performance improvement tools and techniques as advocated by the Egan (1998; 2002) reports and contributes to the TQM literature by validating the direct and indirect relations among the TQM practices on organisational performance.

Keywords: Total Quality Management (TQM), SME's, Questionnaires, Validation

INTRODUCTION

This paper presents the findings of an ongoing investigation into the application of total quality management within small and medium sized construction organisations. (Chileshe and Watson; 2001, 2003 and Chileshe et al; 2003). The rationale for investigating SMEs is that over 95% of construction companies employ fewer than 10 people, and over 50% of the labour force is self-employed. Small and Medium-sized (SMEs) organisations account for 96% of the number of all organisations in the construction industry by employment. It is evident that excluding such a group from any research would be wrong, because of the important role they have to perform in the economy. Though the figure quoted in this research relates only to the construction industry, on a national scale SMEs account for approximately 99.9% of total UK business and support approximately 87.2% share of UK employment and 75.2 % share of turnover. (DTI, 2002). The significance of the contribution made by the SMEs cannot therefore be overlooked.

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The literature review establishes that much has already been written on TQM in the health care, manufacturing and construction sectors, but the focus has been on the deployment process and the identification of the pitfalls rather than offering solutions to any problematic issues associated with the implementation process. Others studies have focussed on large organisations (McCabe, 1996; Anderson and Sohal, 1999). Furthermore, only those organisations implementing TQM are usually targeted when conducting research. To date no studies have been undertaken to investigate whether the developed and validated instruments used within the manufacturing and service industries for the identification of critical success factors have specifically been applied within the UK construction related SMEs. This has not facilitated the SMEs in achieving a sustainable competitive advantage. Existing studies identified are Hoxley (2000) who developed an instrument for measuring UK Construction professional service quality. However the limitation of that study was its main focus on Chartered Surveyors and Architects, no SMEs or construction organisations involved in the production aspect of the construction process were included. Despite the numerous studies on the measurement instruments used in the manufacturing industry, they are not a substitute for information about specific applicability of these empirical scales in the Construction SMEs environment

The paper is structured as follows; first the major constructs of TQM are identified from an extensive literature review which is followed by modifications, refinements and finalisation of the instruments. Data collection through field surveys is conducted with the findings reported. The procedures and the methods used for testing and validating the TQ-SMART are provided in the second part of the paper and it reports on the three stage continuous improvement cycle which according to Chen and Paulraj (2004) lies at the heart of instrument development process and addresses the following issues; confirmatory factor analysis, undimensionality, internal consistency and validity. Having empirically validated and tested the proposed measuring instrument, the proposed TQ-SMART can then used to measure the levels of TQM, the findings of which are presented in another paper (Chileshe and Watson, 2003).

REVIEW OF LITERATURE AND REFINEMENTS OF EXISTING INSTRUMENTS

A comparison between the Powell (1995) instrument as refined in this study and other empirical quality measurement instruments indicates that all empirical studies have some shortfalls in terms of coverage of the constructs. According to Behara and Gundersen (2001), these shortfalls highlight the fact that Quality Management theory building research is in the mapping/relation building stage. The constructs developed in this study are compared with five other major Quality Measurement instruments. The comparison of Powell (1995) is made with the following instruments; Saraph et al (1989), Flynn et al (1994), Ahire et al (1996), and Black and Porter (1996). The five instruments discussed are comprehensive and posse's higher validity than non-TQM studies. In order to measure the levels of TQM practices within UK Construction related SMEs, the framework developed by Powell (1995) has been selected and refined. The rationale for its selection is that this model set out to determine whether TQM was the source of competitive advantage. Secondly, as argued by Grandzol and Gershon (1998), it encompasses the major constructs of TQM which are omitted in other instruments; furthermore it covers most of the requirements as envisaged by the Latham (1994) and Egan (1998; 2002) reports in improving the efficiency and effectiveness of the Construction Industry.

Comparison with Other Quality Management (QM) Instruments
In this subsection, a comparison of the TQ-SMART and Powell (1995) instruments with four other Quality Management instruments is presented: The Saraph et al (1989) instrument, Flynn et al (1994), Ahire et al (1996) and the Black and Porter (1996). For the purpose of this study, the instrument developed by Powell (1995) to evaluate quality management practices in manufacturing or service organisation was used by refining it through the dropping of items specifically related to Manufacturing.

