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Daylight for Energy Savings and Psycho-Physiological Well-Being in Sustainable Built Environments

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Abstract

Natural light is a vital force for human beings. Successful daylighting in buildings requires trade-offs and optimization between competing design aspects (e.g. light distribution, glare, solar gains, views, etc.), whilst also including consideration of façade layout, space configuration, internal finishes and choice/operation of shading devices. However, to design energy-sustainable built environments which are conducive to human health, these variables have necessarily to be related also with biological and behavioural factors such as metabolic rhythms, psychological stimulation and occupants' preferences. Basing on a multidisciplinary review of existing literature, this paper looks at the relationship between quantitative physical measures of the luminous environment (e.g. horizontal and vertical illuminance, luminance ratio, correlated colour temperature), qualitative aspects of vision (e.g. uniformity, distribution), and psycho-physiological human response to natural light. The aim of the study consists in defining a framework to implement existing daylighting practices basing not solely on photopic requirements but also containing awareness of the demands for psychological and photobiological stimulation, so as to positively influence the health of occupants whilst enhancing energy savings.

Keywords: Daylight, Energy, Comfort, Physiology, Psychology, Health, Architecture, Sustainability

1. Introduction

The use of daylight in buildings, with its variations, its spectral composition, and the provision for external views, is of great importance for the comfort and well-being of occupants. In a workplace, for example, daylight can positively influence the health of office personnel, improving efficiency, reducing unnecessary sick leave and resulting in greater benefits for enhanced productivity. If carefully designed, a daylight strategy can also bring tangible energy savings, as long as it minimises energy use for artificial lighting and prevents glare and other visual discomfort (such as contrast, adaptation problems and internal reflections). However, the overall energy efficiency of windows depends also on thermal effects (e.g. solar gains and heat losses through glass) and their balance against heat production of artificial lighting systems.

The importance of daylight has been reflected for centuries in building legislation worldwide. Starting from the first century AD, roman laws established solar rights. British regulation (dating 1189) guaranteed that if a window had at least twenty years of uninterrupted access to daylight, that access should have become permanent ('Right of Lights'). Planning principles adopted in Boston and New York at the beginning of the 20th century banned the dark street canyons emerging in urban centres and required ziggurat-shaped high-rise buildings that favoured the penetration of light at lower levels. Nowadays in Japan, regulations dictate that apartments should have at least four hours of direct access to sunlight per day. Finally, current German codes state that every workstation in a new office building must be naturally lit and placed at no more than 7.5 meters from a window (Carmody et al., 2004).

A daylight strategy has to be designed to simultaneously reflect the needs of the users and the requirements of the building, finding a balance between conflicting needs of transmission and protection. Specifying daylighting solutions for energy efficiency, comfort and well-being can however be a very complex task - often highly dependant on climate, latitude, orientation and functions - where many factors and variables can diverge from each other making selection and optimisation extremely difficult.

The task at hand for the designer is generally to identify the most appropriate properties of daylighting systems that provide adequate luminous levels and contribute to visual comfort. To do this, illuminance, luminance, colour rendering and daylight factor are commonly considered as the physical measures to be comprehensively managed. Nonetheless, in order to design energy-sustainable built environments which are also and foremost conducive to human health, these variables have necessarily to be related with qualitative and behavioural factors such as directionality of light, spectral composition of radiation, time/duration of exposure, metabolic rhythms, psychological stimulation and personal

preference.

Recent findings actually suggest that visual performance and comfort can be strongly influenced by perceptive cues (such as an interesting view) other than merely by physical parameters. According to these results, it follows that psycho-physiological characters could increase the tolerance to extreme daylighting conditions beyond what is stated in international standards, thus potentially reducing the need to install and operate shading devices that could deprive internal environments of beneficial amounts of daylight and also act to the detriment of users' physiological and perceptive well-being.

In 'light' of these new findings, the aim of this study consists in defining a framework to implement existing daylighting practices basing not solely on photopic requirements for visual tasks but also containing awareness of the demands for psychological and photobiological stimulation, so as to positively influence the health and attitude of building occupants whilst also enhancing energy savings.

2. Daylight and Human Factors

2.1 Daylight in buildings

Daylight is an essential resource for life, one of the basic immutable forces of Nature, a primary element that can create meaningful and evocative architectural experiences, dictating the moods and the quality of a space. The presence of daylight in buildings should maximise the potential of architectural form while optimising human comfort and visual perception. Architecture literally depends on light, be it natural or artificial. As light reveals the forms and the spaces created within a building, it simultaneously discovers the meaning and intentions that are released through the process of conceiving and designing it, and extends its value beyond mere functional use (Guzowsky, 2000).

Daylight can reveal the experience of architecture, telling about the task to be performed, the place and the climate, marking the experience of time. Daylight is an intangible architectural tool that can underline the shapes of a building, emphasising its geometry, its spatiality, accentuating or sometimes contradicting its structure, disclosing the properties of the materials, the textures it is made of. Daylight can define and manipulate the spaces of a built environment, marking the boundary or uncovering the link between inside and outside and separating or connecting internal spaces. Daylight can be a practical and lyrical means of providing orientation, a focus, a hierarchy, encouraging movement along a path. Daylight, finally, can conceal a symbolism, a meaning which could be related to the mind or the spiritual forces of life. And yet, daylight is often considered just at one end of the spectrum of its capabilities; either solely for aesthetic purposes or solely for providing visibility for tasks. In fact, natural light should always render both these aspects and, ultimately, acquire also a further, more 'vital', importance.

Scientific research has actually widely proven the relationship existing between lighting conditions, well-being, and our very perception of the environment that surrounds us. To feel healthy, people need appropriate visual contact with the external world, the cycle of day and night, seasons, weather, etc. The species *Homo sapiens* made his appearance on Earth around 250,000 years ago and evolved under bright conditions characterised by daily (*circadian*, *circa* meaning *approximately*, and *dies* meaning *day*) and seasonal (*circannual*, *annual* meaning *year*) cycles of daylight, which dictated the times of sleep/wake periods, farming and hunting seasons, etc., while also regulating physiological and psychological functions such as heart rate, blood pressure, body temperature, emotions, etc. In other words, exposure to daylight has constantly provided the direct stimuli needed to mark the rhythm of life and contribute to feel well and healthy (Boyce et al., 2003). The life of men has always been regulated by a natural luminous rhythm: active outside during the day, and resting at night. Daylight has indeed represented, in the path of human evolution, the only realistic way of denoting basic daily moments and one of the most important means of maintaining human biological rhythms in connection to the rhythms of Nature.

Nevertheless, during the last few centuries, this natural pattern has been distorted drastically mainly as a result of societal, economic and cultural needs which have imposed a constantly increasing part of the day to be spent in confined spaces, with significant effects caused by the shift from a dynamic illuminated exterior to a static artificially-lit interior environment. The consequences of this radical change are that, in most contemporary societies, a great part of human activities is temporally organised in relation to a 'mechanical' time which is basically independent to the rhythms of our body's impulses and needs, and that is gradually moving our existences out of natural cycles and towards a global 24-hour society. In other words, we are increasingly deviating from the organic and natural pace dictated by the intensity, angle, and colour of daylight, and replacing it with an 'artificial' time which is, on the contrary, imposed by the schedule, the calendar and the clock (Van den Beld, 2001).

