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'LEARNSAFE' LEARNING ORGANISATIONS FOR NUCLEAR SAFETY

Theme: Methodology

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1 Abstract

The people engaged in nuclear power generation have been faced with continuous change over the past decade; however, these changes have recently accelerated. Currently, there are rapid external changes taking place within the nuclear sector as a whole including the impact of new electricity tariffs and the establishment of the Liabilities Management Authority (LMA), to oversee legacy waste. At the same time the sector is also faced with a number of internal developments related to station closures and new organizational structures which provide the sector with a plethora of managerial challenges.

This paper will consider how the European research grant 'LearnSafe' (funded by the Nuclear Fission Safety part of the 5th Framework Programme of the European Union) has attempted to address the management of such challenges. Partners include representatives from academia and industry within five European countries. The emphasis of this paper will be on the development of opportunities for learning and the management of change. Initial phases of the research have been completed and preliminary findings will be discussed.

2 Introduction

2.1 Nuclear Energy at a Crossroads?

The nuclear power industry is currently experiencing a period of change, which has brought with it a number of challenges. Currently, there are rapid external changes taking place within the nuclear sector. New electricity tariffs are having a huge impact on the industry as a whole and the sector is experiencing difficulties in competing with other means of power generation. The publication of The UK Energy Review (http://www.piu.gov.uk/2002/energy/report/) has also resulted in a number of challenges due to the fact that the report was not supportive of new build at present. The situation will however be reviewed at a later date. The establishment of the Liabilities Management Authority (LMA), to oversee legacy waste will create huge change for the nuclear power sector as current operators of nuclear installations will be required to tender for clean up work and will need to organise accordingly. At the same time the nuclear industry has also had to deal with a number of substantial internal developments related to station closures and new organisational structures which provide the sector with a plethora of challenges. All Magnox plants within the UK have now been issued with a date for closure, which indicates the beginning of the decommissioning process at the plant. Closure has a potentially huge impact on personnel motivation and is thus an important challenge for senior management to overcome.

2.2 Aims and Objectives

The LearnSafe project (http://www.vtt.fi/virtual/learnsafe) was developed with a number of objectives in mind; (1) to build upon previous EU funded research aimed at defining organisational factors and highlighting their influence on nuclear safety (ORFA); (2) to provide support for senior managers at nuclear power plants (NPPs) and at corporate levels responsible for strategic choices and allocation of resources across five European countries; (3) to develop methods and tools which could support the early identification of emerging safety problems within the sector and indicate problems associated with change strategies; (4) to develop methods and tools for supporting processes of organisational learning within NPPs; and (5) to provide feedback to participants via seminars and discussion groups.

The LearnSafe project involves partners from academia and industry, as well as one international organisation (World Association of Nuclear Operators), from five European countries (see Table 1).

Table 1. *Details of the partners involved in the LearnSafe project.*

VTT, Finland Berlin University of Technology, Germany Lancaster University Management School, UK Ciemat, Spain SwedPower, Sweden UNESA, Spain WANO, Paris Centre	Teollisuuden Voima Oy, Finland Forsmark Kraftgrupp AB, Sweden Kernkraftwerk Grafenrheinfeld, Germany Kernkraftwerk Krümmel, Germany British Nuclear Fuels Ltd (Magnox), UK OKG Aktiebolag, Sweden Ringhals AB, Sweden

LearnSafe has been divided into two major phases of theoretical and empirical investigations. The first phase is devoted to the management of change due to the belief that the adaptation to changed environmental conditions provides one of the major challenges to nuclear power plants today. The second phase is devoted to organisational learning, which is seen as an important process in the pursuit of continued improvement of performance measured in terms of both safety and efficiency.