Rationale for Selecting These Instruments for Comparison
These studies represent the various approaches taken in Quality Management theory development. Furthermore, from the applicability Industry point of view, none of the instruments examined included construction in their samples; they all included either manufacturing or service industries. Of all the instruments only the Saraph et al (1989) and Powell (1995) included both Manufacturing and Services. The omitted construction is identified as the motivation for this research though it is acknowledged that further work by Sharma and Gadenne (2002) did include construction in their sample. The following subsection presents a brief description of the Instruments examined in this study, and then a flowchart showing the various options in selection of the instruments and their justification for selection is presented. The section concludes by presenting the refinements made to the chosen instrument supported by previous studies. Contributions to TQM literature emerging from these revisions are highlighted.

Saraph et al (1989) Instrument (Plant)
Based on the theoretical work of quality gurus, including Deming, Juran, Crosby and Ishikawa. None of the service organisations included construction, more so organisations with less than 1000 employees were excluded as the quality management systems were precluded to be less advanced. One of the main limitations of the study was that it did not consider issues related to Customer Focus and satisfaction, and usage of Statistical Process Control (SPC) satisfaction. The major strength of the instrument is that it had high level of external validity. This was tested in 20 service and manufacturing firms.

Flynn et al (1994) Instrument (Plant)
Published empirically validated scales for integrated quality management. This was based on practitioner and empirical literature which reports on practices in actual use in the US and Japan. They are built on the Saraph et al (1994) study. A major omission of this instrument is that it excluded employee empowerment and benchmarking scales found in Powell's (1995) and Ahire et al (1996) instruments. From the analysis point of view, this study used exploratory factor analysis (EFA) to analyse data from 42 manufacturing plants from three industries and included multiple responses from each facility.

Ahire et al (1996) Instrument (plant)
Ahire et al (1996) made a comparison of the Saraph et al and Flynn et al instruments. They identified, validated and tested 12 constructs based on literature within the manufacturing environment. This was based on a through review of the conceptualisation and empirical literature on TQM. Interestingly enough, both Ahire and the Black-Porter Instruments were published at the same time. In terms of analysis, this study undertook a confirmatory factor approach to the refinement and validation. The focus was on a single industry based on a total of 371 responses from different plants in the automobile parts industry.

Black and Porter (1996) Instrument (Business Unit)
This instrument had the added advantage of using the split-halves test and comparing oblique rotation in the Principal Component Analysis; however the source of scale items was drawn from the Malcolm Baldridge National Quality Award (MBNQA) which is the assessment framework for identifying leaders in quality management in the United States, thus deemed inappropriate for this study.

This Instrument (TQ- SMART) and Powell (1995)
Powell (1995) used the TQM literature as the main literature base. However one of the weaknesses of the Powell instrument is that the sample size was too small to permit generalisation. However in comparing the four instruments, at least the Powell (1995) developed a number of constructs and measures related to continuous improvement and organisation culture which addresses the issues raised in the Latham (1994) and Egan (1998 & 2002). On the other hand, Flynn et al (1994), Black and Porter (1996); and Ahire et al (1996) developed constructs commonly associated with TQM by the Baldrige Award which is more US based as opposed to the Powell Instrument. Only the Ahire et al (1996) and Powell (1995) addressed the benchmarking concept.

Rationale for Selection of Existing Measures
There are various schools of thought as to which route to take. While option one might be desirable where a new concept is being studied, it has its own negatives. For example developing new constructs or scales of measurement is a complex task (Prajogo and Sohal, 2003). In support of Option 2, Tata et al (1999) notes that wherever possible, use pre tested constructs from past empirical studies to ensure their validity and reliability. Furthermore, in order to empirically examine the relationship between TQM implementation and quality performance, a reliable and valid measuring instrument of quality management practices is normally required.

As noted by Fagarasanu and Kumar (2002) and Sousa and Voss (2002), one of the rules for developing an instrument is that, its more economical to search the literature to find an instrument that may be suitable for the study. It's against this background that an extensive literature review was conducted to review existing measurement instruments. The development may draw on empirical data collected to explore the dimensions of the domain under investigation or theoretical knowledge of this domain. Of the two options available, this study opted for the second option and the rationale for that is provided in the next sub section. The following flowchart shown in Figure 1.0 highlights two approaches for developing and validating an instrument.

