Quantitative data and analysis for Construction Research

Monday 21 January 2008
Peter Jost Conference Centre
Liverpool John Moores University

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This research methods forum has been organised to support researchers and doctoral students who use primary or secondary quantitative data in their research. The programme for presentations is given below. Presentations will be supported by brief papers which will be available on registration. Exemplar data sets and audio podcasts of the presentations will also be available after the forum.

10.00 Registration and Coffee

10.15 Welcome and Introduction:
Dr Andrew Ross, Liverpool John Moores University
Prof Paul Stephenson, Sheffield Hallam University

10.30 The problems of measurement and scale development for quantitative research A.D.Ross, Liverpool John Moores University

10.50 Energy Data trend analysis- Dr R J Kirkham, Liverpool John Moores University

11.20 Labour data trends and measurement- David Beaney Northumbria University

11.50 From Questionnaire to data, use of SPSS to manage data sets- Nadim Waafa – University of Salford

12.30 Buffet Lunch

1.15 Construction output and new order statistics in the UK: Measurement, data and reporting. Frances Pottier, Construction Statistician, Department for Business, Enterprise and Regulatory Reform

2.00 Econometric models to forecast demand and supply in the construction industry, (OGC D/C model) Noble Francis, Experian Ltd

2.45 Tea

3.00. Use of SPSS for development of regression models of productivity prediction- Moayad Al Hasan, LJMU

3.20 Use of software for interpreting and presenting results, Amyr Sourani- Liverpool JMU

3.40 Plenary session and close

4.00 Close

If you would like to have a copy of the presentations or listen to the audio recordings of the presentations, please refer to www.bdcm.co.uk

The problems of measurement and scale development for quantitative research

A.D.Ross, Liverpool John Moores University

Introduction

In order to research into social and economic worlds the researcher needs to understand some fundamental aspects of measurement that will be used when collecting and analysing data. This paper explores some of the philosophical aspects of measurement, how scales are used to collect data in its three forms and some lessons that can be used to ensure that the scales are valid and reliable.

In order to make sense of the mass of the world, whether it is economic or social, man has used taxonomies, there are many examples in the scientific word, in botany classifications are used to describe the type of plant, the library systems we use have Dewey decimal systems for organising books, post codes are a form of taxonomy as is the use of the standard Industrial classification system for construction (SIC45). The term, taxonomy comes from the Greek taxis to put things in order. The development of taxonomies involves the recognition of similarities, differences, and then developing categories and rules that can be used in order to place plants, animals, books, homes etc. Essentially development of taxonomies involves splitting sets into subsets and then repeating the process on the subsets. The criteria used to choose the appropriate splits depends on the nature of research, the traditions that exists and are accepted and also what can be recognised. In order to ensure that research is well based a the constructs used should be capable of definition. The definitions of the categories can sometimes be problematic, as language is used and as such logic of measurement is required. The quotation below from Wittgenstein illustrates the difficulty in using language to determine measurements.

If language is to be a means of communication there must be agreement not only in definitions but also (queer as this may sound) in judgments. This seems to abolish logic, but does not do so. -- It is one thing to describe methods of measurement, and another to obtain and state results of measurement. But what we call "measuring" is partly determined by a certain constancy in results of measurement.

The starting position for a theory of measurement

There must be criteria that one can apply to a concept, the criteria can be considered as true or untrue. The object that the theory is to be applied to will have a magnitude and a quantity to be applied to it. The concept of heat can be considered as an interesting example for measurment theory, the researcher knows it exists as it can be experienced and we know from our knowledge of physical science that it can be defiened as an aspect of physical motion within a body of system. However in order to measure heat, one needs a system of measurement which is reliable, that can be used to capture information about a state and then compare this information against known information and then to draw a conclusion about the measured state. This conclusion can then be used to communicate to other parties about the physical state which is reliable.

This simplisistc example can be used to illustate some interesting points about measurement. These are that:

- The units used to measure have to be appropriatley defined and implemented through conventions
- The quality of the definition can be considered as a mathematical representation and the accuracy, reliability and validity
- Measurement scales are simply useful representations of a construct, they should not be considered as unchallengable truths.

Measurement conventions are used all the time and often without really think why we use such conventions, we use miles per gallon rather than gallons per mile, its interesting to observe that this convention still exists even though we buy our fuel in litres, we obviously have a scale in rooted in our history which we can use for comparison. How many people would immediately recognise 0.1137 litres per mile as a fairly economic car, its difficult as we are using mixed conventions and this may well change. The point is that we can choose which conventions we use whether they be a gallons per mile, £/m2 or 1—5 however the convenventions need to have a logical basis and that the measurements can be used to say something about reality.

If a researcher was using a likert scale of 1—5 to capture data on how two different estimators rated the commercial risk of several project, we capture the information and can use two way analysis of variance to draw conclusions about the measurements. This could be used to test a hypothesis about the estimators having similiar ratings of projects by using a two way analsis of variance. This however tells us nothing about commercial risk, the researcher must relate commercial risk to the scale used in the hope that there is a linear relationship with the same slope for each estimator.If the same slope exits then the researcher can use the ANOVA to make inferences about the commercial riskiness of projects (providing all the other statistical assumptions have been met which in this example is highly unlikely!!) Its very important to remember that measurement theory is really concerned with the connection between data and reality in contrast to statistical analysis which is concerned with the connection between data and inference.

The use of measurements of a construct need to be considered very carefully and after long consideration of what others have used. Often even during analysis of the data the researcher can reflects that the data is at the wrong level of measurement, fortunately with packages such as SPSS it is relatively easy to transform the data, from one level of measurement into another more appropriate level. This transformation has of course to have a logical basis. For example in some research considering procurement arrangements and turnover of organisations a wide range of turnover categories was transformed into just three, small, medium and large. However, the scale used in the original measuring instrument captured data at the finest level.

The development of scales

Having consider some of the difficulties in defining taxonomies, determining the rules for membership of categories and the measurement of theoretical constructs the research needs to consider how to develop scales for use in collecting data.

Consider the attributes of the thing being measured, and then consider the "magnitude" of the thing you are investigating, a construction projects could be measured in completed value, contract cost expressed as £ or as an expression of area £/m2, or m2 or in the time taken to construct them. Which you choose to use depends upon the why you are conducting the research.

Remember that direct comparisons are sometimes logically meaningless, a school building costing £700/m2 and an office building costing 1400/m2 are not directly comparable so saying that one is twice as expensive as the other is meaningless.

Measured numbers are meaningful only to the degree by which the numbers reflect the real properties being measured or by which the numbers have interpretable "real world" correspondences.

Properties of measurement scales

A measurement scale therefore can be consider to have three properties

To illustrate the properties the following notations are used

- Firstly a_1 this can be considered as an object within a set of objects
- Secondly $p(a_1)$- can be considered as the property of the object that can be empirically established.
- Thirdly $m(a_1)$, $n(a_1)$ which can be considered as a valid and reliable measurement of the properties of a_1

The data for rebuild costs for primary and secondary schools is used below to illustrate the properties of measurement scales. The properties are number of pupils and cost per m2 gross floor area.

For example
a_1 =, Bleak Hill Primary school, $m(a_1)$= number of pupils, 500 $n(a_1)$=cost per m2 £750
a_2=Parr Primary School, $m(a_2)$= number of pupils, 250, $n(a_2)$=£600
a_3=Rainford secondary school, $m(a_3)$=1650, $n(a_3)$=£1200
a_4=Walton secondary school, $m(a_4)$=1740, $n(a_4)$=£1000

This data can be used to develop an understanding of not just differences between objects within a category for example that the cost of bleak hill school is more expensive than Parr primary school but also a meaningful extent of magnitude i.e. that bleak hill is 25% more expensive than Parr primary school but 37.5% less expensive when measured by cost per pupil. The scales can also be used to examine the magnitude of differences with similar objects within the category of school such as secondary schools, i.e. the differences between the costs of secondary schools when measured by cost per pupil are significantly less than those of primary schools. This use of scales to draw comparisons may help develop hypotheses for further investigation using other data relating to functions etc.