2.2 Non-Visual Effects of Light

Photobiology is a new stream in lighting research, revealing that there is an alternative pathway from the eye to the brain in addition to vision, which governs the complex interactions between biological functions and external stimuli (CIE, 2004). Recent medical and biological research has indeed convincingly proved that daylight, other than providing visual stimulation, has also an important non-visual effect on most of the body's biological processes (Veitch, 2005).

Boyce et al. (2003) have recognised three routes by which luminous signals interact with human functions: visual, circadian and perceptual. When light passes through the eye, its signals are carried out not only to the main visual areas but also to the parts of the brain responsible for hormonal regulation. Visible radiation hence results in stimuli involving the whole of the *physical* (energetic exchanges), *physiological* (transformation of energetic fluxes into nervous stimuli) and *psychological* (brain interpretations of those stimuli) aspects that inform the body and the mind about the characteristics of the surrounding environment and contribute to the biological metabolism of the human organism.

Other than simply providing visual information, adequate light received during the day synchronises the circadian clock, stimulating circulation, increasing the production of vitamin D, enhancing the uptake of calcium in the intestine, regulating protein metabolism, and controlling the level of hormones such as serotonin, dopamine (the 'pleasure hormone'), cortisol (the 'stress hormone') and melatonin (the 'sleep hormone', which distributes internal temporal information to the body).

For almost two centuries of ophthalmic research, the whole of these processes have been attributed to the role of only two photoreceptors in the human eye: the *cones*, active mainly in bright light conditions, and the *rods*, which regulate visual information in dim environments. As light reaches these cells, a chemical reaction occurs which determines electrical impulses to be sent via a nerve pathway to the visual cortex located in the back of the brain where these impulses are interpreted as 'vision'. However, new studies have shown that the biophysical processes that govern circadian regulation are very different from those that govern visual effects.

Berson at al. (2002) have actually detected a third cell-type of photoreceptor - which they defined as an 'intrinsically photosensitive retinal ganglion cell' (ipRGC) - which seems to be the main responsible for the regulation of biological, non-visual metabolic processes (although rods and cones probably also play a role in this respect). This new photoreceptor has been found to have its own neural connections to the pineal gland, responsible for hormone regulation, and to the suprachiasmatic nuclei (SCN) in the hypothalamus, which is the brain's internal biological clock (Figure 1). This discovery is leading towards a substantial revision of the characteristics that the luminous environment should have to sustain both the visual and the biophysical human well-being (Van Bommel, 2006).

The characteristics of the novel cell differ radically from those of cones and rods, responsible respectively for diurnal (photopic) and nocturnal (scotopic) vision. This result is extremely significant for the specification of 'healthy' lighting, especially if considering that international standards are specified basing solely on the photopic sensitivity of the human eye. As known, the light sensitivity of cones varies with the wavelength (and thus the colour) of the electromagnetic stimulus received, and reaches its maximum for green-yellow radiation corresponding to a wavelength of 555 nm. Conversely, the maximum biological sensitivity of the new photoreceptor shows a peak at about 465 nm, in the green/blue part of the visible spectrum, confirming the fact that daylight - with its variability in spectral content and the fact that, at all times, it provides a continuous spectrum with elements in all parts of the visible range - represents one of the most appropriate external forces for stimulating both vision and the synchronisation of the internal biological clock. Also the temporal resolution of the new photoreceptor seems to differ from cones and rods, since it is quite slow to react to luminous changes but then gives a continuous response after adaptation has taken place (after around 20 minutes) (Brainard et al., 2001).

In terms of the characteristics of the external stimulus, research by Aries et al. (2005) suggests that an important role in the triggering of the photobiological process is played by the vertical illuminance corrected for human anatomic restrictions, i.e. the amount of light received in the retina, although obviously the size of the pupil dictated by photopic and scotopic adaptation (and thus by cones and rods) influences sensibly the amount of light effectively entering the eye. This result implies that the vertical spatial distribution of the luminous signal is also a significant factor for biological stimulation.

The light level required for the correct functioning of the biological 'mechanisms' is yet to be systematically defined. Threshold values for the retinal illuminance are however assumed to be in the region of 1,500-2,000 lux, thus of an order of magnitude significantly higher than the recommended illuminance for most functions in common living and working indoor environments (generally ranging from 300 to 750 lux at the task corresponding to about 100-200 lux at the eye, although there is no direct proportionality between horizontal and vertical illuminance). Finally, also the dynamics of lighting in terms of intensity and spectral composition during the day seem to play an influential role for entraining bodily rhythms and the metabolic production of hormones (Aries et al., 2005).

In this regard, cortisol and melatonin play a fundamental role in regulating the level of alertness and sleep, controlling, amongst other functions, the amount of sugar in the blood and, thus, the availability of energy to 'power' human activities. Cortisol levels increase in the morning with exposure to daylight, and then, during the day, decrease gradually reaching a minimum at around midnight (Figure 2). Conversely, melatonin drops in the morning and rises at night (Van Bommel and Van Den Beld, 2004).

Obviously, a sufficient amount of retinal illumination to regulate biological processes can eventually be provided also

by artificial lighting alone, although research by Boyce (2003) suggests that this is less likely to obtain the same results as natural daylight. As a matter of fact, daylight is usually the most appropriate mean to allow clear vision and simultaneously entrain the pace of the circadian rhythms, since it produces a high illuminance at the eye with a spectrum that matches both the specific sensitivity of the visual receptors and of the circadian system. Exposure to abundant natural light in the morning can synchronise the biological oscillator to the 24h rotational cycle of the Earth, thus maintaining the connection of the body's functions with the rhythm of the surrounding environment. Without regular natural light entrainment in fact, the human circadian clock would run on average on a 24h and 15-30m cycle, although differences between 'morning' (*larks*) and 'evening' (*owls*) individuals could be noticed (Van Bommel, 2006). Seasonal changes in the night-day cycle, trans-world travel, night-shift work, etc., can all affect the 'tuning' of the biological clock with the natural cycle, since the light signal received becomes asynchronous with the circadian timing (Rea et al., 2002).

In absence of normal light-dark entraining cues and appropriate exposure to daylight, the difference between the individual own 'free-running time' and the 24h cycle could result in a progressive deviation of the human biological oscillator to the rhythms of the day/night pattern, ultimately leading to a shift of the circadian pacemaker and a consequent de-synchronisation of the internal biological clock. The drawbacks of this shift could determine, also in the short and medium term, diminished sleep quality, decrease of alertness, mood changes, irritability and, ultimately, lower performances on the work place.

