



Closing the gap – the Perception and Reality of Environmental and Waste Performance in Chinese and Polish Industry

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Abstract

This paper is derived from research into the management of industrial and process waste in twelve large manufacturing factories in China and Poland. The research incorporates a unique methodology involving the expert benchmarking of environmental impacts, the use of questionnaires to elicit perceived environmental performance and, related to the same impacts, interviews across the complete management strata of each factory.

Sustainability is considered in the context of waste arising from production processes, including waste chemicals and scrap materials, and non-production wastes such as human ordure and detergents. Process waste results in an unsustainable depletion of raw materials, while human and non-production waste results in the unsustainable and irresponsible use of the atmosphere, ground, groundwaters and rivers.

The paper highlights the management of hazardous industrial waste as one area where an organizational fear and punishment culture is seen to restrict decisions to clearly defined job boundaries in such a way that flexible decision making is avoided and environmental management restricted to compliance rather than improvement and sustainable material use.

Keywords: Sustainability, Waste, Dysfunction, Perceptions, China, Poland

1. Introduction

This paper draws on five years of research in China and Poland in twelve factories at the *heavy end* of manufacturing and directed to the determination of why knowledge essential for the appropriate management of environmental impacts in manufacturing operations is often not evident or not properly deployed. During the period of the research, Poland had emerged from the communist regime, whereas China, while still communist, now had capitalist overtones.

Within such factories there is a clear difference between perceptions related to production and those to environment although, in many cases, scrap and waste are intimately connected to both because it is generally the waste contingent on production operations which causes the pollution of the rivers and contamination of the ground and ground waters. In most cases, *easy* waste such as paper and packing materials is nearly always recycled and does not form a major problem, it is the industrial and human wastes in and from processes and dormitories (China) that lack attention in the factories and thereby pose high risk situations - these are the wastes that are considered in this paper. See Watson and Brady (2007) for a legal position on difficult wastes (including leaking sewer pipes).

Despite China's rapid industrialization, the infra-structure for good governance and corporate social responsibility has not kept pace as evidenced by the severe pollution of its major rivers (Economy and Liebethal, 2007), the effects of centralized industry (Shang, 2008) and the frequent outrages of poisoned workers, mostly due to the lack of control of material and waste in and from the factories.

The paper commences with an explanation of the research context and the methodology employed. It goes on to compare the actual sewage and waste arisings and their impacts in various locations with the environmental

performance as perceived by the management in each factory. Some possible explanations for the identified disparities are discussed in the concluding sections.

2. Industrial waste in China and Poland

China and Poland were chosen as the industrial contexts for the study for two reasons. Firstly, each was experiencing considerable environmental problems alongside rapid economic and political change. Secondly, the lead author had access and was already engaged as an evaluator of environmental management systems in those countries and was concerned that the expected environmental benefits from those systems was not being realised. Table 1 provides a comparison of eighteen key factory attributes in the two countries, ten of which relate to waste or potential for waste-related problems.

Most of the study factories in the South of China lie near to or on the Pearl River Delta, or near other rivers. In consequence it is important for them to have a good control on the waste effluents and chemicals. Two factories near Shanghai are on a plain through which the Suzhou (*sue-joe*) river flows, and the tributaries to this major river are grossly polluted and fed by effluent from the subject factories. All the factories were in development zones that have resembled permanent domestic and industrial building sites since 1994.

In Poland, three of the factories were near rivers with existing or imminent groundwater controls. The largest sites (44ha plus each) were grossly contaminated (Cole, 1989) from many years of uncontrolled disposal of waste chemicals, tars, clinker and fly ash to ground, and this had fed through even to deep wells at 75-100+ metres. The other two factories were/are on greenfield sites and posed no substantial risk to the ground and/or controlled waters.

3. Methodology

The data on which the paper is constructed was derived from a triangulated four part methodology in which each data stream provided a check on the others:

expert derived reality benchmarks (rbm's) arising from detailed observations of factory impacts;

strength of feeling (SOF) perceptions questionnaire (Table 2) to all the 164 managers;

notes from interviews with the top manager at each of the twelve factories;

informal discussions with other managers.

The reality benchmarks represent an objective measure against which the perceived performance could be compared and were formulated by the lead author who had an intimate knowledge of the sites. For instance, in response to Question 18 'we always use non-toxic solvents', all the sites but one (with marginal use) do use such solvents, hence the reality benchmark (rbm) is '0'. For Question 6 'waste and scrap are under control in our factory', there will be different degrees of control among the factories and hence different rbm's (see Table 4).

The interviews with the top managers were face to face and unstructured, with an aim to determine any discrepancies between what the manager believed about the workings of his factory, the perceptions of his sub-ordinate managers and the reality benchmarks which represent one form of environmental measurement.