The properties of such scales can be concluded therefore to be that they have a
Magnitude property,
$m(a_1)>m(a_2)$ i.e. greater than or bigger than
Difference property
$n(a_1)/m(a_1)-n(a_2)/m(a_2)>n(a_3)/m(a_3)-n(a_4)/m(a_4)$ i.e. the difference in costs per pupil per m2 are less in secondary schools than primary schools
Ratio property
Bleak Hill is 1.25 times the cost of Parr Primary school

When considering how these categories translate into the measurement scales identified above the units of measurement require consideration.

Units of measurment

The most commonly used units of measurement are:-

Nominal:-If things have the same attribute they are put into disctinct and discrete categories. This scale possesses none of these categories, it is only used to categorise observations. E.g. Male/Female
Ordinal:- Things are assigned numbers such that the order of the numbers reflects an order relation defined on the attribute, e.g. Academic performance, A---E .This scale only has the magnitude scale and not the difference or ratio
Interval:- Things are assigned numbers such that differences between the numbers reflect differences of the attribute, e.g. temperature in degrees Celsius, This scale has the magnitude property, and the difference properties however doesn't have the ratio property
Log-interval:- Things are assigned numbers such that ratios between the numbers reflect ratios of the attribute e.g. Miles per gallon
Ratio:- Things are assigned numbers such that differences and ratios between the numbers reflect differences and ratios of the attribute e.g. duration in seconds. This scale has all three properties and can be used to calculate differences, ratios and can be used in transformation of the data onto other scales
Absolute; Things are assigned numbers such that all properties of the numbers reflect analogous properties of the attribute, e.g. numbers of children in a family

The scales of measurement have an order from the least precise (nominal) to the most precise (ratio). The higher up the scale, the more precise is the data collected. The more precise scales (such as interval) contain all the qualities of the scales below it

Scales, reliability and validity

Reliability can easily be defined as whether the measurement tool measures something consistently. There are many differing types of reliability, test-retest reliability (Consistency of the test over time), parallel forms reliability (if several forms of a test are equivalent), Internal consistency reliability(if the item on the test only assesses one dimension and interrater reliability (if there is consistency in the ratings of some outcome). Most basic statistics textbooks (Litwin, 1995)describe the processes to apply to measure reliability

Validity can be simply defined that the test measures what it is meant to. The three main categories of validity are content validity (whether the test assesses the extent of the construct under consideration), criterion validity (whether the test scores are related to other criteria which indicate the test taker is competent) and construct validity (whether the test measure the construct under consideration). Its outside the scope of this brief paper to consider the approaches to measure validity

The process of establishing reliability and validity of a measuring instrument can take a great deal of intensive effort in piloting and testing and retesting. This is essential for ensuring that the research is robust however, examples abound of naive and poorly developed measuring instruments.

Some Conclusions

The construction industry uses measurement all the time and has many established conventions that are based on well-developed rules, the BCIS has systematically

collected cost analysis data since 1964, and it publishes cost and price indices based on sound mathematical assumptions. They have developed clear rules for categorising buildings into functional groups and then use a standardised approach to define building elements. Clients use procurement documentation that uses standardised measurement principles to quantify the construction product, bills of quantities are used which categorise the product based on principles of cost significance. The sound principles of measurement are crucial for developing research in our industry.

Construction research is a relatively young discipline and does not have the benefit of well-grounded scales for measurement when compared with existing scales used in other disciplines such as the physical sciences or the medical sciences such as psychology. The scales used in these other disciplines have been cumulatively developed over a long period and have been tested with numerous different subjects and under different experimental conditions to establish their reliability and validity. Excellent work has been undertaken at the BCIS in the development of indices, cost analyses and other economic measures. There is a lot of potential for some secondary analysis to be carried out on these data.

A weakness of research into organisations and people in construction is that it does not use common scales and they are not cumulatively developed over time, in a casual review of papers published over the last ten years at ARCOM numerous definitions and measured of size of construction firm were encountered, measured by turnover, number of employees, size of project undertaken. There is a urgent need to establish measures within the construction research community which are reliable and valid and that can be used to develop a body of reliable quantitative knowledge. As a community, we should start to collect our knowledge of valid and reliable scales for measurement of simple constructs. By doing this we will ensure that, the measuring instruments used in future research are as robust as those used in other disciplines.

This brief paper has aimed to introduce the need for a theory of measurement prior to the development of scales and data collection instruments. It has considered the limitations in the use of language to define categories, considered the problems of reliability and validity and suggested that a central point for the collection of scales could be established which would allow researchers to contribute to the development of cumulatively robust scales.

Bibliography

Aldridge, A. and Levine, K. (2001) *Surveying the social world,* Open University Press, Buckingham

Allen, G. and Skinner, C. (1991) *Handbook for Research Students in the Social Sciences,* The Falmer Press

Building Cost Information service www.bcis.co.uk accessed 10 January 2008

Bryman, A. and Cramer, D. (2001) *Quantitative data analysis, a guide for social scientists,* Routledge, Hove.

Cramer, D. (1994) *Introducing Statistics for Social Research,* Routledge, London.

De Vaus, D. A. (1990) *Surveys in Social Research,* Unwin Hyman Ltd

Field, A (2005) Discovering Statistics using SPSS, Sage

Litwin, M. S. (1995) *How to measure Survey Reliability and Validity,* Sage.

Mental measurements, www.unl.edu/buros/ accessed 10 January 2008

Neural measurements ftp://ftp.sas.com/pub/neural/measurement.html#intro accessed 10 January 2008

Oppenheim, A. N. (1992) *Questionnaire design, Interviewing and attitude measurement,* Pinter, London

Pedhazur, E. and Schmelkin, L. (1991) *Measurement, design and analysis,*Erlbaum, Hillsdale
Sapsford, R. and Jupp, V. (1996) *Data Collection and Analysis,* The Open University, London.

Labour data trends and measurement. An Examination of mobility in the UK labour Force.

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Labour data trends and measurement. An Examination of mobility in the UK labour Force.

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Within the field of labour mobility and labour flexibility; the following aims and objectives were established from the outset.

Aims of this research:
To determine if the effects of the most recent economic shock upon the UK labour force as expressed in terms of migration effects, both residential and sectoral transfer; and to establish if such effects would constitute structural change.

Objectives to these aims:

1. To confirm the low and stable nature of residential migration.
2. To confirm that those industry sectors having the highest levels of productivity are more affected by labour migration.
3. To confirm that net sectoral transfers are now also low and stable, and that this pattern is different to that fund during the last economic shock...
4. To confirm that industry sectors are different in terms of their net migration patterns.
5. To confirm that industry sectors are also different in the extent to which they interact (recruiting from and displacing to) other sectors.

The underlying theory involved examining what is known as Labour Migration and for the purposes of this study, concentrated specifically upon within-nation migration. No attempt has been made to include international migration. The arguments involved relate to the relative influences of both residential migration and sectoral migration, and deal more specifically with the observation that sectoral movements are more volatile than residential migration.

Residential migrations, even those over a relatively short distance need considerable time for movers to analyze, weigh the costs and benefits, and then further time to plan and execute the move. Whereas sectoral labour movements can be undertaken quite quickly and are thus capable of responding with greater immediacy to economic pulses.

This paper describes a comparison of residential and sectoral labour movement between 1989 and 2005 based upon UK Labour Force Survey data. The dataset extracted provides those labour counts which had moved residence within the past year and also those who had moved sector within the past year.

The results of the research much greater volatility during the 1989- 1995 'Economic Shock'. An examination by correlation matrix reveals the unique degree to which the construction industry is connected (in terms of sectoral transfer) to the other industry sectors.

Keywords: Construction sector, **Correlations**, Labour mobility, Residential migration, Sectoral migration.

Introduction

As the purpose of this paper is primarily for research education, some of the preliminary results are provided first to help establish context, followed by an explanation of how they were derived and later processed for a correlations study. Attached appendices (A, B, C and D) should help to show how the data was processed.

A brief word on theory - labour migration theory

Economics-based research into migration is a complex area and from the outset a distinction must be made between migrations which are forced, i.e. a result of wars, enslavements, famines.. where the urgency of simple survival is the main driver; and those which are planned / considered migrations. These last are inspired by the pursuit of personal betterment. Ravenstein (1889), in considered by many to be one of the earliest and most authoritative researchers into this aspect for the UK.