Justification for Selection
In justifying their usage of Saraph et al (1989) instrument, Motwani et al (1994) argued that this was used because the measures were empirically based and shown to be valid and reliable, and the instrument measured directly or indirectly all the critical success factors identified in their study. Similarly, the studies used represent the various approaches taken in quality management theory development.

Model refinement
There are potentially four possible options involved in the refinement process. These are shown in Figure 1.0 and involve the following methods; Scale Reduction, Dropping Items, Inclusion of New Items and Revising Existing Items. The following subsection provides a discussion of these refinements made to the Powell Instrument and draws on literature review to provide support where other studies have used similar methods.

Scale Reduction: The second modification to the Powell instrument involved the scale measuring the implementation of each practice. Powell utilised a scale involving a six-point interval scale (0-5) where 5 = highly advanced in implementation; 1 = have not begun implementation but intend to; 0 = do not intend to implement). This instrument dropped the last scale as it was argued that those not intending to would not even respond to the questionnaire, furthermore any scale having more than five likert scale risk the chance of losing information and reliability. (Hensley, 1999).

Dropping Items: Model refining may entail splitting potentially confusing items. For example Lai and Cheung (2003) refined the Black and Porter (1995) instrument using that approach. Similarly in this study all the items relating to Manufacturing Flexibility were dropped from the instrument. The construct of Process Improvement was equally dropped as it was closely related to customer focus. Faragarasum and Kumar (2002) note that item deletion when conducted properly can enhance reliability and reduce the size of the questionnaire.

The Construct of Manufacturing Flexibility with its seven associated variables were dropped from the instrument because the Powell Instrument does state that there are specifically meant for the Manufacturing setting, thus excluded as this study was construction specific.

Flexible Manufacturing Construct: 1. Design for Assembly (DFA) or Design for Manufacturability (DMA), 2. A flexible manufacturing system, 3. A just-in-time inventory system, 4. Cellular manufacturing, 5, Process capability studies, 6 Statistical Process Control and 7.Taguchi methods, or Design of Experiments (DOE)