2.3 Past Research

Learning, at all levels of employment, plays an important role within high-reliability organisations. Organisations within the nuclear sector, are required to 'manage safety as a major component of operations, and must therefore learn from precursors and near misses rather than exclusively by trial and error' (Carroll, 1998). Learning is a hypothetical construct i.e. it can not be directly observed but can only be inferred from observable behaviour. Learning normally implies a fairly permanent change in a persons behavioural performance as a result of past experience (Anderson, 1995). Espejo *et al* (1997) suggest that the essence of organisational learning is the ability to adapt to change, which is a prerequisite for the survival of an organisation in a changing environment. While, Argyris (1993) suggests that 'Organisational learning is a competence that all organisations should develop.' He believes that the reasons underlying this premise are that the better organisations are at learning the more likely it is that they will be able to detect and correct errors. Cox and Cox (1996) suggest that one of the characteristics of low accident plants was their focus on organisational learning. They believe that, in terms of safety, learning means that an organisation deliberately collates, analyses and disseminates all its performance data, including its accident and incident data, so that the whole organisation and its employees may learn from the incidents that have occurred. It is interesting to speculate whether the conclusions drawn from their work carried out in Industrial Gases (Cox and Cox, 1992) has relevance for other high reliability organisations.

Weick (2001) believes that organisations in which reliability is a more pressing issue than efficiency often have unique problems in learning and understanding, which if unresolved can affect performance adversely. One such unique problem is that a major learning strategy, trial and error is not available to them because errors cannot be contained. Weick (2001) suggests that the more likely an error is to propagate, the less likely the system is to utilise trial and error to understand the source of the error. Due to this limitation high- reliability organisations potentially know little about the very events that can be most damaging to them. As a result of the limited use of trial and error many high-reliability organisations use unconventional means to achieve error free performance. Since learning and reliable performance is difficult when trial and error is precluded reliable performances become dependent on the development of substantial substitutes to trial and error. Weick suggests that substitutes for trial and error come in the form of imagination, vicarious experiences, stories, simulations and other symbolic representations of technology and its effects. Weick believes that a system that values such substitutes is potentially more reliable because people know more about their system, know more about the potential errors that do occur because they know that other people have already handled similar errors.

Failure within a nuclear facility could have potentially disastrous implications and thus have to be avoided. Furthermore, even minor events within nuclear plants are immediately disseminated worldwide. However, Sitkin (1992) proposed that learning from failures is an essential prerequisite for effective organisational learning. He believes that successful outcomes (i.e. no accidents) have four associated liabilities; (1) success can lead to complacency i.e. it is often difficult to get people or groups to pursue new ways of doing things when the current ways are relatively successful, 'if it ain't broke don't fix it'; (2) success can restrict search and lead to low levels of attention; (3) success may lead to risk aversion within the organisation; and (4) homogeneity is a liability of success. Sitkin (1992) therefore, suggests that an alternative to success is strategic failure. He proposes a number of benefits of intelligent failure which include an increase in attention and a quicker response to the processing of potential problems; ease of recognition and interpretation of problems; a stimulation of the search process; an increase in motivation to adapt; the development of risk tolerance; and finally, failure was identified as being a more effective means of pursuing learning. Sitkin suggests that the presence of failure leads to an increased resilience when employees are confronted with novel situations, 'people can cope with surprise better when they have repeated exposure to it' (Weick, 1985). Thus, Sitkin believes that an organisation will learn more effectively from experiencing failure rather than success. Even within high-reliability organisations were the specter of catastrophe makes failure difficult to routinise, it is essential that large-scale problems be reduced to more manageable levels to permit experimentation (Leary, 1988). Within the nuclear industry a Behavioural Safety process has been implemented, which not only trains employees the safe way to perform an act but also informs individuals on the unsafe way to perform the act.

March *et al.* (1991) examined how high-reliability organisations can convert meager experience into interpretations of history by experiencing infrequent events richly and thus learn from such experiences. They believe that organisations attempt to pool historical events across diverse contexts as well as treating unique historical events as detailed stories rather than single data points. March *et al* proposed that high-reliability organisations use a series of techniques to aid the learning process - simulating hypothetical events/ near histories and hypothetical histories. Using the first technique organisations define and elaborate a class of historical non-events i.e. events that almost happened. Whilst the second technique is used to define and elaborate a class of hypothetical historical non events i.e. events that might of happened under certain unrealised but plausible conditions. Using such methods, organisations are able to produce a clearer understanding of unique experiences and events. These techniques aid organisational learning within high-reliability organisations by enabling them to learn even though their history offers only meager samples of experience.