Other authors have also established an informative grounding for this subject area most notably Gedik (2005) who hypothesized that in the longer term; for both migration rates and migration numbers, both urban to urban as well as rural to urban, migration eventually decreases,

Dixon (2003), in an analysis of UK showed that residential moves are both low and stable and that housing considerations are a more important informant of residential migration than job-related reasons. In fact job related moves became more important for longer range moves, but that even so this was only a part of a complex set of motivations.

Greenaway et al (1999) and (20000) established the importance of looking at sectoral transfers as the initial starting point, rather than the usual investigation of regional mobility. They also showed showed their preference for using net sectoral transfer data. As a means of examining structural changes to labour movements within an economy. They argue that "gross flows are not in themselves indicative of the amount of sectoral reallocation occurring in the economy, because a sectoral shock can be accommodated by any amount of gross flows."

This aspect of structural change was also commented on by Ruiz (2004) where in a comment upon economic connections, she comments as to the lack of "clear evidence of whether skills shortages in *(construction and metal trades)* occupations maybe long term and linked to structural changes in the economy, or short term, and linked to economic business cycles."

To summarise; in terms of structural reallocation of labour; given the different labour productivity rates of different industry sectors, and the different rewards to labour associated with them, labour mobility transfers should be more evident between some industry sectors than others.

Early results:

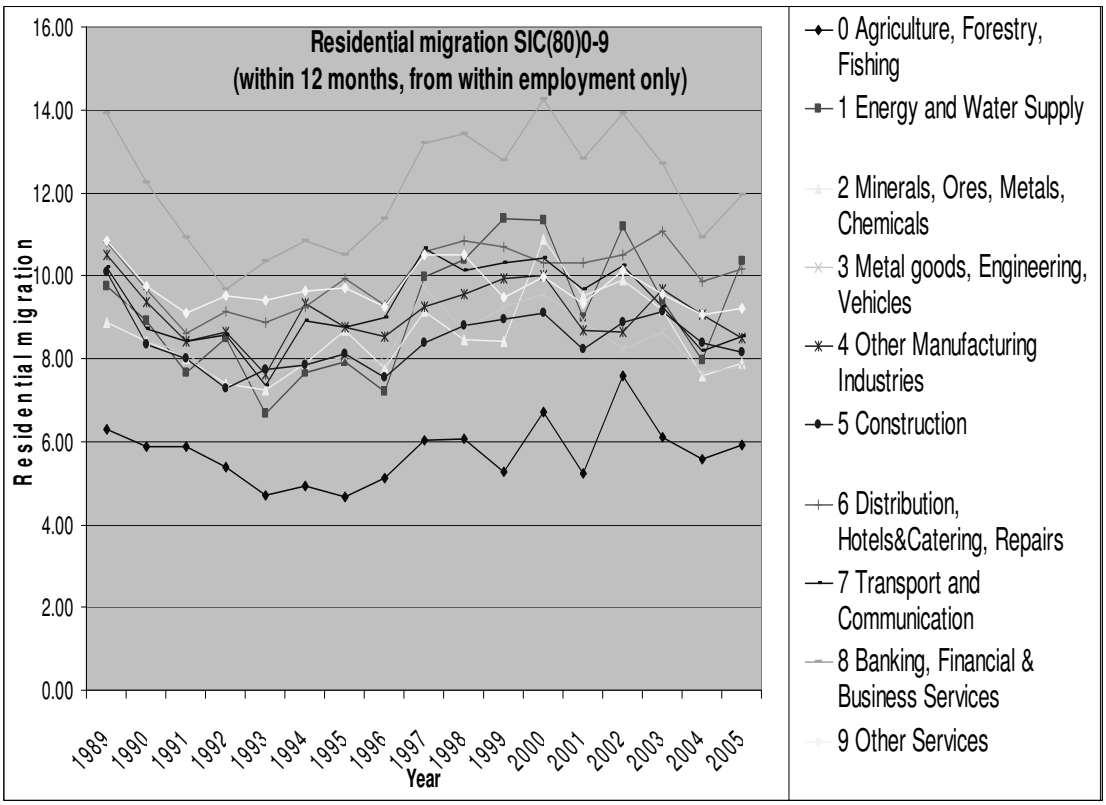

Figure 1: Residential migration as percentages of industry sector stayers. For movements within 12 months. From within employment only. Source: LFS

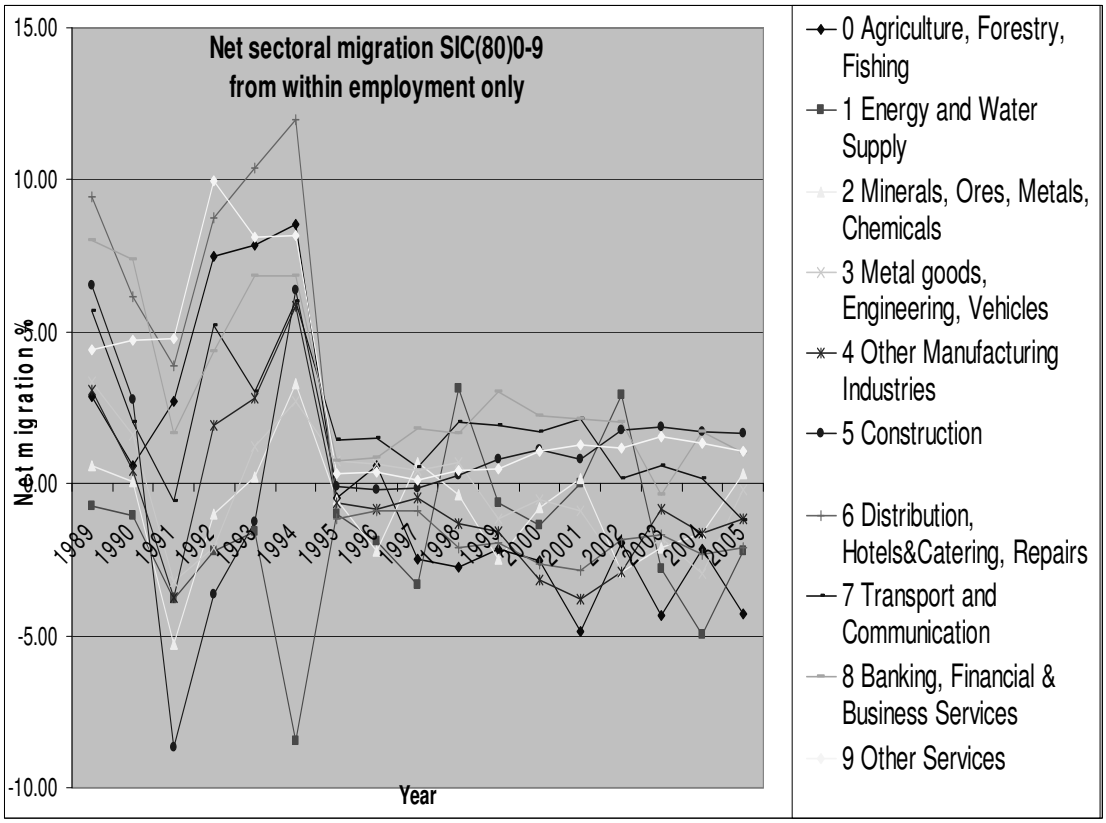

Figure 2: Net Sectoral migration as percentages of industry sector stayers. From within employment only. Source: LFS

Where the data came from - Data assembly and analysis.
Data is initially assembled by ESDS data downloads and unzipped to provide the following 2 categories of data:

1. Information comparing respondent's employment (main job) industry classification at the time of the survey, with that one year previously.
2. Information related to how long they had been at their latest address.

The following table summarizes the data counts for each year extracted from the relevant years adopted (1989 to 2005 inclusive). In order to limit the volume of data sifting for this dissertation the decision was taken to limit the data collection to single quarter snapshots taken at regular (spring quarter) intervals, but add breadth by extending historically over the last UK economic shock. The total data count has been just under one million individuals whose residential migration and sectoral movement has been recorded on a now (i.e. at survey date), and, at one year ago previously.