The questionnaire was designed in such a way that a differentiation could be made between production and environmental (belief) drivers as well as the gaps between core perceptions of socio-cultural groups and reality on the ground in respect of the environment (see also Lynn, 2005). The analysis of the data collected therefrom was performed with the aid of SPSS and Mathcad software programs but is inherently qualitative (as defined by Alasuutari, 1995).

4. Environmental aspects and data

4.1 Main problem contexts

In the worst affected sites for contamination feeding through to ground waters, there were some very severe point sources (see also Price, 1996) and more diffuse paths due to clinker, fly-ash and toxic oils. Many of the chlorinated oils are also volatile, they vaporize and mix with the air in the unsaturated zones, and the vapour travels through the air-filled holes by diffusion. It can then re-liquify into pellicular water (adhering to stones etc as a film) and travel to different parts of the aquifer (Price, 1996). When these hydrocarbons are Non- Aqueous Phase Liquids (NAPL's), either dense and light, they can be very hard to remove from the water to allow it to be made potable - such contamination prejudices the sustainability of sources for potable water. Some good case studies in the remediation of contaminated waters are presented by Cronk and Martin (2004).

In the Polish factories there is significant undeployed knowledge about all the sources of environmental degradation. In three of the factories there is from 3 to 20 hectares of grossly contaminated land from the clinker and fly ash from boiler houses that burned low grade coal (lignite), and waste oils, solvents, daph's (dense aromatic polycyclic hydrocarbons), arsenic, lead etc. The contaminated ground (some exhibiting pH values of 13-14) is only some 3m above the water table and close to rivers and lakes.

In the Chinese factories environmental knowledge was quite low as there were no environmentalists employed at the time of the survey, but the factories were fairly new and the ground was mostly covered with concrete. The significant environmental degradation was due to high BoD/CoD/NH₄/suspended solids (SS's) going to river at five of the plants – this was primarily dormitory ordure, clothes washing effluent, and kitchen vegetable waste except for a small amount of fugitive and waste oils going to surface drains.

The most significant challenges at the sites are shown in Table 3 where and it can be seen that there are some serious common denominators among the factories; some of these will be very expensive to ameliorate but this is not acknowledged by the management as risks for the future. For groundwaters, there are no matching perception patterns between companies in the SOF responses at all.

4.2 Perceptions of the environmental situations

There was little evidence in the study factories of environmental knowledge being communicated, even when the environmental managers possessed it (see section 5). This exacerbates the potential environmental impact with difficult subjects like groundwaters, various soil types and permeability's, where chloro-parafins especially are a bad pollutant for groundwaters. Some of the technical problems and solutions for this can be found in Cronk and Marvin (2004). This would lead to a hypothesis that the responses would be fragmented in pattern similar to the dotted line in Figure 1 for Factory D. A related question is whether the level of perception response fragmentation (responses spread over the score range of 0-10) is inversely proportional to the level of communication of knowledge. The complete line in respect of communication exhibits an integrated pattern (Frost et al, 1991), this indicates virtually complete agreement among the managers. There are similar results for every factory, but communication of the dangers had actually failed badly for groundwaters.

The issue of perceptions being related to context has been discussed briefly above and can be extended to propose that the context can *only* appear as a perception and, therefore, the perceptions will *be* effectively the context. This mirrors the argument presented by de Bono (1993) on reality and context but, in this paper, has been termed the mind-context in order to distinguish it from a locational context, eg a production line or an environmental department.

To take a top management level example, if the company *mission* (Denison et al, 2006) were not *meaningfully* communicated to the lower management levels (Holmes, 2001; Cobley, 2001) for action, then there would be little chance that it *would* be actioned, it is therefore believed fair to assume that a lack of communication at any management level would result in similar effects. It would follow that any matches between fragmented patterns (of responses) are likely to be coincidental due to the paucity of communication in the factories evidenced in the data. Unless perhaps there is a currently unidentified phenomenon which could create this condition, eg. the use of peer group pressure to inculcate knowledge or the employee cultivation proposed by Yang (2008)..

In Table 4, the differences (gaps) between managers' perceptions and the rbm's demonstrate that only three factories (F, P, R) have coherent socio-cultural groups (as gauged by their perceptions)(see also Kuhn, 2006 on identity) which have mental realities congruent with the empirical realities for this question on waste. The perceptions at Factory T are so wide of the mark that there is little prospect of them recognizing the problems and hence doing anything to mitigate these (see also Murphy, 1971).

The effects of WEEE and RoHS (EU Directives on waste electronic and electrical equipment and the register of hazardous substances) on Company products should have perception scores at zero, as all the factories are affected to a greater or lesser extent (exports to the EU), but the perception scores do not recognize this, possibly because the environmentalists tend to detach themselves from production and even more so from the market. The same is true of toxic solvents, which all the factories use and, as this is a real physical and environmental danger, it is strange that little attention is paid to the risk under health and safety auspices – little heed is paid to sustainable human resources!