In summary, due to new discoveries, it becomes quite clear how daylight, other than just providing vision, orientation in space and time and environmental stimulation, can also mediate and control a large number of biochemical processes in the body, which are fundamental for human health. However, current practice for lighting design in buildings is still related to outdated visual criteria related solely to task illuminance (e.g. lux on the working plane, daylight factor, etc.) and luminance (e.g. glare). To truly enhance the sustainability of built environments - guaranteeing energy savings and fostering the health and well-being of their occupants - these criteria have to be extended to non-visual factors.

2.3 Light in the practice of design

Most people nowadays spend more than 90% of their time in confined spaces, and more often than not the lighting they are exposed to is solely regulated upon the notion that, independently from the time of day or season, the task should be accomplished efficiently and with a sufficient degree of visual comfort. Regardless of the options offered by the use of daylight, internal lighting strategies are often designed to provide luminous conditions which remain fairly constant in time, irrespective of the occupant's preferences, differences in metabolic responses and personal needs for performing their tasks.

2.3.1 International lighting standards

Most international standards specify lighting recommendations for a wide range of activities according to visual comfort criteria which are generally limited to horizontal illuminance on the task, uniformity, daylight factor, discomfort glare and colour rendering according to the activity to take place in a space. Traditional paper work to be performed on desks is generally still considered as the dominant visual design parameter, with photopic vision measures remaining the determining factors in lighting practice. Conversely, international standards do not seem to recognise, particularly for offices, the widespread evolution in computer-based activities (requiring a vertical rather than horizontal gaze), whilst they not seem to contain awareness of the requirements for photobiological stimulation and the non-visual biological effects of light. The question now is to ascertain how serious are the consequences of living and working almost exclusively in indoor spaces and often at 'unnatural' times, with much less light than outdoors and with a luminous environment fundamentally detached from biological human needs.

As an example, the European Norm for the lighting of workplaces EN 14264-1 is based upon the following visual criteria: the maintained Illuminance (E_m) - i.e. the value below which the average illuminance on the work surface is not allowed to fall - the Unified Glare Rating Limit (UGR_L) - i.e. the rate of discomfort glare - and the Colour Rendering Index (Ra) - which measures how colours appear under different light sources or when light travels through diverse media. It must be noted that the norm EN 14264-1, as most other standards, features recommendations that are expressly formulated to "enable people to perform visual task efficiently and accurately", thus not necessarily addressing "the safety and health of workers at work", although the threshold values are established also "taking into account psycho-physiological aspects such as visual comfort and well-being" (EN 12464-1, 2002).

In order to foster the visual comfort in living and working environments, whilst simultaneously reducing energy consumption and providing for the metabolic stimulation of building occupants, it is worthwhile to analyse how a 'healthy' lighting design can compensate for deficiencies in recommendations.

2.3.2 'Healthy' lighting design

Light (natural and artificial) can be described in terms of a number of characteristics which interactively regulate visual and photobiological functions: quantity, spatial distribution, spectrum, timing, duration.

In first instance, although human processes are physiologically adapted to the availability of large amounts of outdoor illumination and to significant variations in daylighting levels, interior lighting practice seems to be governed by different priorities. For example, external illuminance variations could range from over 100,000 lux on a bright summer day to a few thousands lux on a fully overcast winter day, and for periods that can fluctuate from only a couple of hours to almost 18 hours per day (this notion applies to UK latitudes). Conversely, in accordance with the standards, regardless of the source (natural or artificial) internal lighting should be set to maintain fairly constant levels at day and night and with an intensity which could be 40 to 200 times less than outside. This implies that, in most living and working places, the lighting levels required for circadian processes could not be achieved if not in areas close to the perimeter, whereas, on the other hand, daylight ingress can often be compromised by the use of shading devices due to temporal thermal or luminous discomfort.

If the criteria for lighting were changed from the current emphasis on photopic vision to photobiological demands, it follows that illuminance levels required in indoor space would need to rise significantly. Yet, if provided solely by an abundant and uncontrolled ingress of daylight, the need of high levels of vertical illuminance at the eye to stimulate biological functions (possibly up to 1,500-2,000 lux for some phases of the day) could increase the risk of thermal drawbacks such as heat losses in winter and thermal gains in summer or visual discomfort (glare, contrast). Rather, if provided by artificial installations, high illuminance at the eye could require twice as much electric lighting, and thus significantly increase energy consumptions (Veitch, 2006). Consequently, to meet at once visual and biological demands in terms of quantity and spatial distribution of the luminous stimulus, a properly designed daylighting strategy should always try to find a balance between all the various factors at play (sometimes eventually pairing with social and cultural habits, such as spending part of the day outside).

Secondly, as the spectral composition of daylight shows significant variations during the day, the photobiological entrainment would require temporal variations in the Correlated Colour Temperature (CCT) of the internal lighting. As far as visual comfort is concerned, according to the Curve of Amenity (Kruithof Diagram), the higher the overall illuminance level, the higher the CCT should be (from a perceptive point of view, high CCT under low illumination tends to make the ambient seem cold and dark, while low CCT under high lighting levels may give a rather artificial appearance to internal spaces). However, although artificial light sources are available with a spectral content similar to that of daylight on some occasions (e.g. xenon and filtered incandescent lamps), most of them are adjustable only in output levels and not in terms of CCT, and they can rarely add a significant meaning to the variability of a place (Begemann et al., 1997). Moreover, the circadian photoreceptors are mainly stimulated by short wavelengths (i.e. at around 465 nm), while artificial systems are generally designed to maximise their light output and energy efficiency according to the sensitivity of the photopic vision, which peaks in the yellow-green band (i.e. at 555 nm). Again, daylight is a luminous source whose continuous spectrum can provide for both visual comfort and photobiological functions and thus the importance of its presence in indoor living and working environments should never be underestimated.

Thirdly, daylight is highly dynamic in its intensity, spatial distribution and direction, and it seems that people strongly prefer to be kept aware of these changes, maintaining a continuous contact with the world outside and its environmental variations. Furthermore, although the receptors for metabolic regulation appear to be spread with a rather random distribution, it seems that the lower part of the retina has greater sensitivity for the entrainment of circadian processes, as it is plausible if considering that the sky tend to selectively illuminate this area rather than the upper part of the retina (Rea et al., 2002). This evidence confirms that vertical illuminance entering the eye is a key factor in 'healthy' lighting.

Finally, another aspect that lighting practices should consider in order to simultaneously enhancing the visual and physiological well-being of building occupants is concerned with the timing and the duration of exposure to light. From a visual point of view, obviously, light is needed just as long as a visual task is involved. Yet, metabolically, the timing and duration of exposure should follow the natural biological body rhythms and provide sufficient stimulation during the course of the day to avoid phase advances or delays. In general, light onset in the morning enables the biological clock to maintain synchronicity with the daily and seasonal changes in the light-dark cycle. Duration of exposure and luminous quantity are also strictly related. For example, research by Rea et al. (2002) shows that a 1h exposure to 500 lux on the work plane - a value in accordance with regulations for visual performance - is barely sufficient to stimulate the circadian photobiological system (this could be a concern for example in winter and at high latitudes, when people go and leave the workplace in the dark, and spend the day in dim interior spaces).