Table 1: LFS Dataset adopted. Spring Quarters 1989 – 2005
Summaries of individual counts and their expression as percentages of the entire quarterly sample taken.
(NB The 1990 data is too qualified and thus excluded from Sectoral Migration)
Moves = residential moves within the past year
Transfers = individuals switching to different industry groups / sectors.

Spring Quarters	Residential Migration Counts of individuals included	Moves	%	Sectoral Migration Counts of individuals included	Transfers	%
2005	56,986	5,395	9.47	47,263	2,215	4.69
2004	57,672	5,297	9.18	48,594	2,335	4.81
2003	60,005	6,079	10.13	50,994	2,516	4.93
2002	62,454	6,500	10.41	54,024	3,008	5.57
2001	61,720	6,064	9.83	52,843	3,093	5.85
2000	63,264	6,682	10.56	54,352	3,027	5.57
1999	64,744	6,564	10.14	55,930	3,032	5.42
1998	65,025	6,796	10.45	56,700	3,184	5.62
1997	65,975	6,892	10.45	56,993	2,839	4.98
1996	63,721	5,786	9.08	57,921	2,879	4.97
1995	64,583	6,033	9.34	58,396	2,729	4.67
1994	154,108	15,347	9.96	68,706	9,097	13.24
1993	157,073	14,813	9.43	70,403	9,339	13.26
1992	154,903	14,818	9.57	70,732	10,108	14.29
1991	158,385	15,219	9.61	70,266	9,036	12.86
1990	Not used	Not used	10.04	Not used	Not used	Not used
1989	165,589	18,040	10.89	74,473	10,083	13.54
Total	**1,476,207**	**146,325**	**9.91**	**948,590**	**78,518**	**8.28**

Deeper analysis:
Concentrating specifically upon the more interesting aspect of labour migration between sectors; and noting that each respondent has been required to answer two particular questions i.e.

1. Where the LFS asked What industry sector are you employed in now?
and
2. Where the LFS asked Which industry sector were you employed in one year ago?

Using these two pieces of info. It becomes possible to measure two different movements:

- In-mig.: Transfers to a given sector now, from other sectors (1year ago).
- Out-mig.: Transfers from same sector (1year ago), to other sectors now.

This will still produce the same all-sector annual totals, but the net transfer data for each sector will be different, and showing reflected data where the net loss from say Sector X to Sector Y will match the net gain to Sector Y from Sector X.

As the focus is entirely on unforced migration, insofar as this is a rational and freely chosen action; for both forms of migration; the measures adopted are specifically from people who are within employment. No attempt has been made to include residential or sectoral moves of the unemployed returning to the workforce, or those who are displaced to unemployment. Similarly new entrants to the workforce and retirees are also excluded:

Labour connectivity

A correlation study was then prepared using the net sectoral data to show how each UK industry sector "traded" labour transfers with all of the other industry sectors.

Table 2: Sector to sector all years - Simple correlations – From Appendix D attached Actual worker counts from LFS March 1989-1995 S- Spring quarter summaries. SPSS output.

Correlations

		Agric	Energy	Mining	Metalgoods	OtherManufact	Construct	Distrib	Transport	Banking	OtherService
Agric	Pearson Correlation	1	.244	.264	.238	.745*	.363	.562	-.079	-.136	-.329
	Sig. (2-tailed)	.	.497	.462	.507	.013	.303	.091	.827	.707	.353
	N	10	10	10	10	10	10	10	10	10	10
Energy	Pearson Correlation	.244	1	.957**	.907**	.741*	.851**	.774**	.755*	.741*	.648*
	Sig. (2-tailed)	.497	.	.000	.000	.014	.002	.009	.012	.014	.043
	N	10	10	10	10	10	10	10	10	10	10
Mining	Pearson Correlation	.264	.957**	1	.823**	.762*	.805**	.808**	.698*	.704*	.553
	Sig. (2-tailed)	.462	.000	.	.003	.010	.005	.005	.025	.023	.097
	N	10	10	10	10	10	10	10	10	10	10
Metalgoods	Pearson Correlation	.238	.907**	.823**	1	.751*	.948**	.815**	.804**	.714*	.586
	Sig. (2-tailed)	.507	.000	.003	.	.012	.000	.004	.005	.020	.075
	N	10	10	10	10	10	10	10	10	10	10
OtherManufac	Pearson Correlation	.745*	.741*	.762*	.751*	1	.803**	.957**	.439	.400	.166
	Sig. (2-tailed)	.013	.014	.010	.012	.	.005	.000	.204	.253	.647
	N	10	10	10	10	10	10	10	10	10	10
Construct	Pearson Correlation	.363	.851**	.805**	.948**	.803**	1	.871**	.832**	.720*	.526
	Sig. (2-tailed)	.303	.002	.005	.000	.005	.	.001	.003	.019	.118
	N	10	10	10	10	10	10	10	10	10	10
Distrib	Pearson Correlation	.562	.774**	.808**	.815**	.957**	.871**	1	.580	.529	.293
	Sig. (2-tailed)	.091	.009	.005	.004	.000	.001	.	.079	.116	.412
	N	10	10	10	10	10	10	10	10	10	10
Transport	Pearson Correlation	-.079	.755*	.698*	.804**	.439	.832**	.580	1	.960**	.866*
	Sig. (2-tailed)	.827	.012	.025	.005	.204	.003	.079	.	.000	.001
	N	10	10	10	10	10	10	10	10	10	10
Banking	Pearson Correlation	-.136	.741*	.704*	.714*	.400	.720*	.529	.960**	1	.932*
	Sig. (2-tailed)	.707	.014	.023	.020	.253	.019	.116	.000	.	.000
	N	10	10	10	10	10	10	10	10	10	10
OtherService	Pearson Correlation	-.329	.648*	.553	.586	.166	.526	.293	.866**	.932**	1
	Sig. (2-tailed)	.353	.043	.097	.075	.647	.118	.412	.001	.000	.
	N	10	10	10	10	10	10	10	10	10	10

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3 Ranked sectoral transference (summarised from Table 2,)

Ranked correlations of sectoral transfers 1 = most connected to other sectors.	Industry sector SIC (80).	Average of correlations with other sectors.	Significance count: No. of strong (cut-off $r = 0.8$) and stat. sig. correlations.
1	05 Construction	0.75	6
2	01 Energy & water	0.74	3
3	03 Metal goods etc.	0.73	5
4	02 Mining etc.	0.71	4
5	06 Distribution etc.	0.69	4
6	07 Transport etc.	0.65	4
7	04 Other manufacturing	0.64	2
8	08 Banking etc.	0.62	2
9	09 Other services	0.47	2
10	00 Agriculture etc.	0.21	0

Thus it can bee seen that the construction sector demonstrates the highest level of participation in labour mobility in terms of it's labour connectivity to other industry sectors.

The following appendices show how the sectoral data was assembled.

Appendix A: Used to supply Appendix B

LFSmarch1995

Industry in main job - 1980 SIC * Industry CLASS (1 year ago) Crosstabulation

Appendix B: Used to provide Fig2.

Consolidation table: Net sectoral mobility (from "within employment" only)

Data collected here from Appendix B (Tables 3.1, 4.1, 5.1 et seq)

Appendix C: Used to supply Appendix D

Agric. Etc. Sector. Sector Migration (identification of areas of gain from and loss to)
Industry in main job 1 yr ago - 1980 SIC

Appendix D: Used to provide correlations study Table 2

Sector to sector all years NET migration collection

Actual worker counts (from previous LFS march 1989-1995 Spring quarter summaries **)

References.

Dixon, S. (2003). Migration within Britain for job reasons. Labour Market Trends. Special Feature: Labour Market Division. London, Office for National Statistics**:** 191-201.

Greenaway, D., R. Upwood, et al. (1999). Sectoral Mobility in UK Labour Markets. Research paper 99/01. Centre for Research on Globalisation. Nottingham, University if Nottingham**:** 1 - 28.

Greenaway, D., R. Upwood, et al. (2000). Sectoral Transformation and labour Market Flows. Globalisation and Labour Markets. University of Nottingham., Nottingham, International Economic Association.

Ravenstein, E. G. (1889). "The Laws of Migration 2nd paper." Journal of the Statistical Society of London **Vol. 52**(Issue No. 2): 241-305.