Tables 5 show possible reasons for inaction which, at the environmentalist and quality manager levels, could also include fear of *making waves* in case of penalties imposed by top management. This raises the question of whether it is possible in such circumstances for the award of ISO14001 certification to be anything other than *window-dressing* for the market, a symbol exhibited to an organization's customers.

4.3 Sewage and waste arisings and effects

Some of the typical waste arisings are shown in Tables 6 and 7 and, as the research took place in a single industry, the arisings have significant common elements and common dangers, however, the pathways are only the perceptions of the people at each factory, the *true* destinations are mainly neither investigated nor known.

In the Chinese factories sampled, apart from where the effluent goes to the town sewage plant, the figures for BOD/CoD/NH₄/SS's, as measured by the local environmental authority, are very high and, where they are not, unbelievable by virtue of the floating ordure or cloudy water on its way to the river. The sustainability of the river systems is totally compromised as small rivers are completely dead and the large rivers too polluted to be treated to give

potable water. It can be deduced that some of the Chinese Environmental Authority (effluent sampling) staff are either incompetent, diffident or subject to *favours* - but they will not get fired. The custom is that a *really* incompetent person will be moved to some remote district of China.

With the Polish factories, although effluent is sometimes near to or over the limits on nitrogens and metals, effluent has been basically under control – a question of knowledge and experience. But, in one factory in Poland, it is sometimes hard to see why *events* going over the limits are not seized upon by the local Environmental Authority. It has been quite usual for seriously over-limit effluent to be allowed to river for months, and without a waiver being requested by the factory – if the environmental authorities choose to turn a blind eye, why query this! However, the Polish rivers are not completely dead.

In neither country are the factory management systems improving the environmental sustainability or health and safety. In China this may be because of a lack of will perhaps due to production pressures or a lack of knowledge, whereas in Poland this is really due to the lack of deployment of knowledge and a fear of punishment for asking for money to improve the system. Rather than the socio-cultural resilience of an organization, with the ability to absorb changes and still function, proposed by Dutra and Hayworth (2008), the study factories exhibited a socio-cultural *resistance* to change which will prejudice it's own and other sustainability's.

From Table 8 it can be seen that all the Polish factories are engaged in the heavy end of the industry but, in China, only five out of seven. In Poland three out of the five send their effluent, after treatment, to the river or stream, in China this is five out of seven. The big difference lies in the BoD/CoD/NH4/SS levels which are somehow allowed to be worse in China despite their regulatory limits being quite near to those of Europe. The original Chinese decision not to have environmental experts at each factory, but to rely on the HQ to keep the factories up to date on legislation, indicated that environmental management was not seen as a knowledge intensive activity and was viewed perhaps as a *no value added* item.

5. Contexts and environmental control

5.1 Situational realities

For a pre-dominant slice of the questionnaire responses, the score levels for perceptive realities were significantly away from the empirical reality (rbm) levels loosely based on the relevant clauses of ISO14001. The socio-cultural groupings as represented by individual perceptions were hence frequently significantly away from what might be a set of groupings based on empirical reality, this will be deleterious to organizational functionality.

For rbm's (reality benchmarking ratings), both countries exhibit poor perceptual reality against management system performance as demonstrated with Question 13 (groundwaters are no problem to our factory) tabulated in Table 9. The core scores for Poland are generally lower than for China, ie more realistic, and could be attributed to the fact that all the Polish factories have had both ISO9001 and ISO14001 certifications for some years, while only three out of the seven Chinese factories had this at the time of the research survey.

5.2 The environmental managers

Between 1996 and 2002, the Polish factories did have environmental managers and experts but, all but one had a lower status than the production managers. Once that full privatization of the Polish companies had been achieved, there were no true environmental managers, only managers of combined quality and environment, with low environmental expertise, and only two experts for five factories (at the time of the survey, there are now three).

One environmentalist covered three factories in Poland but their survey response patterns are all markedly different, obviously his expertise did not produce knowledge which was communicated to, or accepted by, all the workforce. A conclusion can be that the information was hoarded and deliberately not communicated to the body of people in the three factories. Archer (1996) quoting Habermass, talks of instances where the possession of knowledge is based on self-interest, and on the need to identify such hostile self-interest mechanisms within the organization. On the surface the environmentalist was concentrating on keeping the factory set of regulations up-to-date, these regulations being mainly satisfied by calculations which themselves were not checked for some six or so years at a time and were found to be aberrant during the research. In Poland there was little apparent *walking of the job* by the environmentalists and, in the Chinese factories, there was no environmental expert at all *to walk the talk*.