A further important issue not to be neglected in meeting users' comfort and well-being is the influence of colour on biological processes, a matter that may involve subjective as well as objective responses. There are reliably recordable physiological reactions to colour in addition to those associated with vision; exempla of those may be revealed by objective measurements such as galvanic skin response, electroencephalograms, heart rate, respiration rate, oxiometry, eye blink frequency and blood pressure. Whether the association between colour and physiological indexes is direct (i.e. colour stimulates the observer in such a way that the physiological response is elicited without being mediated by a

cognitive intermediary response) or indirect (i.e. if exposed to a colour the observer makes certain associations) is yet to be clearly defined, also in accordance with the psychology of the individual and the influence that the perceived luminous 'message' may have on the observer's behaviour and mood (Kaiser, 1994).

In summary, the routes by which light can influence the ocular performance and the well-being of building occupants involve not only visual (quantity, spectrum and distribution of light) but also circadian and psycho-perceptual factors which take over once the luminous image has been processed. 'Healthy' lighting recommendations have thus to consider awareness of many more factors than what is currently suggested in most standards and regulations, involving, other than well-known visual comfort criteria, additional non-visual issues which are conducive for biological and psychological well-being.

3. Sustainable Visual Environments

3.1 Daylight through windows

Both visual and non-visual criteria have to be carefully applied to the design of fenestration systems to enhance energy savings in buildings (accounted nowadays for more than half of global consumptions), reduce artificial lighting demands, minimise heating and cooling loads by means of a thorough management of natural light, and meet the complex luminous and biological requirements of occupants.

Although there is no conclusive support for the notion that natural light is intrinsically superior than artificial light for stimulating visual and photobiological responses, there is absolutely no doubt that, given a choice, building occupants would prefer to live and work by daylight and to enjoy a view to the outside. Small and artificially lit spaces are often disliked, although sometimes they are accepted due to contingent factors (e.g. stringent visual tasks). Research on windowless office spaces by Boyce (2003) demonstrates that the more rooms are small and give little opportunity to relief and stimulation, the more the occupants become dissatisfied with their jobs and their physical environment. In a small room, a window may actually represent the only source of mental stimulus. Conversely, daylight and a view out may not be strictly essential if spaces are well-lit (e.g. with skylights or internal atriums) and characterised by stimulating interactive activities, as it is often the case in open spaces (social contact is a factor that could contribute to regulate the circadian system and metabolic rhythms).

Given this general preference for daylight, it is however quite hard to demonstrate that just the presence of windows for natural lighting and a view out would improve users' well-being (and thus productivity), even because people will give up daylight as long as it is associated with visual or thermal discomfort (such as glare, contrast, reflections, solar heat gain or a perceived loss of privacy) (Boyce et al., 2003).

Each visual activity demands a different relationship with the spaces surrounding it and has to meet very complex requirements, including a number of needs that reflect people's desire for a specific orientation in space and time (*genius loci*) and also aspects related to society and culture. As a matter of fact, light, both natural and artificial, plays a key-role in creating a mood and an atmosphere that should meet occupants' expectations (functions, aesthetics, ergonomics, etc.) and demands (privacy, concentration, details, etc.), whilst facilitating perception and expressing a design message of its own (Kramer, 2001).

During the day, the presence of daylight should render the spaces lively, activating and motivating in accordance with the human circadian rhythm. Daylight associated with a view should tell about the time of the day, the season, the weather. Views and variations in intensity and colour are indeed extremely stimulating for the brain and the visual apparatus, giving a contribution in terms of perceptual well-being and improving the sense of orientation and feeling of spaciousness.

A good view should normally include both the foreground and the skyline (Littlefair, 1996). Specifically, Bell and Burt (1995) have defined three 'layers' that a view out should consist of: *upper* (distant, the sky, from natural to human-made skyline); *middle* (natural or human-made objects, such as fields, trees, hills or buildings); *lower* (the foreground, including plants and paving).

The best views contain a lot of information, thus it would be preferable if a part of each layer could be seen. The lower layer is obviously particularly important since it is where people's gaze is often drawn, as it contains movement (e.g. vehicles, pedestrians, etc.) and also provides visual cues about the distance, and hence the scale, of objects in the middle layer. The shape of the opening is another important aspect. Considering that the three layers of view are stacked vertically, if the area of glazing is limited it would be generally better to have a tall, thin window rather than a short, wide opening in order to get as much information content from the view as possible. Yet, this design choice will have to be balanced with the risk of excessive thermal gains and overheating, since tall windows tend to be more exposed to high-angle summer sun, although they provide the additional advantage of bringing natural light deeper into the spaces. On the contrary, horizontal windows guarantee a better view of the external landscape. If the window is also operable, occupants will have the added option of using it for ventilation.

Other than providing psychological relief, views are also extremely beneficial to reduce muscle strain by allowing the eyes to shift from the near field surrounding the task area towards distant objects. Actually, various screen-based tasks require frequent eye movement (up to 30,000 times per day) between display, keyboard and paperwork and a limited change of focus, which in the longer term can determine fatigue, tiredness and, thus, decreased productivity. Muscular pain may add to these problems when users shift their seating position to get access to external information or avoid visual discomfort (Osterhaus, 2005).

Nevertheless, the ingress of daylight through windows can also imply major drawbacks: direct sunlight, bright clouds and reflective surfaces can cause glare, contrast and serious visual impairment. Luminance ratios in the field of view should always be contained into certain limits: too large, and it will be difficult for the eyes to adapt; too small, and there will be difficulties in estimating depths and distances.

Since people are phototropic (attracted to light), areas of high luminance in the background of the visual task should be avoided. Actually, as the eye attempts to even out the contrast between different surfaces, the ocular muscles are subject to harder and more frequent movements; tired eyes and an increased level of stress are a direct consequence. To enhance visual comfort, the task should thus normally be brighter than its immediate and general surroundings. For the ratio of luminances in the field of view of the observer, the rule of thumb 1:3:10 generally applies when users do not have immediate access to a natural light source. In case windows can be seen within the VDT area, studies suggest that the tolerable luminance ratios can be much higher, reaching up to 1:50 if the patches of bright luminance remain relatively small (around 5% of the entire field of view; Sutter et al., 2006; Newsham and Veitch, 2001).

Glare, in particular, is a serious source of visual strain that can prevent the viewer from executing his task (disability glare) or cause a significant decrease in visual performance (discomfort glare). Disability glare is generally due to a saturation effect or to a bright light source striking directly in the field of view of the observer (e.g. after-images). Conversely, discomfort glare can be associated with visual contrast and is likely to be due to the location and intensity of the light source relative to the average luminance in the eyes of the viewer. Luminance of the glare source, luminance of the background, solid angle subtended by the source to the observer's eye and the position index of the source relative to the line of sight of the viewer, are the main factors that influence the occurrence of glare, although the level of disturbance depends also on the nature of the task and on personal tolerance (Hopkinson, 1972).