Ravenstein, E. G. (1885). "The Laws of Migration." Journal of the Statistical Society of London **Vol. 48**(Issue No. 2): 167-235.

ESDS (2005). Guide to exploring large-scale government data-series using Nesstar, Economic and Social data Service - Government. **2005**. http://www.esds.ac.uk/support/guides/G1.pdf 06 July 2005

Gedik, A. (2005). Mobility Transition (Test of Zelinsky's Theory) and Economic and Demographic Factors: Japan and Turkey. Ankara, Department of City and Regional Planning, Faculty of Architecture, Middle East Technical University, (ODTU) Ankara, 06531 Turkey. **2005**. http://iussp2005.princeton.edu/download.aspx?submissionId=51383 03 Aug.2005

NESSTAR (2005). NESSTAR ESDS Catelogue, NESSTAR Limited. a wholly owned subsidiary of the UK Data Archive and the Norwegian Social Science Data Services. 2004. **2005**. http://nesstar.esds.ac.uk/webview/index.jsp 18 July 2005

Ruiz, Y. (2004). Skills shortages in skilled construction and metal trades occupations. National Statistics Feature, Labour Market Trends. London, ONS (Labour Market Division). **2004**. http://www.statistics.gov.uk/articles/labour_market_trends/Skills_shortages.pdf 05 Nov.2005

Programmes:

SPSS (2005). SPSS 12.0 for windows (**Statistical Package** for the **Social Sciences**). Chicaho Illinios 60606, SPSS Inc.

AppendixA

LFSmarch1995
Industry in main job - 1980 SIC * Industry CLASS (1 year ago) Crosstabulation
Count

		Industry CLASS (1 year ago)												Total	Sector Stayer	In Mig Diff	% Diff
		0 Agricultu	1 Energy &	2 Minerals,	3 metal go	4 Other Ma	5 Construc	6 Distributi	7 Transpor	8 Banking,	9 Other Se	00 Diploma	Workplace				
Industry in main job - 1980 SIC	0 Agriculture, Forestry, Fishing	1242	1	3	1	5	6	13	0	6	6	0	0	1283	1242	41	3.30
	1 Energy & Water supply	0	822	2	6	3	6	10	3	6	3	0	0	861	822	39	4.74
	2 Minerals, Ores, Metals, Chemicals	0	4	1478	17	14	9	28	4	10	14	0	1	1579	1478	101	6.83
	3 metal goods, Engineering, Vehicles	2	9	23	4729	51	23	81	14	44	42	0	0	5018	4729	289	6.11
	4 Other Manufacturing Industries	5	3	8	40	4496	22	100	23	34	62	2	0	4795	4496	299	6.65
	5 Construction	7	6	5	19	24	3929	42	17	18	19	0	2	4088	3929	159	4.05
	6 Distribution, Hotels&Catering, Repairs	13	6	24	57	85	28	10598	54	89	204	2	2	11162	10598	564	5.32
	7 Transport and Communication	8	3	6	27	27	15	70	3496	45	35	0	1	3733	3496	237	6.78
	8 Banking, Financial & Business Services	2	8	15	44	54	23	123	34	6832	121	1	3	7260	6832	428	6.26
	9 Other Services	10	7	23	42	63	30	220	37	121	17990	3	11	18557	17990	567	3.15
	00 Diplomatic, International	0	0	0	0	0	0	0	0	1	1	40	0	42	40	2	5.00
	Workplace Outside UK	0	0	0	0	1	0	1	0	1	0	0	15	18	15	3	20.00
Total		1289	869	1587	4982	4823	4091	11286	3682	7207	18497	48	35	58396	55667	2729	4.90

Industry CLASS (1 year ago) * Industry in main job - 1980 SIC Crosstabulation
Count

		Industry in main job - 1980 SIC												Total	Sector Stayer	Out Mig Diff	% Diff
		0 Agricultu	1 Energy &	2 Minerals,	3 metal go	4 Other Ma	5 Construc	6 Distributi	7 Transpor	8 Banking,	9 Other Se	00 Diploma	Workplace				
Industry CLASS (1 year ago) - 1980 SIC	0 Agriculture, Forestry, Fishing	1242	0	0	2	5	7	13	8	2	10	0	0	1289	1242	47	3.78
	1 Energy & Water supply	1	822	4	9	3	6	6	3	8	7	0	0	869	822	47	5.72
	2 Minerals, Ores, Metals, Chemicals	3	2	1478	23	8	5	24	6	15	23	0	0	1587	1478	109	7.37
	3 metal goods, Engineering, Vehicles	1	6	17	4729	40	19	57	27	44	42	0	0	4982	4729	253	5.35
	4 Other Manufacturing Industries	5	3	14	51	4496	24	85	27	54	63	0	1	4823	4496	327	7.27
	5 Construction	6	6	9	23	22	3929	28	15	23	30	0	0	4091	3929	162	4.12
	6 Distribution, Hotels&Catering, Repairs	13	10	28	81	100	42	10598	70	123	220	0	1	11286	10598	688	6.49
	7 Transport and Communication	0	3	4	14	23	17	54	3496	34	37	0	0	3682	3496	186	5.32
	8 Banking, Financial & Business Services	6	6	10	44	34	18	89	45	6832	121	1	1	7207	6832	375	5.49
	9 Other Services	6	3	14	42	62	19	204	35	121	17990	1	0	18497	17990	507	2.82
	00 Diplomatic, International	0	0	0	0	2	0	2	0	1	3	40	0	48	40	8	20.00
	Workplace Outside UK	0	0	1	0	0	2	2	1	3	11	0	15	35	15	20	133.33
Total		1283	861	1579	5018	4795	4088	11162	3733	7260	18557	42	18	58396	55667	2729	4.90

		In Mig	Out Mig	Net Mig
Industry CLASS (1 year ago) - 1980 SIC	0 Agriculture, Forestry, Fishing	3.30	3.78	**-0.48**
	1 Energy & Water supply	4.74	5.72	**-0.97**
	2 Minerals, Ores, Metals, Chemicals	6.83	7.37	**-0.54**
	3 metal goods, Engineering, Vehicles	6.11	5.35	**0.76**
	4 Other Manufacturing Industries	6.65	7.27	**-0.62**
	5 Construction	4.05	4.12	**-0.08**
	6 Distribution, Hotels&Catering, Repairs	5.32	6.49	**-1.17**
	7 Transport and Communication	6.78	5.32	**1.46**
	8 Banking, Financial & Business Services	6.26	5.49	**0.78**
	9 Other Services	3.15	2.82	**0.33**
	00 Diplomatic, International	5.00	20.00	**-15.00**
	Workplace Outside UK	20.00	133.33	**-113.33**
Total		4.90	4.90	**0.00**

AppendixB

Consolidation table: Net sectoral mobility (from "within employment" only)
Data collected here from Appendix B (Tables 3.1, 4.1, 5.1 et seq)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0 Agriculture, Forestry, Fishing	2.87	0.60	2.70	7.47	7.87	8.56	**-0.48**	0.59	-2.46	-2.75	-2.18
1 Energy and Water Supply	-0.75	-1.07	-3.80	-2.22	-1.59	-8.45	**-0.97**	-1.92	-3.31	3.16	-0.65
2 Minerals, Ores, Metals, Chemicals	0.61	0.05	-5.26	-1.02	0.24	3.29	**-0.54**	-2.20	0.69	-0.37	-2.47
3 Metal goods, Engineering, Vehicles	3.37	1.59	-3.20	-2.10	1.23	2.72	**0.76**	0.63	0.43	0.68	-1.13
4 Other Manufacturing Industries	3.08	0.42	-3.76	1.91	2.80	5.86	**-0.62**	-0.85	-0.49	-1.32	-1.60
5 Construction	6.55	2.78	-8.66	-3.66	-1.24	6.35	**-0.08**	-0.18	-0.16	0.29	0.78
6 Distribution, Hotels&Catering, Repairs	9.44	6.13	3.88	8.76	10.40	11.99	**-1.17**	-0.88	-0.89	-2.12	-1.96
7 Transport and Communication	5.66	2.03	-0.55	5.19	3.04	6.00	**1.46**	1.52	0.56	2.01	1.91
8 Banking, Financial & Business Services	8.01	7.36	1.64	4.33	6.85	6.83	**0.78**	0.87	1.82	1.65	3.03
9 Other Services	4.43	4.70	4.77	9.98	8.10	8.17	**0.33**	0.36	0.10	0.44	0.49
00 Diplomatic, International	NA	NA	NA	NA	NA	-20.93	**-15.00**	-30.77	0.00	-8.33	-12.90
Workplace Outside UK	-472.73	-1122.40	-385.71	-533.33	-323.08	-188.24	**-113.33**	-94.44	-85.71	-143.75	-236.36
NA	-17.50	-45.21	-5.26	-221.74	62.50	-13.89					
DNA	-3.85	-2.94	-0.54	-3.64	-3.97	-4.89					
Avg (0-9)	4.33	2.46	-1.22	2.86	3.77	5.13	-0.05	-0.21	-0.37	0.17	-0.38