For two other factories in Poland, one still has an environmentalist who understands the objectives, but who reports to a production-oriented manager in charge of Quality. Despite this there has been a substantial improvement in the operation of the sewage plant, she is however, sometimes ineffective in the production areas, which contain some extreme hazards. The second factory demotivated and thereby lost a very good chemist turned environmentalist, her place being taken by a competent but young and pleasant chemist, who, on past experience, will have little effect in the production arena due to her youth and gentleness pitched against very tough production managers (see also Kirkland and Thompson, 1999).

5.3 ISO14001 certification and effectivity

At the time of the survey in China, there were no environmentalists employed; the associated tasks fell within the remit of Quality Managers with limited environmental knowledge which only marginally increased during the regular ISO14001 audits (but see Balzarowa et al, 2006; Raines, 2002). However, for four of these companies that are in a corporate group, the HQ eventually employed a professional environmentalist in late-2004, (see Gouldson and Murphy, 1998 for the impact of lone environmentalists).

At the time of the data collection from late-2002 to early-2004, the Polish ISO14001 certifications were theoretically mature but, despite having in-house environmentalists, not really accomplishing what might have been expected in the control of waste. The Chinese systems were relatively new and their performance was on the boundaries of acceptability for certification to ISO14001 (see Table 10).

In the comparison between the two countries for operational performance, there is no apparent significant distinguishing affect. This suggests that environmental control issues are not significantly affected by differences between factories as organizations, or between the two countries. Both countries have management systems codified under ISO14001 and, where this certification is not yet possessed, there is still a *custom and practice* pseudo-ethical management system. Within the extant systems, commands are issued from the top within an informal set of rules and these are passed down the severely hierarchical bureaucratic management chain (Confucian bureaucracy in Tsui et al, 2004; Western bureaucracy from Weber, 1922).

6. Discussion

6.1 Imaginary realities and hierarchical dysfunction

Imaginary created or adopted mind-contexts, or realities, can be conceived or adapted in response (inter alia) to hierarchical cultures (Schein, 1992), and used in strategies and tactics for the communication, deployment or restriction of knowledge. Also, irrational connections are likely to arise from different mind-contexts and realities and, in the absence of some coherent culture, this situation will continue (see also Murphy, 1971).

Gurr (2004) proposes also that the change from State to Capitalist systems leads to a *distance* between workers and management that was not there under State control, this leading to communication failures. In this current research the *distance* is apparently within the different layers of management such that the communication of environmental knowledge and legislative requirements either does not take place effectively, or the meaning of the communication is altered at the social interface between manager and sub-ordinate (see also Blenkinsop and Zdunczyk, 2004), to fit into the respective (sub) socio-cultural mores (see also Chreim, 2006). Some of the mechanisms behind these phenomena are elaborated in Sperber (1996) and Holmes (2001). The behaviour of the people involved is thus determined by their respective socio-cultural groupings, and this affects subsequent decisions reflected from their individual environmental dimensions, or mind-contexts (Frost et al, 1991).

Several writers (eg. Armson & Paton, 1994; Fritz, 1999; Selfe, 1987; Senge, 1992; Taylor, 1911; Weber, 1922) have commented that the management hierarchy determines the culture which, in turn, determines the operational outcomes. Components of these phenomena are when top management commands (Archer, 1996) are elided going down the chain of command, and when agency (lower level) culture comes to dominate certain areas of activity in the absence of any detecting and correcting actions (as with the technical decisions). There is also an argument in Sperber (1996) that could be applied to the management level interfaces in the hierarchies, namely that people on either side of a socially constructed communication interface may have:

Beliefs which are not only very different, but even mutually incompatible, both sides believe the others are irrational. (The) reality on that view is a social construct and there are as many realities or worlds as there are societies – different beliefs are rational in different socially constructed worlds.

In this context, Hogarth (1998), quoting Simon's portrait of decision makers with limited information processing capabilities, refers to people's perceptions being selective, hence their *habitual domains* (or mind-contexts) play a large part in how they see a world (see also Bower et al, 2006).

6.2 Mental prisons and rational decisions

In the hierarchical context, the perception patterns demonstrate strong mental (psychic) prisons (Morgan, 1988) exhibiting an adopted reality whereby there is an unwillingness of management to take mitigating action on the environment and sustainability in case of perceived deleterious affects on production output. Zey (1992) is quite specific:

It is an onus on managers to replace non-rational decisions with rational behaviour. It may have little to do with the goals of workers, labour management and society as a whole. Real models of sub-dominant organizations are unexplained and unable to explain differences in preferences, interests, resetting conflicts, domination, subjugation with the organization. They do not question the goals or ends of the dominant coalition.

From the research data, it is clear that the same type of hierarchical structures and factory cultures are hosting very different patterns of perceptions, hence it is unlikely that the structures are themselves driving the significantly different perceptions observed. The key drivers may be organizational dysfunction and logical contradictions, but modified by the different cultural dispositions of the managers involved at these interfaces (Frost et al, 1991; Spicer, 2006). Other variables may also be at work and the research problem is to identify the predominant drivers; these may lie in the fields of background social culture, knowledge, training or even the style of management which, as Welford (1997) notes, may be capricious.

