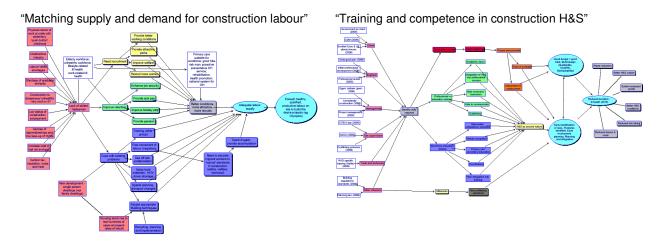
Key Steps in the Analysis of Causal Maps

This note outlines key steps in the analysis of causal maps, resulting from industry workshops undertaken as part of the Big Ideas research project. It is important to note that, although these steps suggest a fairly structured and linear approach in the analysis, the actual process may be more of iterative and trial and error in nature. The overall process can be divided in two parts, namely constructing 'global' (combined) map and analysis. The analysis as explained here focuses on identifying central issues and their connections with other peripheral issues within the 'global' map, although another possible analysis is also suggested. A detailed description is presented in 'skills' paper.

Constructing 'global' map

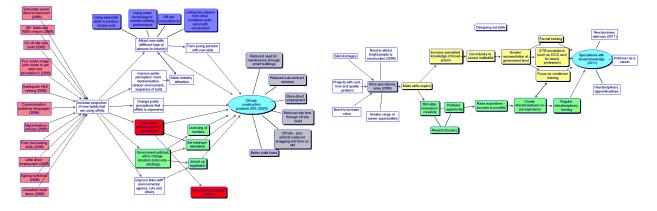
Step 1: Determine theme of the paper; and assess and select relevant causal maps

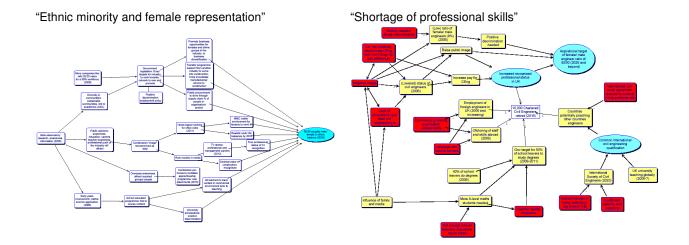
The assessment investigates issues depicted within potential causal maps, look for similarity, resonance between issues for possible merging. Ensure that issues within the maps cover a range of related topics. There is no guidance on the optimum number of maps, but say between 4 to 7 maps for further analysis. For example, six causal maps have been included in the skills themes:



"Improving site condition using offsite"

"Greater emphasis on multi-skilled/ inter-disciplinary workforce"





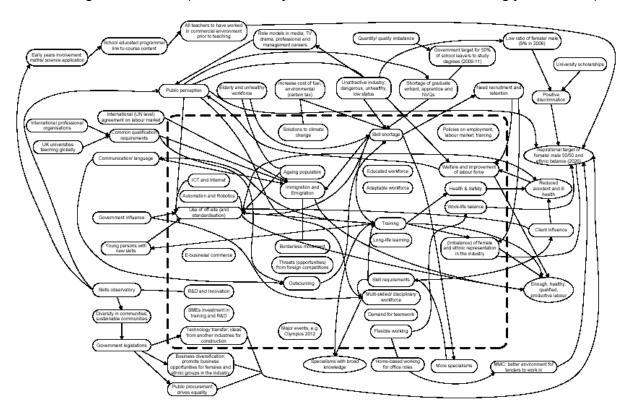
Step 2: Develop table for exploration and cross-reference

Explore driver table for identifying issues which may be associated with the chosen theme of the paper (see example below). These will be cross-referenced with those of the causal maps. This provide a basis for 'screening' individual issues for possible combining issues (i.e. common term) to be put in the 'global' map. Given the wide scope of the workshop discussion, it is most likely that some issues from the causal maps are not identified in the driver table. Issues identified from both causal maps and drivers table could be separated from those identified from causal maps only. The purpose is for organising the issues within the global map. The same process of combining closely related issues of those not identified from the literature and workshops, should be conducted and then put in the 'global' map. Refer to the global map of skills theme (below), those in the box were identified from both literature and workshops, whereas those outside the box are only from causal maps.