NA = Not applicable
DNA = Did not answer

Agric. Etc. Sector. Sector Migration (identification of areas of gain from and loss to)

Industry in main job 1 yr ago - 1980 SIC

	0 Agricultu	1 Energy &	2 Minerals,	3 metal go	4 Other Ma	5 Construc	6 Distributi	7 Transpor	8 Banking,	9 Other Se	00 Diplom	NA	V
2005	679	0	0	3	0	0	6	5	1	8	0		
2004	653	0	2	3	0	3	5	6	1	8	0		
2003	669	0	0	2	3	1	8	1	4	11	0		
2002	714	1	0	5	6	5	12	1	0	10	0		
2001	743	1	2	2	3	1	7	2	4	12	0		
2000	871	0	0	4	7	2	11	5	9	8	0		
1999	918	0	0	3	6	3	8	3	1	9	0		
1998	1019	0	2	5	3	4	6	2	3	6	0		
1997	1099	2	0	2	2	0	7	4	1	7	0		
1996	1178	0	2	1	7	8	9	4	6	7	0		
1995	**1242**	**1**	**3**	**1**	**5**	**6**	**13**	**0**	**6**	**6**	**0**		
1994	1308	1	1	3	7	2	12	2	4	8	0	1	
1993	1321	1	1	3	9	5	10	3	5	11		0	
1992	1432	2	2	10	4	6	9	3	0	4		10	
1991	1482	1	2	9	5	7	14	6	5	13		0	
1990													
1989	1570	1	4	2	4	6	13	3	3	17		0	
Total in	16898	11	21	58	71	59	150	50	53	145	0	11	
Total out	16898	7	18	65	71	110	222	85	72	234			
net	0	4	3	-7	0	-51	-72	-35	-19	-89			

Industry in main job 1 yr ago - 1980 SIC * Industry in main job - 1980 SIC Crosstabulation

Count

Industry in main job - 1980 SIC

	0 Agricultu	1 Energy &	2 Minerals,	3 metal go	4 Other Ma	5 Construc	6 Distributi	7 Transpor	8 Banking,	9 Other Se	00 Diplom	NA	V
2005	679	1	1	3	5	3	9	6	11	13	0		
2004	653	0	0	3	3	7	6	4	7	12	0		
2003	669	0	0	3	3	9	13	8	6	17	0		
2002	714	0	2	4	6	4	11	8	6	15	0		
2001	743	0	2	7	8	7	13	12	3	19	0		
2000	871	0	1	4	4	10	13	4	6	26	0		
1999	918	0	1	2	6	3	22	3	6	10	0		
1998	1019	0	2	5	3	6	15	4	8	17	0		
1997	1099	0	0	6	5	10	14	4	2	11	0		
1996	1178	0	1	3	1	5	11	4	2	10	0		
1995	**1242**	**0**	**0**	**2**	**5**	**7**	**13**	**8**	**2**	**10**	**0**		
1994	1308	1	1	3	3	0	14	1	4	12	0	0	
1993	1321	0	0	1	4	9	13	3	1	13		0	
1992	1432	2	2	6	2	4	16	5	3	22		1	
1991	1482	2	3	8	7	7	11	4	3	18		0	
1990													
1989	1570	1	2	5	6	19	28	7	2	9		0	
Total out	16898	7	18	65	71	110	222	85	72	234	0	1	

AppendixD

Sector to sector all years NET migration collection
Actual worker counts (from previous LFS march 1989-1995 Spring quarter summaries **)
Research group dimensions:
LFS 1989-2005 spring quarters 948,590 individuals

Total sector movers (1990 excluded) 78518 individuals

	0 Agriculture, Forestry, Fishing	1 Energy & Water supply	2 Minerals, Ores, Metals, Chemicals	3 metal goods, Engineering, Vehicles	4 Other Manufacturing In	5 Construc
0 Agriculture, Forestry, Fishing	**0**	**4**	**3**	**-7**	**0**	**-51**
1 Energy & Water supply	-4	0	3	-19	-1	-33
2 Minerals, Ores, Metals, Chemicals	-3	-3	0	-33	-27	-51
3 metal goods, Engineering, Vehicles	7	19	33	0	60	-84
4 Other Manufacturing Industries	0	1	27	-60	0	-90
5 Construction	51	33	51	84	90	0
6 Distribution, Hotels&Catering, Repairs	72	-28	-38	-162	58	-108
7 Transport and Communication	35	18	15	182	125	19
8 Banking, Financial & Business Services	19	43	82	257	183	87
9 Other Services	89	44	91	191	326	81

** 1990 data is excluded (see LFS warning notice #3211)

Industrialising the Construction Industry –
A Collaborative Training and Education Model
From Questionnaire to Data: Use of SPSS to manage data Sets

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ABSTRACT: *Since the early 1900s debate has been (and still is) about skills shortages and skills gap in the UK construction industry along the different organisational levels. Hence, firms are argued to often pass up opportunities in new markets due to lack of 'relevant' skills. Currently, the UK Government is embarking on Modern Methods of Construction (MMC) initiative to reduce the dependence on skilled labours. Nevertheless, concerns have been raised regarding the shortfall in the number of professionally qualified workers.*

The objective of this research is to develop a collaborative training and education model for MMC for the UK construction professionals. This requires the investigation of skills requirements in general and MMC – Prefabrication in particular from both the construction industry and academia perspective. This investigation aims to identify the relation between skill requirements and means of collaboration between the UK construction industry and academia.

Considering the nature of this research and the different research methodologies for data collection and analysis; it has been concluded, that quantitative data collection and analysis is the most appropriate methodology for this research. This paper addresses the process for developing the quantitative data collection tool (questionnaire) and potential analysis using SPSS for managing data sets.

1. BACKGROUND

The UK construction industry has been the centre of criticism and debate for its poor performance since the early 1900's. Post-war regeneration and fragmented planning policies together with skills shortages has seemingly exacerbated this situation.

Recently, the UK Government has embarked on Modern Methods of Construction (MMC) initiative, the remit of which aims among others to address and alleviate the construction industry skills shortage vis-à-vis capability and current and future skills requirements. However, although MMC may (arguably) reduce the dependence on skilled labour, this in itself does not altogether negate the need to address and provide other types of skills. Notwithstanding these issues, Higher Education Institutions have also been criticised for not delivering the required and relevant skills to the UK construction industry to enable the industry to perform satisfactorily, not to mention

taking up new technologies. Cognisant of this, it is important to factor into the equation the collaboration between the construction industry and the UK's Higher Education establishments regarding the 'apparent' skills gap/ shortage particularly in respect of MMC-prefabrication.

2. THE RESEARCH PROCESS

The research process evolves around a particular theory and starts with a research question(s) (Jagannathan, 2002; Fellows and Liu, 2003); and is followed by formulation of hypotheses. In order to test the hypotheses, data collection and analysis is considered to be a major milestone for the research journey (Figure 1).