In both the Polish and Chinese factories the focus is on optimizing the production process and reducing scrap and production waste whereas, for the rest of the environment, their objectives are only directed at satisfying the regulations. Is this grounded in a knowledge deficiency, or an informal culture of not asking for money for reducing the impact of the factories on the environment? Most of the surveyed people would not admit directly to this last point perhaps due to top management autocracy, but also perhaps due to living in a reality that says 'our company has a beneficial affect on the environment' when this is, at best, arguable.

Lower down the management chain, the technologists in the Polish factories have more fragmented perceptions than the Chinese, usually well away from the assessed benchmarks (rbm's), while the quality and environmental managers are also well away. This is perhaps due to a situation wherein groups of people have a culture that has grown with them over the years and formed an *operational* set of mental images to protect them from having to *think* about incompatible disturbances from the outside world, and these disturbances are perhaps rationalized away in another mind-context, or ignored as *noise*.

6.3 Toxic chemicals, communication and meaning

Smallman & Weir (2000) posit that 'communication in complex organizations is an *achieved* process; it has to be worked at and continually reviewed in order that its importance is not neglected'. They go on to argue that 'modern organization systems by their very nature, distort information to meet organizational needs'; Denison et al (2006), also discuss the link between organizational culture and effectiveness within which, even good human resource practice cannot prevent the *natural* filtering of information transmitted via communication systems. In the factories, while a key element in the spread of knowledge is communication, and one which is accepted by senior managers as important, little is apparently done to facilitate it and the perceptions of the workforce do not reflect the inadequacy of their knowledge especially on waste streams and recovery. The relationships and difficulties between language used in communication and meaning is explored in Weisler & Milekic (2000).

In the case of toxic chemicals where, despite workshops dedicated to the problems of dangerous chemicals (in process use and as waste), perceptions of the dangers were very mixed and coincided with a strong tacit perception that the implementation of stricter controls could interfere with production. The failure to communicate the environmental risk to the totality of the workforce could be for one or a number of reasons but mainly because, where there are no coherent cultures or missions there is no stimulus to share knowledge about the environment.

6.4 Production, environment and sustainability

As previously noted, the employees at management levels think mainly of production, hence this becomes a focal point for mental comparisons neglecting other associations such as river pollution and ground contamination. These mental prisons (Morgan, 1988) or versions of reality (Patten, 1996,) could perhaps be changed by a coherent culture promoting more beneficial association patterns. The data indicates that, for China at least, there is substantial agreement between the MD and the senior managers, which could indicate a lack of will to challenge to the MD, thereby militating against beneficial change, eg. Communication of an innovative, synthesized culture (Archer, 1996; Stacey, 1992)) to the next management levels. Yang (2008) takes the cultural argument further with a concept of 'construction of sustainable innovation' wherein all employees are *cultivated* to accept the concept of *company* sustainability by innovation – this could facilitate a culture incorporating environmental sustainability.

The data gives a strong indication that the reason for only marginal compliance with ISO14001 tenets is that the production culture, fuelled and protected by an over-arching fear and punishment culture, submerges the environmental management system in these factories, such that, in Poland, the young environmental managers have little chance of success (Gouldson & Murphy, 1998). This is exacerbated by an unwillingness of the environmentalists, where they exist, to look beyond the letter of the national environmental regulations for both environmental and business opportunities and challenges. In addition, there is clear evidence that some knowledge essential for the good of the factories and their surrounding environments was not always being passed on to the general workforce by the environmentalists or, if it was, the meaning was not understood, such that the risks to health, environmental degradation and sustainability were significantly increased.

In most cases, the data demonstrates that empirical reality and perceptual reality concerning environmental and related aspects such as solid and liquid wastes, most frequently do not correspond and can be considered as largely independent

of each other. Moreover, the perceptual realities, as represented by the strength of feeling scores, more often than not disagree one with another on the question topics, with few logical linkages exhibited between logically related questions, the subjects of which will all impact sustainability. This lack of coherence carries over from factory to factory, with relatively few matching perception patterns. These different patterns represent different context-dependent imagery, hence multiple realities which, unless remediated, will continue to produce sub-optimal factory performance on environmental and waste issues.

7. Remediation needed to enhance sustainability in the subject factories

It is proposed that, without changing the organizational culture at the top and lower levels of management, it would be impossible to change the dynamics of the communication and spread of knowledge in respect of the environment (BT & Cisco, 2008). Patriotta (2003), writing on the subject of organizational knowledge, considers the situation wherein people are projected into a different set of circumstances, a different context, but where the people remain entrenched in an old set of (tacit) routines. So it would appear to be with the managers in the study factories who, without a coherent organizational culture for their impact on sustainability and the environment, remain entrenched in a world that is past.