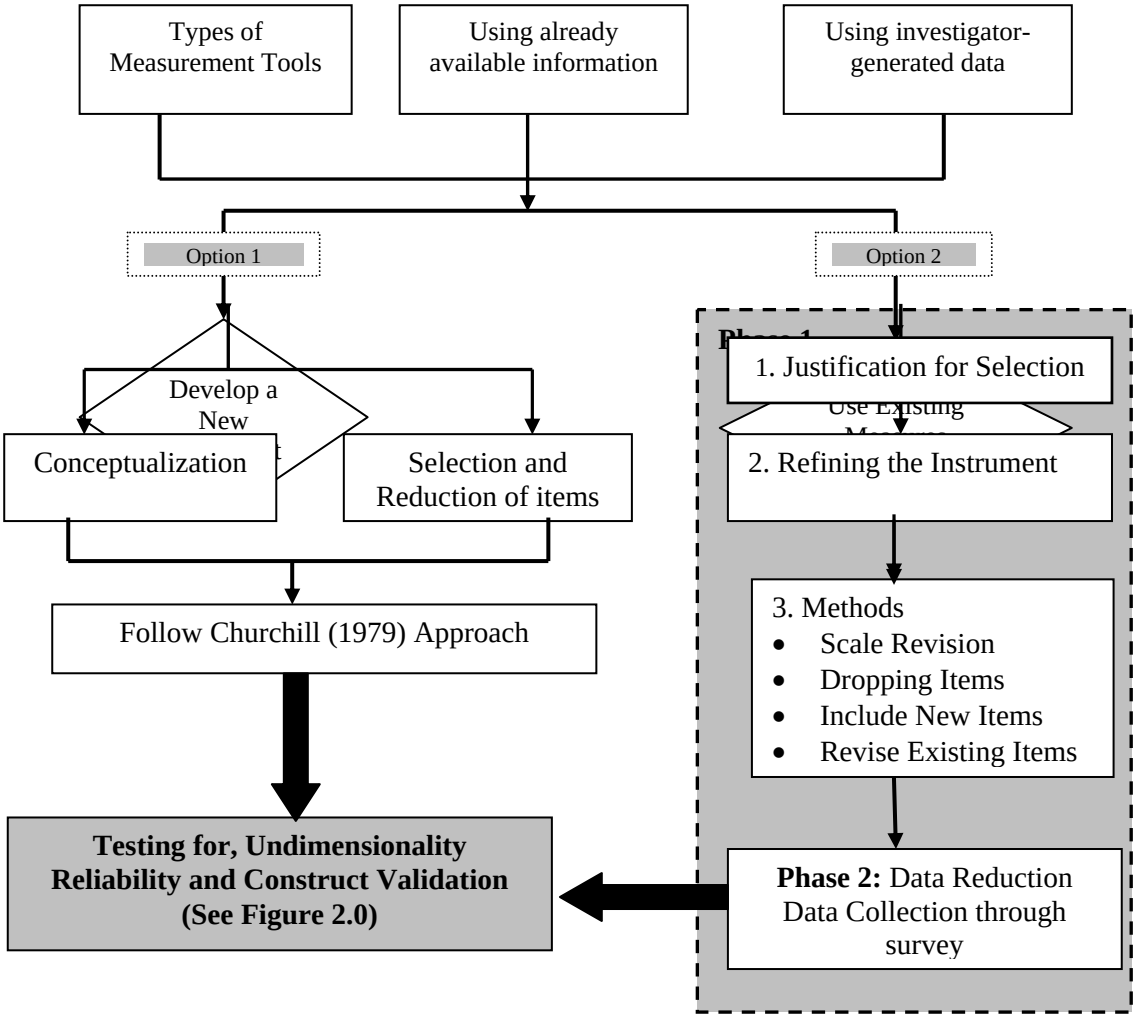

Fig 1.0: Flowchart comparison of developing a new instrument to using an existing one (Author's Interpretation)

The second construct dropped with its associated five variables was that of Process Improvement as the items included were more manufacturing specific. Even though the construct was considered important, an examination of the instrument revealed that process improvement involved accounting for variation either through taking customer and supplier's requirements into account. These needs are already reflected in the Supplier Focus and Customer Focus constructs.

Process Improvement**:** 1. A program to reduce order-process cycle time, 2. A program to reduce new product or service development cycle time, 3. A program to reduce overall product or service delivery times, 4. A program to reduce paperwork and 5. A program to find wasted time and costs in all internal processes

Open Organisation: The Open Organisation construct had its four item scale reduced to three by dropping the following item "frequent use of cross-department teams" as it be would confusing for SMEs especially Sub-Contractors dealing on site. More so, usage of cross-department teams is more prevalent in manufacturing oriented environments.

With the dropping of the two constructs namely Flexible Manufacturing and Process Improvement, and one variable item from the Open Organisation construct, the original instrument now had ten constructs with a total of 34 variables.

Revising Existing Items: The third item of the second construct namely adopting the philosophy read as follows; "Entering a Baldridge Award competition". As this award is specifically meant for US organisations, it was changed to include the EFQM Excellence Model, thus the new revised item read as follows "Entering a European Foundation for Quality Management (EFQM) Award competition".

Renaming Existing Scales: The Closer to Suppliers and Closer to Customers constructs were renamed Supplier Focus and Customer Focus respectively. The rationale behind the remaining was that the word "closer to" didn't capture the full extent of the relationship as it was distance oriented, as such it only provided a vague approximation. On the other hand, the word 'focus' was more specific.

After the above refinements, the original Powell instrument with 12 constructs and 47 items now had 10 constructs with 34 items. Forker et al (1997) in refining the Saraph et al (1989) instrument dropped a total of 16 items from the original instrument; the dropping of 13 items is justified with the above reasons provided.

Previous Studies Using the Powell Instrument

Other studies have that have used the Powell (1995) Instrument are by Dow et al (1999) who extended Powell's work albeit within the manufacturing environment and focussed on larger organisations. Recent studies are by Sharma and Gadenne (2002) who used the Powell instrument in an inter-industry comparison of quality management practices and performance. Their sample included the service, manufacturing and construction organisations. The limitation as with the Powell study was the small sample size of construction organisations (n=20), more so the study was exploratory in nature and the data analysis utilised was regression. On the other hand, this study is different from the two mentioned as it specifically targeted the constructional related SMEs.

SCALE VALIDATION AND EMPIRICAL ASSESSMENT OF TQ-SMART

According to Sureshchandar et al (2002), a critical aspect in the evolution of a fundamental theory in any management concept is the development of good measures to obtain valid and reliable estimates of the construct of interest. The various steps involved in the development and validation of the measurement scale are shown by means of flow chart in Fig. 2.0 Issues in applying the instrument development and validation process illustrated in Figure 2.0 were used to develop the TQ-SMART instrument that satisfies the requirements of reliability, validity and undimensionality. The following sub section describes the process undertaken in meeting the requirements of the steps in the development process.