The paradox between learning and safety within the nuclear industry creates a number of challenges in itself, thus it is important to develop existing tools and create new methods to support learning within the sector. This has paradox acted as a stimulus to take things further and lead to the development of the 'LearnSafe' project.

2.4 Research Questions

Phase 1 – Management of Change

Q1: What are the perceived emerging challenges in the management of nuclear power plants?

Q2: How do senior managers cope with emerging challenges in the management of nuclear power plants?

Q3: What improvements could be made in respect to coping with emerging challenges in the management of nuclear power plants?

Phase 2 – Organisational Learning

Q4: What kind of features and attributes characterise learning organisations?

Q5: What are the most common barriers to organisational learning and how can they be removed?

Q6: How are various company cultures and sub-cultures influencing organisational learning?

3 Methods

The LearnSafe research team selected several methods to be utilised to respond to research question Q1. The target groups and the chosen methods are illustrated in Figure 1.

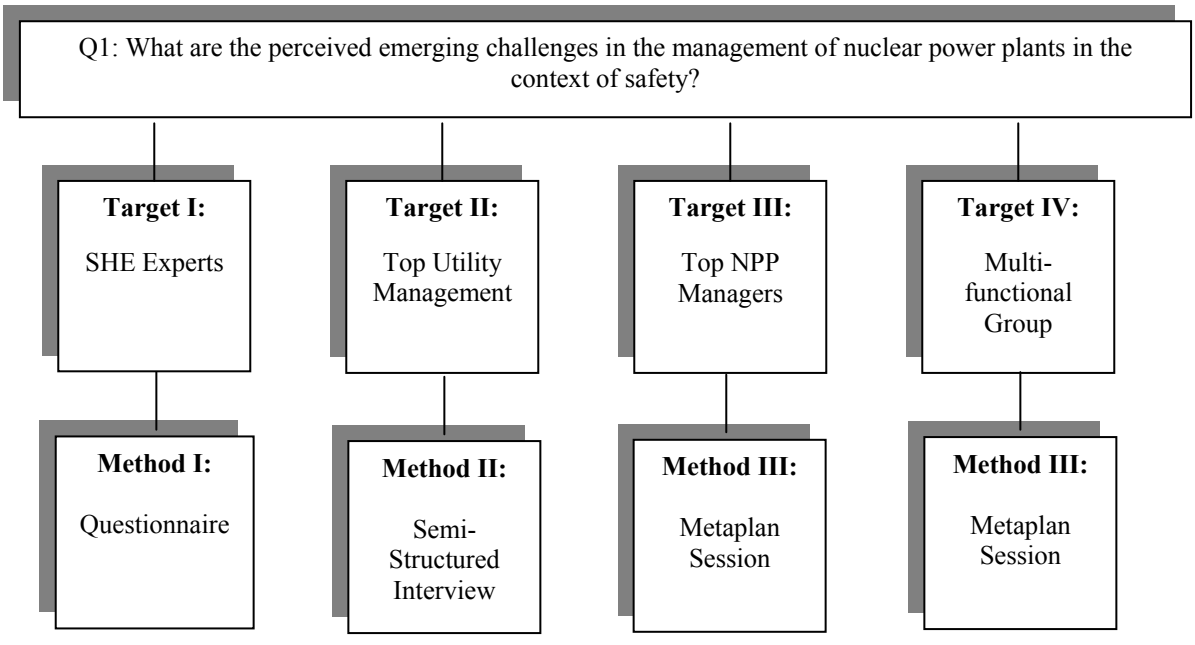

Figure 1. *Methods utilised for answering the research question Q1 of the LearnSafe project*

3.1 Questionnaire Study

Safety, Health and Environmental (SHE) professionals (n=35) were selected using an opportunity sampling method, to become part of an expert group (Target Group I). Two questionnaires were utilised to gather data from the expert group in relation to the urgency (current challenges: 0-5 years, intermediate challenges: 5-10 years, future challenges: +10 years) and importance (extremely important, very important, fairly important, neither important or unimportant, fairly unimportant, very unimportant, extremely unimportant) of challenges faced by the management of nuclear power plants. Questionnaires were completed and then returned to the research team.