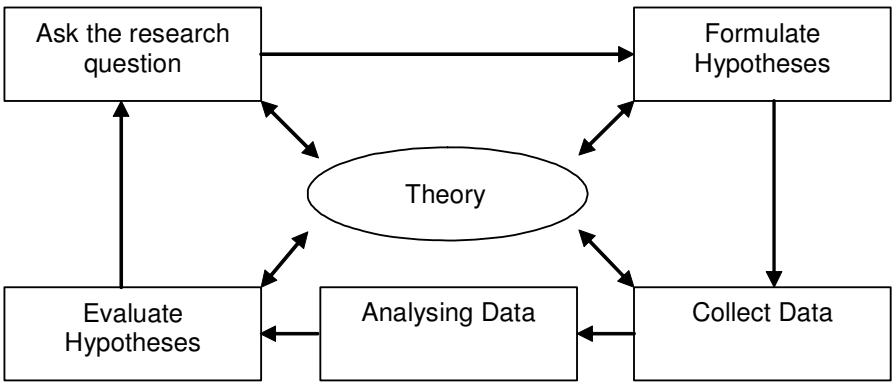

Figure 1: Research Process
(Jagannathan, 2002)

There is agreement in literature about the different classifications of research (Fellows and Liu, 2003). Kumar (2005) classifies research from three not mutually exclusive perspectives: application of the research study; the objectives in understanding; and the inquiry mode employed. In the same context, Denzin and Lincoln (1994) distinguish between qualitative and quantitative research in that the former implies emphasis on processes and meanings that are not rigorously examined or measured; whereas the latter emphasises the measurement and analysis of causal relationships between variables within 'value-free' context. Nevertheless, there is increasing recognition that both types of approaches are important for a good research study (Kumar, 2005; McNeill and Chapman, 2005).

The nature of this research, which encompasses the development of a training and education model, requires the identification of skills requirements of the disparate stakeholders across the UK construction organisations; as well as the identification of the main features for effective collaborative delivery of skills. This is followed by exploring the relation between skills requirements and means of collaboration between the UK construction industry and Higher Education establishments. The diversity and complexity of this research makes the triangulation approach more applicable in order to

tease out the distinct nuances associated with this research. In this context, the quantitative approach will adopt a 'scientific method' for identifying the most required and common professional skills/ needs for adopting 'prefabrication' across the supply chain. Furthermore, the quantitative approach will be employed to investigate relationship between skills requirements and preferred means of collaboration between the construction industry and academia. This is an attempt to draw inference between the independent variable 'profession/ discipline' and the dependent variable 'skill' and 'means of collaboration'. In order to be able to draw conclusions, statistical analysis will be employed. The qualitative approach, on the other hand will be employed to explore the subject matter in order to gain understanding and to inform the quantitative approach for inference and conclusion.

3. DATA COLLECTION AND ANALYSIS

This research will focus on contemporary events and does neither require control over the independent variable profession, nor require the personal involvement of the researcher. Furthermore, a large number of participants is required in order to gain a more comprehensive 'picture' of the UK construction industry in respect of skills requirements (Worsley, 1977). Hence, the most suitable research style for this research is the 'survey' approach (Figure 2).

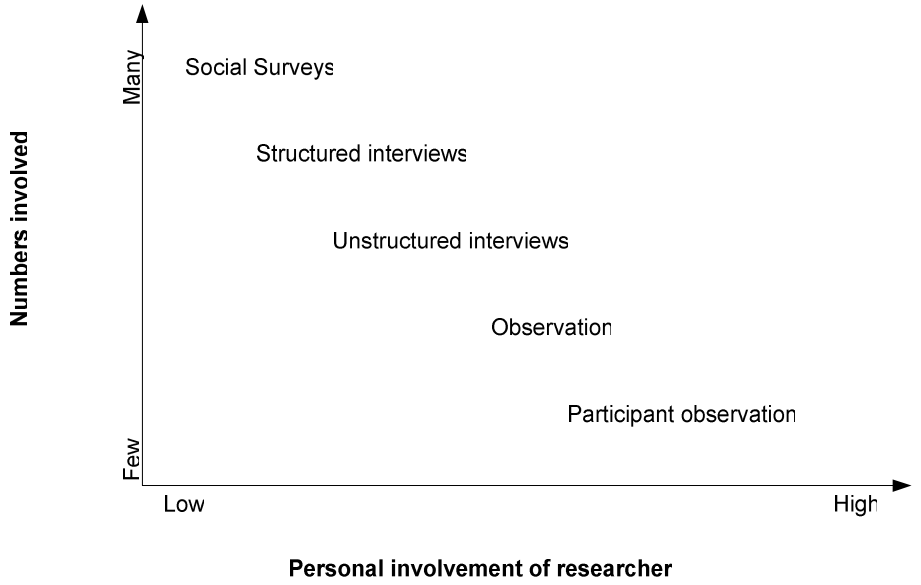

Figure 2: Methods of Data Collection
(Worsley, 1977)

'Survey' is a research method traditionally used for obtaining large amounts of data from large number of people using statistical techniques. Although 'survey' may use different tools, it usually takes the form of self-completion questionnaire(s). Surveys are characterised as being 'value-free' as they are organised in a logical and systematic fashion via questionnaire design (McNeill and Chapman, 2005; Fellows and Liu, 2003).
Thomas (1996) resembled surveys with laboratory experiments, in that they aim to collect data in a systematic way to make inferences from the results. This is in agreement with McNEill and Chapman (2005), who argue that 'surveys' are highly

reliable because of the ease of replication and verification of data. Moreover, the survey approach produces statistical information relatively quickly and inexpensively; and furthermore, enables comparisons to be made. Notwithstanding these issues, surveys tend to be aimed at large groups of people thus making them more representative of the wider community/ population.

Surveys, however, are often criticised for their low response rate (25-35% useable response rate), and hence not producing data from which results can be relied upon to support or reject a hypothesis and/ or draw conclusions. Hence, the combination of qualitative and quantitative approaches (triangulation) in this study is thought to alleviate the threat of low response rate/ bias/ distortion associated with the 'survey' approach. In order increase the chance of a high response rate, it is imperative to make the questionnaire 'interesting', of value, short, clearly thought through, and well presented. Inducements to complete surveys e.g. offering a report of the survey findings to respondents is also common practice. Furthermore, it is advised to send questionnaires to an identified individual as opposed to e.g. Managing Director (Burgess, 2003).

3.1 Sampling

The objective of sampling is argued to provide a practical means to enable data collection, given an 'extremely large' population (Fink, 2003; Fellows and Liu, 2003; Kendrick, 2005; and Kumar (2005). Nevertheless, consideration must be given to ensure that the sample provides a good representation of the population. A 'representative' sample implies that the sample has the exact same proportions as the population from which it was drawn, but in smaller number (Welman et al., 2005).

3.2 Data collection

Primary and secondary data collection approaches (Kumar, 2005) are employed in this research. The primary sources for data collection will mainly be data collected through mailed questionnaires, followed by semi-structured interviews as appropriate.

The aim of data collection is to obtain an appropriate set of data which will enable the research to proceed. Buckingham and Saunders (2004) emphasise the importance of justifying each item included in the data collection against the theoretical purpose of the research, regardless of the research being primary descriptive or analytical. Figure 3 illustrates the process for linking the data collection instrument (questionnaire) to the research aim.

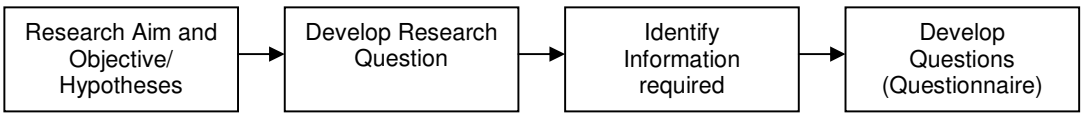

Figure 3: Linking data Collection to Research Aim/ Hypotheses

Closed and open-ended questions are employed in the questionnaire; however, in order to keep the questionnaire easy to answer, and as concluded from the pilot study; open-ended questions are kept to a minimum. In addition, categories provided for the closed

questions are exhaustive and include the 'catch-all' type option i.e. 'other' (Burgess, 2003). This is particularly important for the analysis stage.