Hence, for remediation, the most important thing is to establish such a culture or mission but, to communicate that culture in a meaningful way, it will be necessary to train all the managers in how to use words and language that are understood and committed to up and down the management chain.

The next essential remediation strategy would be to train the upper levels of management in how to measure the gap between perceptions and reality, one such method was used to obtain the data for this research. The training must encompass both the expertise required to determine the reality benchmarks in sustainability and environmental performance, and how to structure perception questionnaires so as to obtain reliable data. As it is unlikely that a member of the management team would be able to inspire sufficient trust in his/her colleagues, the data might need to be collected by an outside agency.

Once the benchmarks and data were obtained, further training would be needed to analyse the meanings of any significant gaps between the two and, finally, knowledge training on how to close the gaps. It would be also essential to monitor the gaps on a regular basis in order to prevent fossilization of tacit knowledge. It would also be an imperative to set measures for, and monitor, improvements in environmental performance and enhanced sustainability

8. Conclusions

One of the imponderables at the start of the research reported above related to why management commands or training in environmental responsibilities did not seem to produce the desired actions or results. Was this due to a lack of knowledge, the non-communication of knowledge, non-cooperation, or perhaps to a deliberate act of minor sabotage? Interviews and the observation of inter-person transactions demonstrated that some quite subtle mechanisms were in play. This was supported by the survey perception data which showed more and more fragmentation of perceptions on the same subject the lower down the management chain. It was thereby determined, and subsequently confirmed with several of the plant managers, that:

In China, the sub-ordinate performs a task according to their *understanding* of what they are told;

In Poland, the sub-ordinate will *massage* any communication into a form congruent with their in-built or peer culture.

The determination of gaps, by the new methodology employed in this research, between what is evidenced as real on-the-ground (empirical reality) and the reality that exists in some context in a person's mind, in the dimensions of cultures and sub-cultures, is seen as being a powerful tool in uncovering the intricate/complex mechanisms which drive company direction, be that to disregard the environment or the opposite. It is important to note that, where perceptions of a real or imaginary situation are at odds with the *truth* of a situation, these perceptions may be forming the initiatives for action within complex socio-cultural groupings, and easily lead to undesired outcomes and significant environmental degradation from waste of one kind or another.

To sum up, the paper has proposed a novel method of determining the socio-cultural dynamics of organizations in relation to how they can affect decisions on waste and the consequential effect on sustainability. Moreover, it has elaborated the use of the gaps between perceptions and empirical reality to isolate tacitly-entrenched socio-cultural groups and, from this identification, a set of remediation strategies has been proposed.

The research was grounded in practical case studies which demonstrated that each factory had different overall perceptions and socio-cultural groupings but, on the whole, this did not affect their problems with sustainability, the environment and waste management, in general they were equally deficient in the different countries and factories.

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Table 1. Comparison of factors affecting waste in China and Poland

Chinese/Polish aspects	similar	mixture	dissimilar	comment
geo-location	x			mostly near rivers
effluent	x			mostly going to rivers
organizational hierarchies	x			'I say, you do' = command & control
industry	x			within same product ranges
raw material use control	x			not good, but China worse
in line scrap/waste	x			not good, but China worse
chemical waste control	x			poor
control of energy and water	x			quite poor, no focus
heavy/light industry	x	x		China has more <i>light</i> products
organizational stability	x	x		Poland poor, China better
business culture		x	x	Western/Asian mixture in China
clinker & fly ash ground contamination			x	more severe in Poland
ground/groundwater contamination			x	Poland is worse, China more potential
national culture			x	Asian and Western
training			x	China: single job skills only
technical knowledge			x	Poland insufficient, China lower
environmental knowledge			x	Poland insufficient, China far lower
political system			x	capitalist and communist

Table 2. Actual SOF question proposals (agree/disagree: 0-10)

	question (responses score 1-10)
1	the company has a clear environmental statement and/or policy
2	our environmental knowledge is adequate
3	we know the life cycles of all our products
4	we continually innovate for process improvement
5	production is more important than the environment
6	waste and scrap are under control in our factory
7	there are too many environmental rules issued by the European Union
8	the company has a beneficial affect on the environment
9	the WEEE & ROHS directives will have no effect on our products
10	our processes are strictly controlled for spillage, run-off etc
11	all our employees are aware of their environmental responsibilities
12	environmental protection costs us less than 10% of our profit
13	groundwaters are no problem under our site
14	we consider training as essential for performance improvement
15	we have a good relationship with the environmental authorities
16	environmental decisions are easy to make
17	communication in our factory is very good
18	we always use non-toxic solvents
19	our decisions on the environment always have good results
20	we keep absolutely up-to-date on environmental legislation