3.2 Semi-structured Interviews

Interviews were conducted with top utility management (n=12) within each of the participating countries (Target Group II). Semi-structured interviews were used to gather data. Interviewees were asked to talk freely around research question Q1 and share their thoughts on a number of challenges generated by the LearnSafe research team from past research. Detailed interview notes were taken during the course of the interview.

3.3 Metaplan Sessions

Senior nuclear power plant managers (n=63) at participating sites were asked to participate in metaplan sessions (Target Group III). Sessions were designed to create an opportunity for mapping the challenges. Metaplan is an active data collection technique during which the researcher acts as a moderator to the process and guides the group through the discussion, while notes are taken to reflect the discussions between the members of the group. The metaplan methodology was also used with a group of functional managers (n=85) from participating NPPs (Target Group IV).

3.4 Case Studies

Case studies are currently being generated in response to research question Q2. These case studies are intended to identify methods of coping with the most important challenges identified in the preliminary data analysis. Two methods are currently being utilised to collect data for the case studies. The first method involves holding group sessions with a team of nuclear power plant senior managers. While, the second method involves building the case study through an open-ended questionnaire distributed to selected group of people within the nuclear power plant.

3.5 Group Brainstorming Sessions

Data will be gathered in response to research question Q3 via group brainstorming exercises involving all partners. Representatives from participating reactor sites and utility's from across Europe will be invited to the WANO Paris Centre to take part in brainstorming sessions to generate alternative methods of coping with the challenges faced by the nuclear industry. A web-based "chat room" to facilitate interactions between research partners will also be established.

4 Results

Preliminary data was analysed by researchers using several complementary data analysis methods.

The questionnaire data was analysed using SPSS. Descriptive statistics and frequency data portray similarities and differences between each of the European data sets. Preliminary analysis of the data has uncovered some interesting findings (see Table 2 and Table 3 and Figure 2).

Most Important

• Public opinion • Importance of human Factors • Adaptation to reduce costs • De-motivation of personnel • Difficulties in recruitment/ Ageing of staff • New methods of regulation • Competition • Ageing components	
• Floods of paperwork • Mergers • Multi-regulators • Subcontractors • Globalised perception of events • Terrorism	• Opting out • Decommissioning • Deterioration of the fuel cycle • Increase in specialisation

Current — Future

Least Important

Figure 2. *Challenges faced by the nuclear industry across Europe*

Table 2. *Percentage scores for the importance and urgency of challenges across Europe*