Especially in modern offices, the extensive use of computer displays and visual technologies has recently caused the primary work gaze to shift from a horizontal desk surface to a vertical display screen surface. Vertical windows can thus frequently constitute glare sources (e.g. from the sky vault, the sun, reflections off surrounding buildings, high contrast of luminances), while also internal surfaces (e.g. reflective or specular finishes) or artificial lighting installations can be at the origin of the discomfort.

The occurrence and effects of glare have long been on the agenda of researchers. Disability glare has now been almost completely characterised, while the comprehension of the process linked to discomfort glare is still incomplete, especially when the visual distress is due to daylight. Actually, disability glare causes a reduction of visual performances, and it consists of an instantaneous physiological phenomenon that is likely to be quantifiable. Conversely, discomfort glare can be deemed a psychological phenomenon that is not easy to compute and predict. It consists of a non- instantaneous sensation, which does not necessarily reduce visibility in the short term and can remain unnoticed to observers, although it can cause headaches or eyestrains after long-lasting exposures (Osterhaus, 2005).

In this regards, it is worth noting that although several methods have been developed for assessment and prediction of glare from natural light - amongst others, Daylight Glare Index (Hopkinson, 1971; Chauvel et al., 1982), New Daylight Glare Index (Nazzal and Chutarat, 2001), Visual Comfort Evaluation Method (Velds, 2000), Predicted Glare Sensation (Iwata, 1998), Glare Prediction Index (Wienold and Christoffsen, 2006) - all of them appear to give higher calculated degrees of discomfort glare than those perceived under real conditions (Velds, 2002). On the other hand, more reliable glare indices developed for electric lighting systems (e.g the UGR, Unified Glare Rating; Sørensen, 1998 and CIE, 2002) cannot be applied to daylight situations. No method is currently available to assess the simultaneous impact of both daylight and artificial lighting sources on the perception of glare.

Lighting fluctuations coming from windows seem anyway to be generally more accepted than discomfort glare from artificial lamps or luminaries. This notion is consistent with the results of a number of studies (e.g. Hopkinson, 1971; Chauvel et al., 1982; Osterhaus, 2001) which also suggest that this increased tolerance to glare can be due to the natural light source being accompanied by a view. In particular, Tuaycharoen and Tregenza (2005 and 2007) have highlighted that there is less discomfort glare from a window with an interesting view than from a window of the same mean luminance but with a view of less interest. These studies substantiate previous work by Markus (1967), specifically demonstrating that less discomfort is experienced when natural scenes and multiple distance layers (e.g. foreground, middle distance, far distance and sky) are in the field of view of the observer.

The implication of these studies is that the *perceptive* effect of a subject's interest in a view can have a greater effect on

comfort than the relative *objective* brightness range. It follows that if a glare source contains some information regarded as interesting, standard formulae and physical calculations are likely to overestimate the degree of visual discomfort, although it is still not clear whether this increased tolerance should be considered as a short-term effect, which may gradually disappear after prolonged viewing, or one that endures, particularly if the scene is highly dynamic. These implications could be particularly important for the design of windows especially in east/west-oriented spaces (or south orientations in winter at high latitudes), where, due to low-angle sun, discomfort glare is more likely to occur and would often suggest the design and use of obstructive shading devices.

Ongoing research by the author is investigating the complex interaction between glare, view, installation/operation of shading devices, and the effects that an excessive use of daylight protections may have on the reduction of photobiological stimulation and the energy balance of a building. Indeed, whilst an obstructive shading device is normally deployed to alleviate visual (or thermal) local discomfort, in reducing luminance in the field of view of the observer it also decreases the amount of illuminance entering the space, to the detriment of a more effective entrainment of the metabolic processes of the human body and with increased energy demands due to lower lighting levels available. In addition, by impairing (or anyway reducing) the view to the outside, obstructive daylight protections also deprive the observer of the interest, information and variation given by a contact with the outside that could have increased his tolerance to extreme lighting conditions. The consequence of this decreased tolerance is that, paradoxically, shading devices will be presumably operated more often.

The results of this continuing research are expected to provide further evidence that, when examining visual comfort, a purely physical approach can be insufficient, whereas the usefulness in practice of existing standard measures and formulae would be greatly enhanced if the inclusion of non visual-related factors improved their predictive and assessing power.

3.2 Integrated Daylight Design

3.2.1 Daylighting devices and strategies

To control the amount and distribution of natural light entering a space and to guarantee a comfortable and ‘healthy’ luminous environment, in general a good daylighting strategy should be composed of more than a simple opening in the façade (window) or on the roof (skylight). Depending on climate, orientation, functions and requirements, customised solutions or devices may need to be implemented.

Daylighting systems range from simple static (louvers, light-shelves, fixed overhangs, laser-cut panels, prismatic elements, anidolic systems, etc.) to adaptable dynamic elements (blinds, movable lamellae, advanced glazing, holographic optical elements, etc.), and/or combinations of these (IEA Task 21, 2000). The palette of devices available is very broad and numerous cutting-edge techniques are constantly being implemented in the practice of design to increase daylight penetration within indoor spaces, improve distribution and uniformity, control direct sunlight and/or reduce glare (Altomonte, 2005a).

A proper daylighting approach should always attempt to address several needs with a bespoke design, able, for example, to simultaneously provide for both, shading and deeper light penetration. In some cases, however, a thorough distinction between requirements could lead towards a differentiation of the devices to be applied, for example when addressing thermal needs (e.g. solar protection: external shading systems) or visual requirements (e.g. glare protection: internal devices).

Good daylighting strategies start from exploring simple solutions (window size, placement, self-shading, etc.) and then integrating advanced elements if required. As a matter of fact, the performances of complex and dynamic systems often depend on maintenance and durability of components, and should be adopted only in extreme situations. The positioning of shading devices for luminous and solar protection depends primarily on orientation: generally, horizontal for equator-facing façades or vertical for eastern and western openings. If internal blinds are used for visual control - as it is often the case in offices - they should preferably be composed of light, diffusive material. In terms of operational strategies, preferably each individual occupant should be able to manage his luminous environment to suit his own preference. However, it has to be considered that when blinds are closed to reduce luminous discomfort, if manual operation is the only choice human ‘inertia’ will often cause the blinds to be kept closed even after the source of disturbance has ceased (Escuyer and Fontoynont, 2002).

Proper daylight design should hence try to minimise the occurrence of the conditions under which actions aimed at reducing or eliminating the ingress of natural light arise (Boyce et al., 2003) and to develop methods whereby the actions taken to decrease or eliminate daylight penetration are reversed at the end of the day (e.g. with an automatic control of shading devices; Lee at al., 2002).

Several daylight-directing and composite shading systems have been developed to enhance daylight protection and distribution in spaces. These usually exploit the upper part of the window (clerestory) to provide light penetration deeper into the room in combination with a reflective ceiling, while the lower part of the vertical opening is often

expressly designed to optimise visual performances (glare reduction) and to provide a view and a visual contact with the out of doors. For example, light shelves can be used to throw more light on the ceiling and then deeper into the spaces, delivering daylight at greater depths without significantly augmenting luminous levels near the window, whilst reducing glare in the areas close to the perimeter. Simultaneously, other than just improving the distribution of natural light, a light shelf may double as a solar protecting device, blocking direct sun when required (Figure 3).