What is shown in Figure 2.0 is part of the overall steps involved in the development and validation process. The steps not shown are as follows: **Step 1** deals with expounding the theory and concepts that underlie a particular management theory. This involves the review of literature and the identification of the critical dimensions of the TQM constructs. Forza and Filippini (1998) describe this step as the first of the three components of theory. In reality, it can be described as the "what's" in the

development of empirical theory and deals with issues of identification and definition of the concepts. These issues have been presented in the earlier sub sections.

Step 2 involved the design of survey instrument by careful selection of the representative items. **Step 3** dealt with the pre-testing of the instrument, either objectively or subjectively by experts in the field. This is defined as content validity which forms part of the confirmatory factor analysis. **Step 4** is addressed by the modifications, refinement and finalisation of the TQ-SMART instrument which is provided for in the subsection dealing with the review of literature and refinements of existing instruments. Finally but not least, **Step 5** dealt with data collection through a postal survey addressed to 350 Quality Managers of Construction related SMEs within the UK. The survey methodology undertaken in **Step 5** is explained in the following sub section.

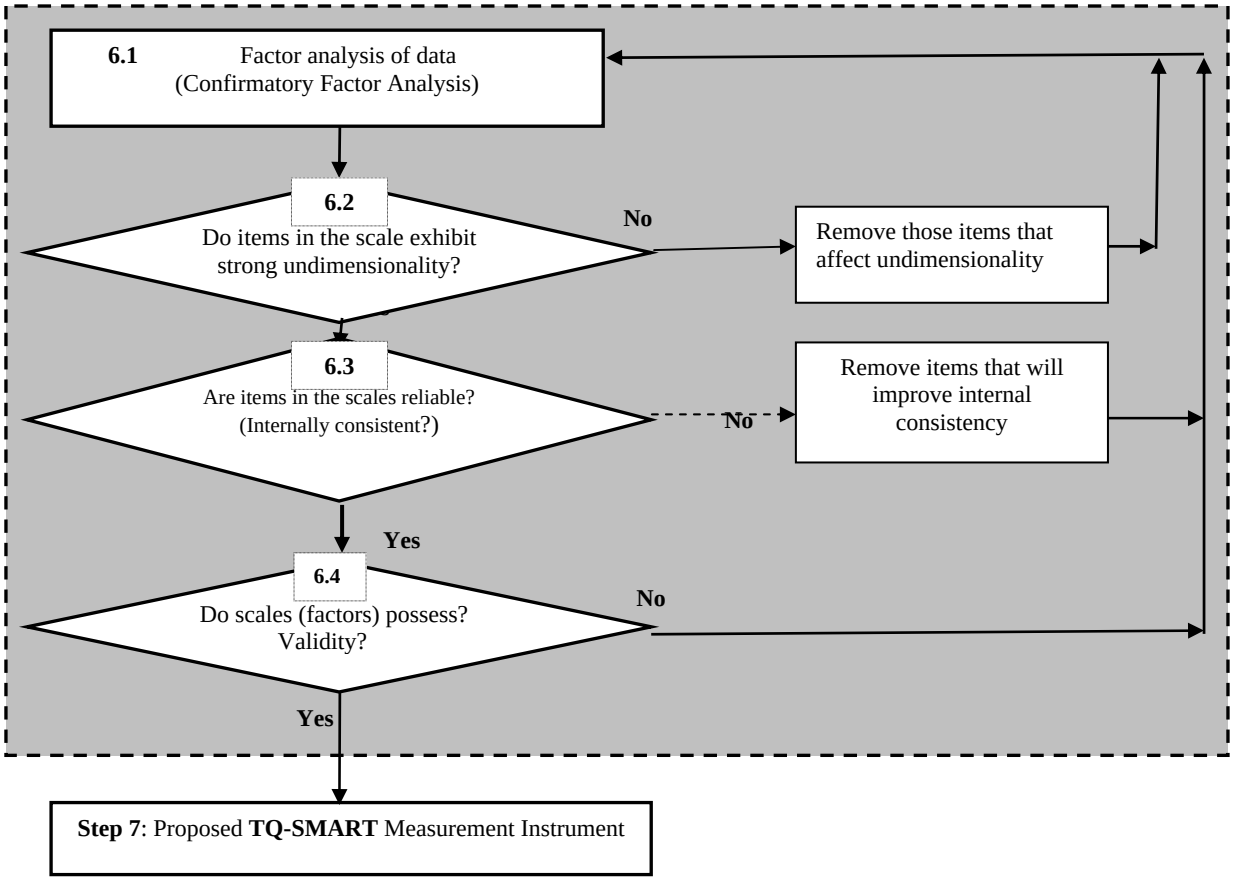

Figure 2.0: Development and validation of the measurement scale
(Source: Adapted from Sureshchandra et al, 2002)