Challenge	Urgency			Importance						
	Current	Intermed.	Future	Extremely Important	Very Important	Fairly Important	Neither Imp/ Unimp	Fairly Unimp.	Very Unimp.	Extremely Unimp.
Ageing of Personnel/ generation shift/ preservation of competence	52.9	41.2	5.9	51.4	40.0	8.6	0	0	0	0
Contractors (availability, skills and competency)	45.7	54.3	0	11.4	51.4	25.7	8.6	2.9	0	0
Difficulties in recruiting young people	50.0	44.1	5.9	14.7	44.1	32.4	5.9	2.9	0	0
De-motivation of personnel	64.7	29.4	5.9	17.1	40.0	28.6	8.6	2.9	2.9	0
Premature closing of plants due to electricity prices	14.7	29.4	55.9	5.7	11.4	22.9	22.9	20.0	11.4	5.7
New methods and principles of regulation	73.5	17.6	8.8	2.9	41.2	38.2	5.9	8.8	2.9	0
Floods of Paperwork	87.1	9.7	3.2	3.2	16.1	51.6	16.1	3.2	9.7	0
Globalisation of perception of events	61.8	29.4	8.8	2.9	25.7	37.1	25.7	5.7	2.9	0
Public opinion	79.4	20.6	0	25.7	45.7	25.7	2.9	0	0	0
Mergers and Acquisitions	60.6	30.3	9.1	2.9	20.0	42.9	22.9	8.6	2.9	0
Subcontractors/ contractors: cancellation and monopolisation	39.4	54.5	6.1	2.9	26.5	44.1	20.6	2.9	2.9	0
Deregulation/ competition	62.9	34.3	2.9	20.6	38.2	32.4	8.8	0	0	0
Increasing importance of human and organisational factors	72.7	27.3	0	26.5	52.9	8.8	8.8	2.9	0	0
Constraints to reduce costs: shorter outage/ corporate influence/ dismissals	85.3	11.8	2.9	23.5	44.1	23.5	8.8	0	0	0
Distrust in authorities: national and international	19.2	53.8	26.9	3.4	20.7	20.7	17.2	10.3	13.8	13.8
Ageing components	39.4	51.5	9.1	11.8	47.1	41.2	0	0	0	0
Decommissioning	8.8	23.5	67.6	2.9	20.6	20.6	11.8	20.6	17.6	2.9
Terrorism/ sabotage	64.5	25.8	9.7	0	39.4	33.3	12.1	12.1	3.0	0
Difficulties to proceed with programmes for waste storage	27.3	36.4	36.4	17.6	32.4	20.6	2.9	5.9	17.6	2.9
Uncoordinated regulatory actions	62.5	18.8	18.8	3.1	25.0	34.4	25.0	9.4	3.1	0
Utilisation of information and telecommunication technologies	64.7	29.4	5.9	2.9	52.9	23.5	20.6	0	0	0
Increase in specialisation	27.6	58.6	13.8	3.4	27.6	31.0	27.6	3.4	6.9	0
Difficulty in maintaining competency in specialised nuclear fields	28.6	64.3	7.1	28.6	42.9	17.9	7.1	3.6	0	0

Table 3. *Mean scores for the importance (I) and urgency (U) of challenges*

Challenge	Finland		Germany		UK		Sweden		Spain	
	I	U	I	U	I	U	I	U	I	U
Ageing of Personnel/ generation shift/ preservation of competence	1.22	1.56	1.50	1.40	1.40	1.20	1.67	1.00	2.00	1.78
Contractors (availability, skills and competency)	2.56	1.56	1.83	1.17	2.60	1.60	2.17	1.67	2.67	1.67
Difficulties in recruiting young people	2.33	1.38	1.83	1.67	2.40	1.00	2.20	1.67	2.89	1.89
De-motivation of personnel	2.67	1.38	2.33	1.50	3.20	1.60	2.33	1.17	2.11	1.44
Premature closing of plants due to electricity prices	5.00	2.63	3.50	2.17	3.40	2.00	3.50	2.17	3.89	2.78
New methods and principles of regulation	3.33	1.50	2.17	1.00	3.20	1.20	2.60	1.17	2.78	1.67
Floods of Paperwork	3.38	1.13	2.20	1.00	4.00	1.00	2.80	1.20	3.78	1.33
Globalisation of perception of events	3.33	1.56	2.83	1.33	3.20	1.50	2.83	1.17	3.33	1.67
Public opinion	1.67	1.11	2.67	1.00	2.20	1.40	2.50	1.20	1.67	1.33
Mergers and Acquisitions	3.00	1.56	3.67	1.20	3.20	2.00	3.00	1.00	3.33	1.63
Subcontractors/ contractors: cancellation and monopolisation	3.44	1.75	2.17	1.80	3.80	1.80	3.00	1.17	2.78	1.78
Deregulation/ competition	2.44	1.44	2.50	1.00	2.00	1.60	2.33	1.50	2.13	1.44
Increasing importance of human and organisational factors	2.56	1.57	2.00	1.33	2.00	1.20	1.83	1.00	1.89	1.22
Constraints to reduce costs: shorter outage/ corporate influence/ dismissals	2.33	1.13	1.67	1.00	3.00	1.60	2.60	1.00	1.67	1.22
Distrust in authorities: national and international	5.13	2.14	6.20	2.00	2.50	2.00	2.60	1.83	3.29	2.25
Ageing components	2.22	1.62	2.33	1.67	2.40	1.20	2.20	1.80	2.33	2.00
Decommissioning	4.78	2.75	4.00	2.50	2.00	2.00	4.60	2.83	3.44	2.67
Terrorism/ sabotage	2.89	1.75	3.50	1.00	2.60	1.00	4.00	1.67	2.63	1.50
Difficulties to proceed with programmes for waste storage	4.67	2.63	1.83	1.33	1.40	1.25	4.20	2.67	2.78	2.11
Uncoordinated regulatory actions	3.89	2.13	2.76	1.00	2.20	1.00	3.00	1.17	3.44	1.89
Utilisation of information and telecommunication technologies	2.44	1.13	2.33	1.83	3.40	1.40	3.00	1.17	2.33	1.56
Increase in specialisation	3.38	1.71	3.20	1.75	4.67	2.00	2.80	1.50	2.76	2.25
Difficulty in maintaining competency in specialised nuclear fields	2.33	1.88	0	0	2.40	1.20	1.80	1.83	2.00	2.00