3.2.2 Daylight-controlled artificial lighting

As far as the integration between daylight and artificial lighting is concerned, a good combination between the two can generally make it possible to gradually dim the amount of electric light required when natural illumination is sufficient for the task and for photobiological stimulation. Daylight availability, however, decreases rapidly with the distance from the window, so an adequate supplementary system is often required to balance luminous distribution.

The design of an artificial lighting system should address the requirements of both the visual task and the well-being of the occupant, allowing flexibility and personal over-ride to adjust (at least partially) the luminous environment according to personal demands. Although the option of a personal over-ride can sometimes jeopardise optimum performance in terms of energy balance, this is in general highly valued by users in terms of psychological comfort. In order to save energy and ensure at any time an optimum light distribution, a control system able to dim artificial light and/or turn luminaries off when there is sufficient daylight or after working hours may enhance best achievements and often result in minimal complaints from building occupants. Dimming control is generally easily accepted by users since changes in light levels are less abrupt and disturbing, although fully automated systems without the choice of a local personal management should preferably be avoided.

Concerning light distribution, a balanced combination of diffuse and direct light can provide recognition of three dimensional objects and liven up the environment. The lighting of an internal space should be arranged so as to guarantee an appropriate luminous 'unevenness' and some degree of disuniformity, thus maintaining a connection with external variations (standards normally suggest a degree of uniformity around 0.7). Daylight, in fact, is by its nature directional, so too uniformly lit environments are often disliked and do not contribute to the physiological (biorhythms) and perceptive (alertness) comfort of users. Carefully blending daylight with artificial light can, in general, ensure the best results.

In working environments, several adjustable lighting systems should be preferred to evenly distributed ceiling luminaries. Artificial ambient illumination levels should be designed to be significantly lower than task requirements, while user-controllable task lights can assure that luminous needs are met at all locations. However, if excessive glare or contrast from direct (windows) or indirect (reflections) sources is threatened, internal average luminance levels can be increased to raise adaptation levels and balance glary surfaces brightness, although this solution is likely to lead to sensible energy consumption. As a general rule, glare should preferably be counteracted directly at its source (e.g. at the window line).

To ensure adequate illumination and reduce energy consumptions, fixtures and lighting circuits should preferably be grouped by areas of similar daylight availability (e.g. in rows parallel to the window wall). It must also be noticed that artificial light usually has a mainly horizontal component, while daylight through windows, with its contribution in terms of vertical illuminance at the eye, is surely more beneficial to biological processes. To overcome these differences in directionality, suspended luminaries should be preferred to ceiling-mounted lighting systems in order to contribute to achieve non-visual stimulation, whilst providing abundant light on the task, the walls and the ceiling (Aries et al., 2002).

In terms of the correlated colour temperature (CCT) of artificial light sources for luminous stimulation, the choice should be in general determined by the function of the space, thus also involving psychological aspects such as the impression of warmth, relaxation, clarity, with other considerations. For best CCT pairing with the relatively high lighting levels required for metabolic entrainment at specific times of the day, the preferred strategy should foster the installation of lamps characterised by cooler light colours, and thus a minimum colour temperature of 4,000-5,000 K. Moreover, since in a work place both action and relaxation are needed, a dynamic artificial lighting system should also guarantee variance in both colour and lighting levels (from cool-white to warm-white) during the course of the day and according with variations in the natural light penetrating the internal environment.

Finally, regarding interior finishes, light-coloured surfaces contribute to better distribute daylight in the spaces rather than dark hues. Conversely, specular surfaces may create glare due to excessive luminance if viewed directly from a task position, while diffusive ceilings and wall-reflected daylight can increase light penetration and also facilitate the achievement of high levels of vertical illuminance for photobiological stimulation (international lighting standards generally suggest for walls a reflectance between 0.3 and 0.8, and for ceilings between 0.6 and 0.9). Furthermore, since mood can significantly be affected by the surroundings, colour monotony should be avoided as much as colour fatigue. Yet, eye-catching centres are desirable to produce a visually pleasant and mentally appealing environment.

3.2.3 Successful daylight design

A successful example of integrated daylight design is represented by the recently built City Council House 2 (CH_2) of Melbourne, the first six-Green star rated sustainable building in Australia (Note 1).

In this case, a scaffolding of plants on the northern façade (i.e. the solar-facing elevation in the Southern hemisphere) provides shading and light diffusion as well as air purification at the building openings. To decrease the risk of glare and overheating, steel trellises and external balconies - supporting vertical gardens that run the full height of the building alongside the windows - filter daylight and form a 'green' microclimate. The presence of the vines contributes to increase visual comfort for the users, both in terms of glare reduction and due to the positive psychological effect of a 'green' presence in the office areas. Light shelves, made of 50% perforated steel internally and movable fabric externally, block high-angle sun penetration during summer, while also reflecting incoming radiation deeper in the space. At the same time, internal upward-rolling retractable blinds located at the level of the light shelf, together with manually-adjustable vertically sliding timber screens at the window line, guarantee the required protection from low-angle horizontal light penetration in winter and in the late afternoon, whilst also maintaining an unrestricted view to the outside at eye level (Figure 4).

Due to the deep open plan of CH_2, natural lighting is complemented in internal areas by an artificial system designed as a two-component scheme: a background ambient lighting supplied by T5 fluorescent lamps incorporating high frequency dimmable electronic ballasts that provide a low ambient illuminance in the spaces (160 lux); and individually controlled lamps at workstations guaranteeing an additional 320 lux on each desk. In order to achieve an optimal distribution of light, materials and finishes have been chosen with an overall reflectance of 0.3 for the carpet, 0.5 for the walls, and 0.7-0.8 for the ceiling and the desktops. The lighting output is regulated by an automatic system that monitors the amount of daylight coming in the building and reflected off the light shelves and accordingly dims the electric lighting levels, thus creating a balanced mix of natural and artificial illumination. The use of workstation task lighting also creates the illusion of 'campfires' of activity which contributes to generate a rather warm and inviting atmosphere in the working spaces (Altomonte, 2005b).

A fifth of the 50M AUD overall budget of the CH_2 has been devoted to facilitate the development and implementation of sustainable principles and technologies in the design and construction process; obviously, daylighting and solar control have played a substantial role in defining the success of the strategy devised. The City Council of Melbourne has actually valued the payback period of this increase in costs in less than 10 years, with savings of more than 1M AUD per year due to reductions in energy consumption (when compared to a conventional 'green' commercial building), healthier staff, increased workplace effectiveness, and the value of a building as a guiding 'beacon' in sustainable design that is likely to influence the attitude and behaviour of its occupants (City of Melbourne, 2006).

4. Concluding Remarks

The use of daylight in buildings is commonly assumed to reduce lighting energy demands and contribute to the sustainability of built environments. However, the drawbacks normally associated with a poorly- designed and managed daylighting strategy and the energy reductions made possible by up-to-date artificial lighting systems and controls (e.g. T5 lamps with electronic ballasts), often make it difficult to justify an extensive use of daylight solely on the basis of potential energy savings (Boyce et al., 2003).