Category		Issues	Related to Skills							
				Demographics	Training and competence	Site Conditions	Multi-skilled/ interdisciplinar y workforce	Shortage of professional skills	Ethnic minority and female representation	Common Term
cal	ICT	ICT use	*							ICT and Internet
		3D technology (VR, CAD)	*							
		Knowledge management	*							
ġ		Network and internet use	*							
ĕ		Sensortechnology				*				Automation and Robotics
를	Automation	Robots use	*							
Technological		Sensors and control equipment in building				*				
	Off-site & standardisation	Off-site & standardisation	*	*		*				Off-site & standardisation
		New manufacturing technologies	*							
		Innovative approaches to sustainabilit	*							
		Reduce waste			*					
_		CO2 production/emission		*						
重		South East (London) as competitive global hub	*							
Environmental	Demography	Demography profile	*							
	, , ,	Ageing population (UK)	*			*				Ageing population
		Young people in workplace (availability of workforce)	*					*		
		Increasing migration (and emigration)	*			*		*		Immigration and Emigration
ш		Radical solutions to climate change*	*							Solutions to climate change

Step 3: Assimilate 'global' map

Locate all the issues (combined or otherwise) in a map and assemble their interconnectivities (solely) derived from the causal maps. There are two types of relationships, one is 'cause and effect', depicted by line with arrow at the end, and the other one is association and/or connotation, illustrated by line without arrow. Cause and effect relationships are mainly suggested by the causal maps, whereas association/connotation relationships are those 'weakly' suggested by the maps. Here, 'weak' relationships may mean indirect relationships as depicted by the maps. In addition to these, some of the association relationships could be drawn based on their strong connotation (as decided by the researcher, but with strong justification).



Analysing 'global' map

Step 4: Conduct 'domain' and 'central' analyses and compare results

Examination of the global map showed that some issues have more connections with the other issues than the others do. Higher number of connections attached to an issue suggests the importance of that issue, which potentially may influence and/or be influenced by others. The assumption is that informants tend to talk more about what they see as important issues (di Gregorio, 2006). Identification of issues with higher number of connections was conducted using 'domain' and 'central' analyses within the Decision Explorer (henceforth DE) software (Ackermann *et al.*, 2005).

Domain analysis counts the total number of arrows in and out from each issue. It establishes linkages with other issues within its immediate domain. The analysis indicates the richness of meaning of each individual issue. However, this analysis only calculates local complexity and completely ignores the wider context of the issues (Eden, 2004). Central analysis extends the domain analysis to include successive issues after the immediate vicinity. The central analysis traces all issues

which are connected to the central issues both directly and indirectly. The score of central analysis is derived by adding domain score with diminishing weight of each successive layer. For example, each issue directly linked to a particular issue is given a weight of 1; issues in the second layer are given ½; issues in the third layer are given 1/3, and so on (Eden, 2004).

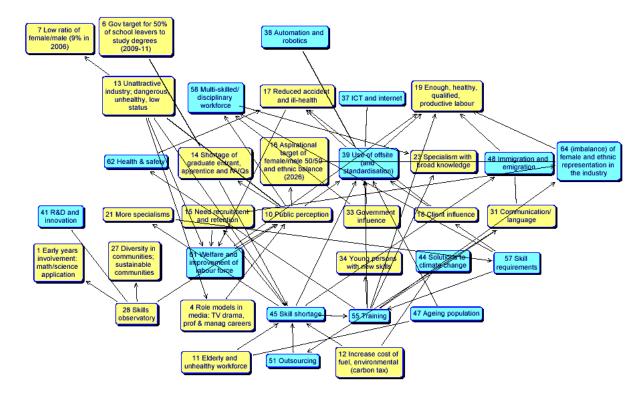
Guidance on how to execute this function can be seen in di Gregorio (2006) page 23 or DE user's guide version 3.2 pages 66-68, DE online reference version 3.3 pages 180-181 and 190. Then, compare the results between two analyses to identify few most important issues (see example below).