3.3 Data Analysis using SPSS

Huberman and Miles (1998) define 'data analysis' as a combination of three linked sub-processes: data reduction, data display, and conclusion drawing/ verification. 'Data reduction' involves data summaries, coding, finding themes, clustering, and writing stories. Data display, however, involves organisation and assembling of information to permit inference and conclusion drawing; while 'conclusion drawing and verification' involves interpretation by drawing meaning from displayed data. Fellows and Liu (2003) argue that data analysis involves searching the data collected to confirm themes and categories found in the theory and literature, as well as discovering differences in the data from what theory and previous findings suggest. Statistical Package for Social Science SPSS package (with window interface) version 16 will be employed for the quantitative data analysis process for this research.

Statistics is collection of numerical facts and numbers; it is a legitimate field of study for 'making sense' of data. Statistics can be defined as 'data-relationship' and 'data-manipulation'. This involves data collection, organisation, analysis, interpretation communication (Jagannathan, 2002). There are two branches of statistics, namely 'descriptive' and 'inferential'.

The descriptive statistics only describes the data at hand and explores the distribution/ frequency of the different variables. The inferential statistics, on the other hand takes the descriptive data a step further to measure relationships/ correlations in an attempt draw inference/ conclusions (Jagnnathan, 2002; Field, 2005).

The SPSS is a statistical package with 'windows interface'. It can be used for primary data entry and manipulation/ analysis; and/or for secondary data manipulation/ analysis. Furthermore, it is used as an analytical tool and for graphical display of data as well (Evans, 2006).

Prior to entering the data into the SPSS package it is crucial to understand the data at hand and define its structure (Evans, 2006). In SPSS, all types of data are called 'variables'. Variables are attributes or characteristics of the subject under study; these characteristics vary across the population/ sample and hence, are not constant. There are two types of variables, 'independent variable' (e.g. age) and 'dependent variable' (e.g. professional experience). There are three types for variable measurements, namely 'nominal', 'ordinal', or 'interval/ ratio'. A variable that is 'nominal' is a categorisation that does not imply any 'order' (e.g. religion, gender, colour, yes/no etc.). A variable that is 'ordinal' is similar to 'nominal' but with implied 'order' (e.g. education, age, social classes, likert scale etc.). An 'interval/ ratio' has a 'numerical meaning' and 'order' that has equivalence in magnitude (e.g. income, number of children, temperature, etc.).
Before manipulating the data collected it is imperative to identify the variable measurement first as this will determine the type of statistical tests that can be carried out otherwise the analysis will be meaningless.

3.3.1 Data Management and Manipulation

The current research depends mainly on primary sources for data collection and analysis. Hence, the first step for data management and manipulation is the creation of the database. In SPSS each row represents a 'case' i.e. the different participants and their relevant data; while columns represent the different variables associated with each participant. For ease of data handling and analysis the 'values' of 'variables' are designated by codes. When giving codes to value(s), it is imperatives that the codes are exhaustive (Evans, 2005; Field, 2006).

Recoding of a particular variable may be essential for data manipulation and management; e.g. the variable 'number of years of experience' (e.g. 3, 6, 12, 13 years, etc.) may not be appropriate for the analysis as such, however, the categorisation of years of experience may be more meaningful. In this case using the 'recoding' command in SPSS, a new variable can be created (e.g. 0-5 years, 6-10 years, 11-15 years, etc.). The new variable 'category of years of experience' is then the one to be used for the analysis. The recoding process may also be used for data reduction for a more manageable data set.

3.3.2 Data Display

Data can be organised in three different ways, namely 'tabular', 'graphical', and 'numerical'. 'Tabular' refers to 'frequency table' where the values of observation/ variables are listed in one column and the corresponding frequencies are displayed in the adjacent column. 'Graphical' summarisation of data is displayed using e.g. pie-charts, bar graphs, histograms, time-charts etc. Jagannathan (2002) argue that the level of measurement determines the type of graph used. Measures of central tendency (mean, median, mode) and measures of variability are the two means for producing numerical data.

3.3.3 Inference and Drawing Conclusion

Following an extensive review of literature on SPSS, the following bullet points/ steps are concluded for carrying out basic statistical analysis. These analysis are thought for the current research.

- Generate simple descriptive summaries for each variable. These statistics summarise the univariate distribution of rates for each of the variables
- Explore the descriptive statistics, for emerged/ observed patterns around one or a number of variables. These patterns will require further tests to either confirm or reject the observed.
- The mean score provides an average score for the variable but does not provide details of the range of scores i.e. the variability. Relying solely on the observed differences in means scores between groups can be misleading.
- T-test is most commonly used to examine whether the means of two groups of data are significantly different from one another. With a t-test, the independent variable is 'nominal' or 'ordinal' and the dependent variable is measured at 'interval/ ratio'. In case of more than two groups of data the ANOVA test (analysis of variance) should be used.

- Cross-tabulation tables are frequently employed to examine the relationship between two variables (usually nominal or ordinal) that have a small number of categories. With inferential statistics, the aim is to draw conclusions about the 'population' that the 'sample' was drawn from. In other words, to find out whether the difference between two variables observed in the cross-tabulation represents a real difference in the population as a whole; Chi-square test enables to make such judgement in case of nominal/ ordinal measurements.
- Chi-square test is a non-parametric test. It accepts weaker, less accurate data as input than parametric test (e.g. t-test and ANOVA).
- To measure the strength of an association; Phi and Cramer's V are frequently used if one or more of the variables is nominal.
- Factor Analysis is a 'data reduction' statistical technique that allows to simplify the correlational relationships between a number of continuous variables. What factor analysis does is provide reliable means of simplifying the relationships and identifying within them what factors, or common patterns of association between groups of variables underlie the relationships.
- Correlation tests aim to investigate association between two or more variables. This would be through testing whether changes in one variable are met with similar changes in the other variable (Field, 2005)

There are more advanced statistical analysis such as 'regression', as it is predicting some kind of outcome from one or more predictor variables. This is argued to be a powerful tool as it allows going a step beyond the data actually at hand (prediction). This is, however, beyond the scope of this research, but is considered for future research to 'predict' the behaviour of the UK construction industry requirements in respect of MMC.

4. CONCLUSION

This paper investigated the quantitative research strategy for the current research for developing a collaborative training and education model for the UK construction industry professionals in respect of Modern Methods of Construction (MMC) in general and Pre-fabrication in particular. This investigation encompassed the process for developing the data collection instrument (questionnaire); data management and manipulation using the Statistical Package for Social Science (SPSS) for data reduction, data display, and conclusion drawing/ verification. Furthermore, suggested statistical tests for the current research were highlighted; and test for future research identified.

5. REFERENCES

Buckingham, A. and Saunders, P. (2004). The Survey Methods Workbook: From Design to Analysis. Polity Ltd. Cambridge, UK

Burgess, T. (2003). A general introduction to the design of questionnaires for survey research. Information Systems Services, Guide to the Design of Questionnaires. University of Leeds

Denzin, N. K. and Lincoln, Y. S. (1994). *Handbook of qualitative research*. Sage. London

Evans, J. (2006). Survey Design and Analysis. MRes Course at University of Salford, Salford, Greater Manchester, UK

Fellows, R. and Liu, A. (2003). *Research Methods for Construction*.2nd edition. Blackwell Science Ltd. Oxford, UK

Field, A. (2005). *Discovering Statistics Using SPSS*. 2nd ed. Sage Publications Ltd. London, UK

Huberman, A. M. and Miles, M. B. (1998). Data Management and Analysis. In N. K. Denzin and Y. S. Lincoln (eds). *Collecting and Interpreting Qualitative Materials*, Sage Publications, Inc. California.

Jagannathan, R. (2002) Methods of Planning Analysis. Course at Bloustein School of Planning and Public Policy, Rutgers University, New Jersey, USA

Kumar, R. (2005). *Research Methodology: A Step-by-Step Guide for Beginners*.2nd. Sage Publication Ltd. London

McNeill, P. and Chapman, S. (2005). Research Methods.3rd ed. Routledge.Oxon, UK

Thomas, R. (1996). Surveys. In T. Greenfield (eds). Research Methods: Guidance for Postgraduates, Arnold. London

Welman, C., Kruger, F. and Mitchell, B. (2005). Research Methodology. 2nd ed. Oxford University Press Southern Africa. Cape Town

Worsley, P. (1977). Introducing Sociology.2nd ed. (Penguin Education) Harmondsworth: Penguin