Step 6 involved applying the Confirmatory Factor Analysis Approach**.** This is shown as the shaded box in Figure 2.0 and contains the three-stage continuous improvement cycle which according to Chen and Paulraj (2004) lies at the heart of the instrument development process and addresses the following issues of Confirmatory Factor Analysis.

Undimensionality: This is a mandatory condition for construct validity and reliability checking. In order to check for undimensionality, a measurement model not shown in this paper was specified for each construct and confirmatory factor analysis is run for all the constructs.

Validity Analysis: According to Carmines and Zeller (1979), validity can be defined as the extent to which any measuring instrument measures what it is intended to measure. Even though this measurement instrument is based on a refined scale of Powell (1995), it is tested for validity in the construction environment context which is different from the manufacturing and service oriented industries. Cui et al (2003) used a similar approach in applying the SERVQUAL model to the Asian context, though in the banking sector. **Content Validity** can be examined at the level of the entire instrument and that of individual items (Hyrkas et al 2003). Content validity at the instrument level expresses how the instrument's sub-scale represents the target or content domain being measured. Content validity at the item level measures the target or content domain, which it is supposed to measure. This present instrument has been re-defined and developed based on the detailed analysis of the Powell (1995) instrument thus ensuring validity as the instrument has been previous tested in the manufacturing and service industries. Prior to data collection as indicated in phase 2 of Figure 1.0, the content validity was established by grounding it in literature and **Criterion Related Validity** of the combined set of ten TQM constructs was evaluated by examining the multiple correlation coefficients for the ten measures and an outcome measure of the TQM implementation programme. The multiple correlation coefficient obtained was 0.778 ($p < 0.001$) providing strong evidence of criterion-related validity.

Item Measure Correlations: Saraph et al (1989) showed how the assignment of items to scales should be evaluated. Using the method developed by Nunnally (1988), the correlation of each item with each scale was conducted. The item-score to scale-score correlations are used to determine if an item belongs to the scale as originally assigned by Powell (1995). All values apart from item 3 of the "Adopting the Quality Philosophy" scale were greater than 0.5. As suggested, all items with the value lower than 0.5 indicate the lack of sharing enough variance with the rest of the items in that particular scale therefore would be deleted. In this particular case the item was not deleted in order to have a homogenous scale. As the detailed item analysis results were satisfactory, the remaining 34 items were considered as the final items used in the survey.

CONCLUSIONS

In order to bridge the gap between Construction and the Service/Manufacturing Industries, this study provides UK Construction related SMEs with practical assistance in the area of TQM implementation, and was aimed at identifying TQM implementation constructs, developing and refining an instrument for measuring these constructs, and empirically validating the instrument using data from the UK construction related SMEs. The framework developed by Powell (1995) has been refined and used in this study. The first reason for its selection was provided in the second section of the paper. The contribution of this paper can be summed up under the following areas; testing of instruments and contribution to theory building efforts.

The testing of the existing instruments to measure quality management practice or dimensions typically developed using samples of large companies in a well developed industry such as construction but in a less well studied context such as SMEs. Furthermore this study extends the work of Sousa and Voss (2002), and is the only one that has focussed exclusively on construction, and in particular SMEs. The findings also suggest that it addresses the limited effort in the UK Construction

industry by specifically refining the QM constructs based on construction organisations. It expands the effort of studying SMEs across the UK Construction industry. According to Filippini (1997), in order to support theory development, more attention should be dedicated to comparisons between studies and accumulation of Knowledge. This study achieves this requirement by replicating the Powell (1995) Instrument and comparing the results of this study to different studies which are described in the first part of the paper. It has contributed to TQM-theory building by identifying the constructs associated with TQM, refining the scales for measuring these constructs, and empirically validating the scales

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