Tables 3. Comparisons of contributions to unsustainability – Poland/China

Aspects in Poland (5 factories)	contingent effects	notes	problem sites (no.)
badly contaminated land	contaminated groundwaters	high water tables	3
badly contaminated land	contaminated well water	deep levels	4
foul and industrial effluent to river	river contamination/pollution	high BoD/CoD/Nitrogens	2
foul and industrial effluent to sewer	sewage contamination	high BoD/CoD/Nitrogens	2
major toxic oil storage – high risk	near drains/ground	bunded but not safe	2
toxic oils to ground (large amount)	ground/water contamination	chloro-parafins	2
toxic chemicals to factory air	severe dangers to health	eg: Kresols/oil, vapours/chem dust	4
hazardous solvents	severe dangers to health & air	eg. acetone, ketones, benzenes	5

Aspects in China (7 factories)	contingent effects	notes	problem sites (no.)
contaminated land	contaminated groundwaters	near swamp/streams/rivers	2
badly polluted rivers	dead/devastated rivers	high BoD/CoD/Nitrogens/solids	5
foul and industrial effluent to river	river contamination	high BoD/CoD/Nitrogens/solids	4
foul and industrial effluent to sewer	sewage contamination	high BoD/CoD/Nitrogens	2
major toxic oil storage – high risk	near drains/soil	bunded but not safe	3
toxic oils to ground (significant)	ground/water contamination	chloro-parafins	4
toxic chemicals to factory air	severe dangers to health	eg: MEK/chemical dust	3
hazardous solvents	severe dangers to health & air	eg. acetone, ketones, benzenes	7

Table 4. Gap analysis by factory for Question 6 (waste and scrap are under control)
(Chinese factories in italics)

factory	manager's core perception scores	rbm	gaps
<i>A</i>	6 & 10 (2 groups)	7	1 & 3
<i>B</i>	8 – 10 (range)	5	3 - 5
<i>C</i>	8 & 10	6	2 & 4
<i>D</i>	5 & 8 & 10	6	1 & 2 & 4
<i>E</i>	8 & 10	7	1 & 3
<i>F</i>	7	6	1
<i>G</i>	8 & 9 & 10	5	3 & 4 & 5
P	9 – 10	9	0 - 1
Q	9 – 10	5	4 - 5
R	9 – 10	9	0 - 1
S	8 – 10	5	3 - 5
T	9 - 10	2	7 - 8

Tables 5 . Likely reasons for inadequate action on serious environmental outrages

Contingent effects - Poland	notes	most likely reasons for inadequate action
contaminated groundwaters	high water tables	low belief, knowledge and finance
contaminated well water	deep levels	low belief, knowledge and finance
river contamination/pollution	high BoD/CoD/Nitrogens	no stimulus for improvement beyond limits
sewage contamination	high BoD/CoD/Nitrogens	no stimulus for improvement beyond limits
near drains/ground	bunded but not safe	low belief , knowledge & finance
ground/water contamination	chloro-parafins	low belief , knowledge & finance
severe dangers to health	eg: kresols/oil vapours /chemical dust	low belief/appreciation of the risk/dangers
severe dangers to health & air	eg. acetone, ketones, benzenes	low belief /appreciation of the risk/dangers

Contingent effects - China	notes	most likely reasons for inadequate action
contaminated groundwaters	near swamp/streams/rivers	not considered a problem in the China context
dead/devastated rivers	high BoD/CoD/Nitrogens/SS's	not considered a problem in the China context
river contamination	high BoD/CoD/Nitrogens/SS's	no stimulus for improvement beyond limits
sewage contamination	high BoD/CoD/Nitrogens	no stimulus for improvement beyond limits
near drains/soil	bunded but not safe	low belief (in the problem), and knowledge
ground/water contamination	chloro-parafins	low belief (in the problem), and knowledge
severe dangers to health	eg: ketones/chemical dust	low belief/appreciation of the risk/dangers
severe dangers to air/health	eg. acetone, ketones, benzenes	low belief appreciation of the risk/dangers

Table 6. waste arisings and disposal pathways

category	type	pathway
effluent waste	common sewage	to river or to town authority
	chemically contaminated sewage	to river or to town authority
	chemically contaminated rainwater	to river or to town authority
	kitchen waste: oils and vegetables	to river or to town authority
hazardous waste	oils, solvents and chemicals	mainly to recovery, some to landfill
	oil, solvent and chemical containers	returned to sender or to (hazardous) other use
	oil, solvent and chemical absorbents	landfill
	contaminated soils and clothing	landfill
	particulate heavy and other metals	recovery and sale
non-hazardous waste	plastics	granulation and re-use or sold for other use
	metals	sale for recovery or other use