It is interesting to note that all of the challenges were considered by the expert group to be current and this could reflect the view that nuclear power generation throughout Europe is increasingly perceived to be a dying industry (in Finland however the Government has recently commissioned a new build). There are both differences and similarities evident between each of the European data sets (see Table 3).

Two methods were utilised to analyse the data collected via metaplan sessions and semi-structured interviews - content analysis and fuzzy sets analysis. Content analysis is a process by which communication content is transformed, through the objective and systematic application of categorisation rules, into data that can be summarised and compared.

Researchers utilised computer assisted qualitative data analysis software (NVivo) to carry out such analyses of the data. Data was coded by researchers using standardised instructions based on the LearnSafe research model (see Figure 3). Analysis of the data using content analysis allows for the observation of both similarities and differences between the European data sets (see Table 4).

Table 4. *Frequency data generated from the Content Analysis*

Country	Strategic Financial Management	Human Resource Management	Technology Management	Quality Management	Environment
Finland	4	31	21	12	29
Germany	16	31	13	28	37
UK	34	98	24	32	68
Sweden	34	87	28	35	79
Spain	41	98	16	31	93
WANO	11	11	5	2	11
Total	**132**	**343**	**102**	**132**	**308**

Data was also analysed using fuzzy sets theory; this method of analysis involves challenges being classified into a small number of fuzzy sets, which are defined by an underlying model of management tasks (see Figure 3). The degree of membership to the five fuzzy sets was assessed by three independent researchers using a standardised set of instructions and a scale of 0 to 100 points (100 points denotes a very strong membership while 0 denotes no membership).