Conversely, to substantiate the choice of a daylighting strategy (particularly in commercial and tertiary buildings), it is essential to prove that such solution can simultaneously foster other significant advantages to the overall quality of the architectural space, bringing benefits to the comfort, health and well-being of the people that live and work inside the building and to the finances of organisation commissioning or occupying it (e.g. reduction in energy consumptions, increased productivity of occupants). In this regard, it must be noted that in commercial organisations salaries and benefits for employees are often of an order of magnitude up to ten times higher than building capital and operating expenses. It becomes clear that investments on the improvement of the overall quality of the working environment - such as the higher design and installation cost of bespoke daylighting systems and devices - could be easily outweighed by the financial benefits of increased satisfaction on the work place, reduction in absenteeism, turnover, and, potentially, improvement in mood, efficiency and productivity.

'Health' has been defined by the World Health Organisation as 'a state of complete physical, mental and social well-being and thus not merely as the absence of disease and infirmity' (WHO, 1946). Basing on a multidisciplinary review of existing literature, this paper has substantiated that, as a source of electromagnetic radiation, natural light is not essentially better than artificial light to ensure visual performances. However, daylight presents unique features which are proven to be conducive to human health, particularly in that it is generally available in relatively large quantities, it ensures excellent colour rendering and, simultaneously, it guarantees a variation in spectral content which represent an effective stimulation for the entrainment of the metabolic system. In addition, windows are strongly favoured in enclosed spaces also for the view out they provide, meeting the occupants' psychological needs of a

continuous contact with the surrounding context, offering environmental stimuli that are beneficial for the sense of well-being, mood, concentration, motivation, etc., and potentially fostering an increased tolerance to visual discomforts such as glare, contrast or adaptation.

In summary, daylight through windows can comprehensively meet the whole of the visual, non-visual and perceptual requirements of the people living and working in built environments, clearly enlightening both the task and the internal spaces, and providing the conditions needed for health and well-being. Furthermore, if properly managed, good daylighting can contribute to reduce the energy loads for lighting and heating (solar gains) needs - and, thus, reduce the impacts of buildings on the environment - whilst concurrently creating interesting, inspiring and meaningful architecture.

Yet, when improperly delivered and regardless of its assets, daylight can increase task difficulty and cause distress that can impair the visual and perceptual comfort of users (e.g. glare, reflections, shadows, eyestrain, etc.). As an example, daylighting that provides poor visual conditions and fails to meet the occupant's needs would not only decrease performances, but may also develop frustration and alter the worker's concentration once he becomes aware of the poor level of his visual environment. In addition, an extensive use of glass for better light ingress could increase thermal losses to the outside, while an excessive penetration of daylight in confined spaces - due to an inappropriate placement and size of openings or to the lack of protections - can bring tangible solar gains, which could be regarded as beneficial in winter especially in residential buildings, but that are surely detrimental to the thermal comfort and cooling loads in summer and mid-seasons particularly in commercial built environments.

In these cases, a proper design and use of daylighting components (e.g. windows with spectrally-selective glazing) and shading devices, together with a thorough integration of daylight with artificial lighting, can optimise the balance between luminous and thermal requirements, contributing to reduce energy consumptions and increasing comfort and satisfaction for the users.

As a conclusion, when discussing daylight, the very concept of sustainability has to go beyond the exclusive optimisation of a range of energy performance factors leading to reduction of consumptions and environmental impacts, but has also to acknowledge the whole of the physical, physiological and psychological human needs. Sustainability calls for long-term changes through the interplay of several interconnected dimensions, adopting an integrated approach to architecture where a decision in one area can influence another. In this context, daylight is an intriguing aspect of design in which environmental, energetic, aesthetic, social, cultural, financial and human aspects can come together at once.

In the practice of design, hence, daylighting should not be considered as an afterthought which is taken into account only when the spatial characters of the building have already taken shape. Rather, daylight should be valued as a necessity that literally drives and directs the design of a built environment from its early stages of conception and development, dictating the quality of internal spaces and ultimately leading to buildings which are economically cheaper to run, less harmful for the environment, and, above all, healthy, inspiring and stimulating for their occupants.

References

Altomonte, S. (2005a). *L'involucro architettonico come interfaccia dinamica. Strumenti e criteri per una architettura sostenibile.* Firenze: Alinea Editrice.

Altomonte, S. (2005b). CH_2 - Lighting and Physiology. *Australian Journal of Construction Economics & Building*, 5 (2): 40-46.

Aries, M.B.C., Begemann, S.H.A., Zonneveldt, L., Tenner, A.D. (2005). Retinal illuminance from vertical daylight openings in offices. *Right Light 5*. Nice, France.

Bell, J., Burt, W. (1995). *Designing buildings for daylight*. BR288, BRE, Watford, Hertfordshire.

Begemann, S.H.A., Van den Beld, G.J., Tenner, A.D. (1997). Daylight, artificial light and people in an office environment; overview of visual and biological responses. *Industrial Ergonomics*, 20: 231-239.

Berson, D.M., Dunn, F.A., Takao, M. (2002). Phototransduction by retinal ganglion cell that set the circadian clock. *Science*, 295: 1070-1073.

Boyce, P. (2003). *Human Factors in Lighting*. Troy (NY): Lighting Research Center, 2nd Edition.

Boyce, P., Hunter, C., Howlett, O. (2003). *The benefits of daylight through windows*. Troy (NY): Lighting Research Center.

Brainard, G.C., Hanifin, J.P., Greeson, J.M., Byrne, B., Glickman, G., Gerner, E., Rollag, M.D. (2001). Action spectrum for melatonin regulation in humans: evidence for a novel circadian photoreceptor. *The Journal of Neuroscience*, 21 (16):6405-6412.

Carmody, J., Selkowitz, S.E., Lee, E.S., Arasteh, D., Willmert, T. (2004). W*indow systems for high-performance*

buildings. New York: Norton&Company.

CIE (2002). *Glare from small, large and complex sources*. CIE Publ. 55, Vienna.

CIE (2004). *Ocular lighting effects on human physiology and behaviour*. CIE Publ. 158, Vienna.

City of Melbourne (2006). *CH_2 - Setting a new world standard in green building design. Technical Research Papers.* AUSIndustry. [Online] Available: http://www.melbourne.vic.gov.au (May 12, 2008).

Chauvel, P. Collins, J.B., Dogniaux, R., Longmore, J. (1982). Glare from windows: current views of the problem. *Lighting Research and Technology*, 14 (1), 31-46.

Escuyer, S., Fontoynont, M. (2001). Lighting controls: a field study of office workers' reactions. *Lighting Research and Technology*, 33 (2): 77-96.

European Standard EN 12464-1 (2002). *Light and Lighting - Lighting of work places*. CEN.

Fontoynont, M. (Ed) (1999). *Daylight performance of buildings*. London: James & James.

Guzowski, M. (2000). *Daylighting for sustainable design*. New York: Mc Graw-Hill.