Table 7. Waste arisings and risk to the environment

stored waste item	typical locations	spillage risk	effect
chloro-parafins	near drains, gulleys, on bare soils	high	contaminated soils, polluted rivers and ground waters
toxic oils	near drains, gulleys, on bare soils	high	as above
acids: sulphuric borofluoric	glass containers over bare soils plastic containers on bare concrete	very high moderate	contaminated soils, ground waters. pollution to drains/surface waters.
contaminated emulsions	near drains, gulleys, on bare soils	high	as above
kresols/ketones/solvents (toxic)	near drains, gulleys, on concrete	high	contaminated soils, polluted rivers and ground waters
empty paint/solvent cans	in cages on concrete	moderate	polluted rivers and ground waters
lead and tin	in cages on concrete	low	contaminated soil
plastics	in cages on concrete	low	minimal

Table 8. Environmental degradation at each factory – water and ground

factories (China)	industry type	effluent waste	ground & g.waters	factories (Poland)	industry type	effluent waste	ground & g.waters
A	medium	to river	probably contaminated	P	heavy	to river	light contamination
B	heavy	to sewer	light contamination	Q	heavy	to river	contaminated
C	light	to river		R	heavy	to sewer	contaminated
D	heavy	river & sewer	light contamination	S	heavy	to sewer	probably uncontaminated
E	heavy	river & sewer	light contamination	T	heavy	to stream	contaminated
F	heavy & light	river & sewer	light contamination				
G	heavy	collected	light contamination				

Table 9. Question 13 and site characteristics affecting groundwaters – perceptions and reality(Chinese factories in italics)

fact	site characteristics giving risks affecting groundwaters	Managers' core scores	rbm	gap
<i>A</i>	much open ground, chemical/oil, effluent to river bank and river, permeable soil	8/10	0	8-10
<i>B</i>	mostly concrete, significant permeable bare soil (possible waste oil spills)	8/10	0	8-10
<i>C</i>	mostly concrete, some minor risk to groundwaters from river underflow	8/10	9	1-2
<i>D</i>	mostly concrete, some risk to groundwaters from river underflow; kitchen effluent	6/8	0	6-8
<i>E</i>	mostly concrete, significant permeable bare soil (probable waste oil spills)	8	0	8
<i>F</i>	significant semi-permeable bare soil (probable oil spills), oily effluent to stream bank	8/9	0	8-9
<i>G</i>	mostly concrete, oily effluent to stream.	6/10	0	6-10
<i>R</i>	major bare permeable soil, oil spills, leaking sewage pipes (ammonium in well water)	5/8/10	5	0-5
<i>P</i>	significant badly contaminated bare soil, damage already done; sewage contaminants	4/5/6	6	0-2
<i>Q</i>	significant badly contaminated bare soil, damage already done; bad spills still abound	6/8/10	0	6-10
<i>S</i>	mostly concrete, few spills, permeable soil	5/6/8/10	0	5-10
<i>T</i>	significant badly contaminated bare soil, damage already done; bad spills still abound	7/8	0	7-8

Table 10. ISO14001 and pollution and waste (*same environmentalist)

factories	A	F	B	C	D	E	G	P	Q	R	S	T
14001 certification	N	N	Y	Y	N	Y	N	Y	Y	Y	Y	Y
environmental knowledge	poor	poor*	poor*	poor*	poor	aver						
process waste control	poor	poor	aver	good	poor	poor	poor	good	poor	good	poor	poor
other waste control	aver	poor	aver	aver	bad	poor	poor	good	aver	good	aver	aver

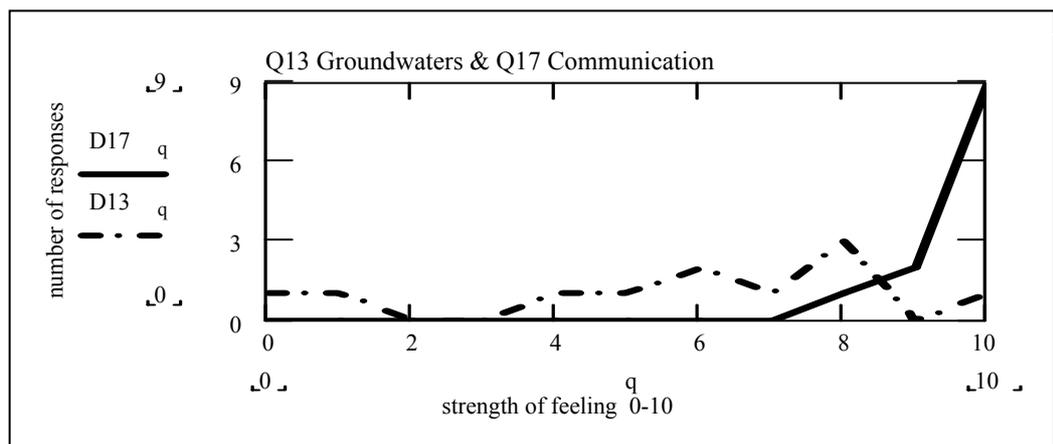


Figure 1. Perception pattern differences between groundwaters risk and communication