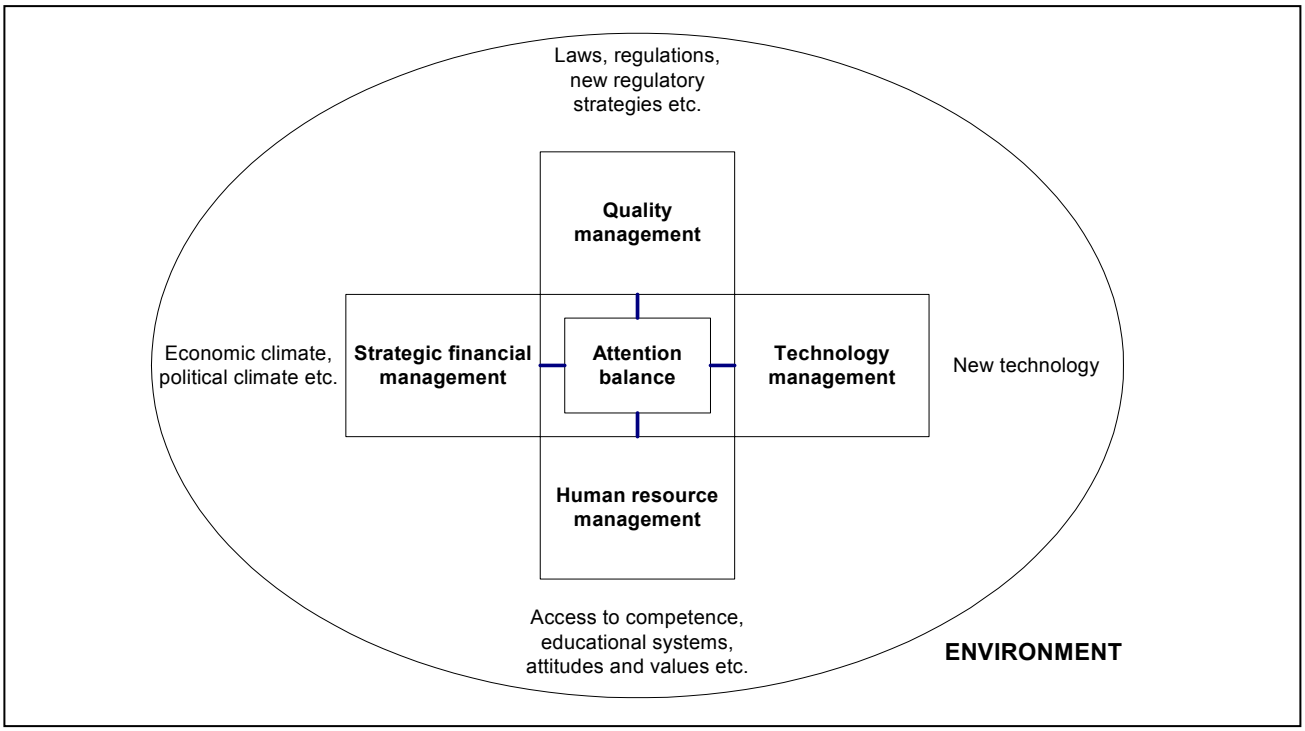

Figure 3. *LearnSafe model of management tasks*

A cluster analysis was performed using the average score from the three independent assessors coding. The cluster analysis revealed the presence of eight clusters within the data set. The clusters were labeled to reflect the challenges within (see Table 5). The groups of

challenges and their loading on the five dimensions (Strategic Financial Management, Human Resource Management, Technology Management, Quality Management and Environment) are given in Table 5. Loadings below 0.20 have not been included. The largest loading is presented in bold to indicate the centre for the challenges within each group. The loadings indicate that the challenges in the group should be balanced between demands in the basic dimensions.

Table 5. *Clusters and their loadings on each of the five dimensions*

Cluster	Strategic Financial Management	Human Resource Management	Technology Management	Quality Management	Environment
Economic pressures	**0.84**			0.47	0.66
Human resource management	0.42	**0.96**		0.49	0.43
Nuclear know-how	0.38	0.62		0.44	**0.80**
Rules and regulation				0.78	**0.85**
Focus and priorities		0.40		**0.76**	
Ageing, modernisation and new technology	0.49		**0.91**	0.43	
Public confidence and trust				0.30	**0.90**
Climate and culture		**0.87**		0.53	

5 Discussion

The importance of learning within the nuclear sector must not be understated. Senior managers of NPPs must remain alert to possible challenges and they must be clear on how they will deal with such challenges if they were to arise. There have been a number of interesting findings from the analysis of the LearnSafe European data sets. Researchers have identified challenges faced by the European nuclear power industry along with challenges specific to each of the participating countries. Similarities and differences that are present between the data sets have also been uncovered during the analysis of the data.

The analysis of the questionnaire data generated from SHE experts enables us to assess the challenges faced by the nuclear power industry. The majority of challenges have been given a mean score, on the urgency scale, of between 1.2 to 2.2. This suggests that the majority of experts considered the challenges to be current and dealt with relatively urgently. Only a small number of challenges were identified as challenges for the future (see Table 2). The majority of challenges were rated, on the importance scale, as having a mean score of between 2.0 and 3.4. This suggests that the challenges were considered to be either very important or fairly important. The most important, variable rated by the expert groups across Europe, was the 'ageing of personnel/ preservation of competence' with 91.4% of experts rating this challenges as either extremely important or very important. While, the most urgent challenge was considered to be 'floods of paperwork' with 87.1% of experts rating this challenge as current. Further analysis of the data revealed that 'constraints to reduce costs', 'public opinion' and 'the increasing importance of human factors' were the most important and most urgent challenges as per to the experts ratings.