Domain Analysis		Central Analysis					
Issue	Score	Issue	Score				
Skill shortage	10	Use of offsite (and standardisation)	24				
Training	9	Public perception	24				
Aspirational target of female/male 50/50 and ethnic balance (2026)	8	Training	23				
Use of offsite (and standardisation)	8	Skill shortage	23				
Public perception	7	Aspirational target of female/male 50/50 and ethnic balance (2026)	22				
Enough, healthy, qualified, productive labour	5	(Imbalance of) female and ethnic representation in the industry	20				
Welfare and improvement of labour force	5	Enough, healthy, qualified, productive labour	20				
Unattractive industry; dangerous, unhealthy, low status	4	Unattractive industry; dangerous, unhealthy, low status	20				
Reduced accident and ill-health	4	Welfare and improvement of labour force	19				
Government legislations	4	Shortage of graduate entrant, apprentice and NVQs	19				
Common qualification requirements	4						
Immigration and emigration	4						
Skill requirements	4						
Multi-skilled/disciplinary workforce	4						

Step 5: Map most important issues identified by domain and central analyses and compare results

The most important issues as identified by domain and central issues could be used to generate maps which show all the (peripheral) interconnected issues. Map function is available in DE software (see di Gregorio (2006) page 19). Guidance for mapping to specific levels and including only out/in elements can be seen in di Gregorio (2006) page 50.

A map generated based on 'use of offsite (and standardisation)' is shown as follows.



Step 6: Compare issues associated with central issues

Develop a table that compare issues identified from mapping the central issues (e.g. those issues identified in the map above) and investigate possible overlap between maps. This should identify fewer maps with most central issues in them. The 'angle' and discussion of the paper should be guided by these maps.

ID	Issue Description	Cluster with Central Issue (ID)							
		61	13	19	16	45	55	10	39
1	Early years involvement: maths/ science application								
2	School educated programme/ link to course content								
3	All teachers to have worked in com env prior to teaching								
60	Flexible working								
61	Welfare and improvement of labour force								
62	Health & Safety								
63	Work-life balance								
64	(Imbalance) of female and ethnic rep'tation in the industry								
	Proportion of issues covered in cluster 39 (%)	100	95	94	65	94	100	100	

Note:

: indicates central issue

: indicates issues within immediate vicinity of central issue

: indicates related issues

Other potential analysis technique

Steps 4-6 are considered as one route in analysing data of this kind. Other possible approach is using 'cluster' analysis, which function is also provided in the DE software. Cluster analysis was not suitable for the skill theme as it arrives at two large clusters, also bypasses the identification process of the most important issues (i.e. domain and central analyses). The use of particular analysis is very much contingent upon data pattern, which could be explored (and detected) by trial and error using analysis as demonstrated here. Edkins et al. (2007) provides a brief overview of interesting cluster analysis for cognitive maps. This might be considered for future 'bespoke' analysis of the other emerging themes.

References

di Gregorio, S. (2006) Introduction to Decision Explorer. A short course note.

Banxia Software Limited (2002) *Decision Explorer User's Guide version 3.2*. Banxia Software Limited, Kendal, UK.

Banxia Software Limited (2005) *Decision Explorer Online Reference version 3.3.* Banxia Software Limited, Kendal, UK.

Edkins, A.J., Kurul, E., Maytorena-Sanchez, E. and Rintala, K. (2007) The application of cognitive mapping methodologies in project management research. *International Journal of Project Management* (article in press).