There appears to be some differences in the national opinions of the expert groups (see Table 3). 'Distrust in authorities' for example does not seem to be an important challenge in Germany however, in the United Kingdom it was rated by the expert group as being very important. While, 'premature closure of plants due to electricity prices' was not seen as being an important challenge in Finland in the United Kingdom it was rated by the expert group as being important. There are also a number of similarities in the expert ratings of challenges. There appears to be agreement between countries with regards to the 'ageing of components'; experts from all countries considering this challenge to be very important. There also seems to be agreement in relation to 'the ageing of personnel/ generation shift/ preservation of competence', with this challenge achieving the highest value on the importance scale in all countries. There are also both similarities and differences in the expert ratings on the urgency scale. The smallest difference in ratings exists for 'floods of paperwork'. While, the challenge that seems to have the widest difference in ratings is 'mergers: regional/ national/ international/ global'.

The content analysis of the data has also produced some interesting findings (see Table 4). Issues related to human resource management were considered to be the most important challenges facing senior managers at nuclear power plant within all participating countries; an example of the challenges that continuously appeared within the data set are the ageing of personnel at NPPs, the generation turnover and skills renewal. Issues within the environment, over which the NPP had little or no control, were also regarded as being a huge challenge for senior managers at NPPs. Public opinion pressures and globalisation of events were considered to be the most pressing issues within the environment. Technology management was not considered to be a pressing challenge within the management of a NPP in Europe. This suggests that managers at NPPs do not regard the ageing of equipment, plant maintenance, plant modernisation and the introduction of new technology as a pressing challenge. There do not appear to be any major differences between the data sets generated from Finland, Germany, the United Kingdom, Sweden, Spain or WANO. Thus there is reasonable agreement across Europe on the challenges faced by senior management of NPPs.

The analysis of the data using fuzzy sets theory reveals a number of clusters present within the data set (see Table 5). The clusters have been labelled to reflect the challenges within them. Examples of challenges loading on to the Economic pressure cluster include 'reducing costs', 'mandatory reduction of overhead expenses' and 'tension in the electricity sector'. Challenges loading on to the Human resource management cluster include 'staff wind down to closure', 'competency' and 'generation turnover'. While those challenges loading on to the Nuclear know-how cluster included 'decline of knowledge at the suppliers' and 'external competency support'. An example of challenges loading on to the Rules and regulation cluster includes 'new methods and principles of regulation' and 'lack of recognition of improving world standards'. While those challenges loading on to the Focus and priorities include 'avoid focusing on only short term issues' and 'reviews of working practices'. The cluster labelled Ageing, modernisation and new technology includes the challenges 'ageing components', 'modernisation of equipment' and 'technical renewal'. While the cluster labelled Public confidence and trust includes 'public opinion pressures' and 'an accident anywhere is an accident here'. The final cluster, Climate and culture, includes 'stimulation of critical thinking' and 'motivation of personnel'.

Organisational learning is seen as an important process in the pursuit of continued improvement of performance measured in terms of both safety and efficiency. However, the

nuclear power generating industry operates within a complex and paradoxical environment where organisational learning is essential but where many of the methods and tools utilised by other industries are not actually available to them (see for example Weick, 2001; Sitkin, 1992; and March *et al.,* 1991). It is therefore essential that new methods and tools are developed to assist learning processes within the nuclear power industry; it is hoped that LearnSafe will provide such assistance. Preliminary results from the analysis of the data sets will be fed back to industrial partners in each participating country. The analysis of the data has uncovered the main challenges faced by NPP senior managers across five European countries. The LearnSafe project will facilitate the sharing of this information across the participating European countries and beyond. Individuals will have the opportunity to learn more about the challenges that are affecting other nuclear power plants within specific countries and will as a result be better prepared to deal with such challenges should they arise.

6 Summary

The LearnSafe research has so far examined the plethora of challenges faced by the senior managers of nuclear power plants across Europe. Data gathered via questionnaires, semi-structured interviews and metaplan sessions have been analysed by researchers and preliminary findings have been discussed. The emphasis of this paper has been on the development of opportunities for learning and the management of change within the nuclear power generation industry.

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