Hopkinson, R.G. (1971). Glare from windows. *Construction Research and Development*, 2: 98-105.

Hopkinson, R.G. (1972). Glare from daylighting in buildings. *Applied Ergonomics*, 3 (4): 206-15

International Energy Agency (IEA), Task 21 (2000). *Daylight in Buildings - Source book on daylighting systems and components*. Berkeley: LBNL.

Iwata, T., Tokura, M. (1998). Examination of the limitations of predicted glare sensation vote (PGSV) as a glare index for a large source: towards a comprehensive development of discomfort glare evaluations. *Lighting Research and Technology*, 30 (2): 81-88.

Kaiser, P.K. (1994). Physiological response to colour. *Colour research and application*, 9 (1).

Kramer, H. (2001). Mastering office lighting. *International Lighting Review*, Philips Lighting, 1 (01).

Lee, E.S., et al. (2002). Active load management with advanced window wall systems: Research and Industry Perspectives. *Summer Study on Energy Efficiency in Buildings.* Asilomar, California.

Littlefair, P.J. (1996). *Designing with innovative daylighting.* BRE Report, Watford, Herts.

Markus, T.A. (1967). The functions of windows - a reappraisal. *Building Science*, 2: 97-121.

Nazzal, A., Chutarat, A. (2001). A New Daylight Glare Evaluation Method: A Comparison of the Existing Glare Index and the Proposed Method, and an Exploration of Daylighting Control Strategies. *Architectural Science Review*, 44: 71-82.

Newsham, G.R., Veitch, J.A. (2001). Lighting quality recommendation for VDT offices: a new method of derivation. *Lighting Research and Technology*, 33 (2): 97-116.

Osterhaus, W.K.E. (2001). Discomfort glare from daylight in computer offices: how much do we really know? *CIE Symposium on Lighting Quality*. Ottawa, Canada.

Osterhaus, W.K.E. (2005). Discomfort glare assessment and prevention for daylight applications in office environments. *Solar Energy*, 79: 140-158.

Rea, M.S., Figueiro, M.G., Bullough, J.D. (2002). Circadian photobiology: an emerging framework for lighting practice and research. *Lighting Research and Technology*, 34 (3): 177-190.

Sørensen, K. (1998). *Proposal for a general UGR formula*. DLO-note 61.

Sutter, Y., Dumortier, D., Fontoynont, M. (2006). The use of shading systems in VDU task offices: A pilot study. *Energy and Buildings*, 38: 780-789.

Tuaycharoen, N., Tregenza, P.R. (2005). Discomfort glare from interesting images. *Lighting Research and Technology*, 37 (4): 329–41.

Tuaycharoen, N., Tregenza, P.R. (2007). View and discomfort glare from windows. *Lighting Research and Technology*, 39 (2): 185-200.

Van Bommel, W.J.M., Van den Beld, G.J. (2004). Lighting for work: a review of visual and biological effects. *Lighting Research and Technology*, 36 (4): 255-269.

Van Bommel, W.J.M. (2006). Non-visual biological effect of lighting and the practical meaning for lighting for work. *Applied Ergonomics*, 37: 461-466.

Van den Beld, G.J.(2001). Light and Health. *International Lighting Review*, Philips Lighting, 1 (01).

Veitch, J.A. (2005). Light, Lighting and Health. Issues for Consideration. *Leukos*, 2 (2): 85-96.

Veitch, J.A. (2006). *Lighting for high-quality workplaces. Creating the productive workplace*. London:Taylor & Francis.

Velds, M. (2000). *Assessment of lighting quality in office rooms with daylighting systems*. PhD Thesis. Delft University of Technology; The Netherlands.

Velds, M. (2002). User acceptance studies to evaluate discomfort glare in daylit rooms. *Solar Energy*, 73 (2): 95-103.

WHO (1946). *Preamble to the Constitution of the World Health Organization*. New York.

Wienold, J., Christoffersen, J. (2006). Evaluation methods and development of a new glare prediction model for daylight environments with the use of CCD cameras. *Energy and Buildings*, 38: 743-757.

Notes

Note 1. Research on the daylighting strategies applied in the design and construction of the Council House 2 (CH_2) building in Melbourne was conducted by the author under the support of the "CH_2 Study and Outreach Program" funded by the City Council of Melbourne, Australia, in 2005.

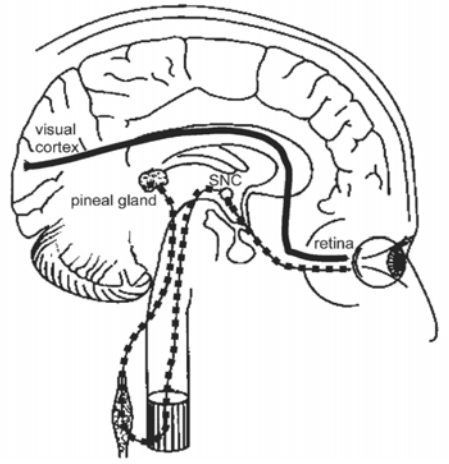

Figure 1. Visual and biological pathways from the eye to the brain

(Source: Van Bommel, 2006)

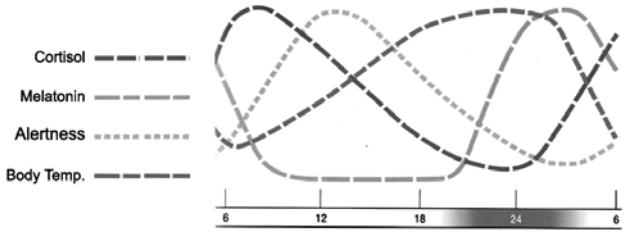

Figure 2. Daily rhythms for a 24h light/dark cycle

The Figure summarises some of the typical biological processes dictated by a regular 24h light-dark pattern, such as body temperature and the secretion of the main hormones for body regulation.

(Adapted from: Van Bommel and Van den Beld, 2004)

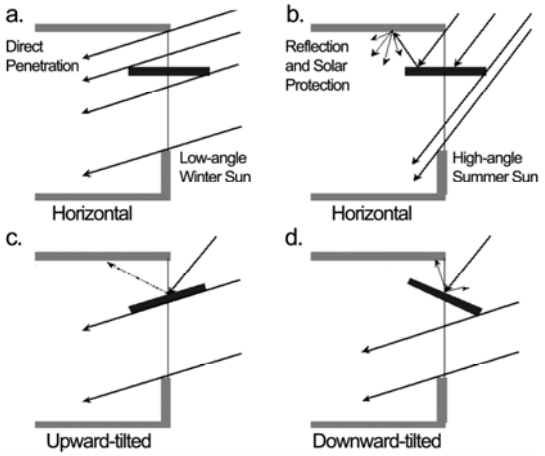

Figure 3. Exempla of Light Shelves

The Figure illustrates the functioning principles of a horizontal (a. and b.), upward- (c.) or downward-tilted (d.) light shelf in terms of solar protection and distribution of incident light.

(Adapted from: International Energy Agency, Task 21, 2000)

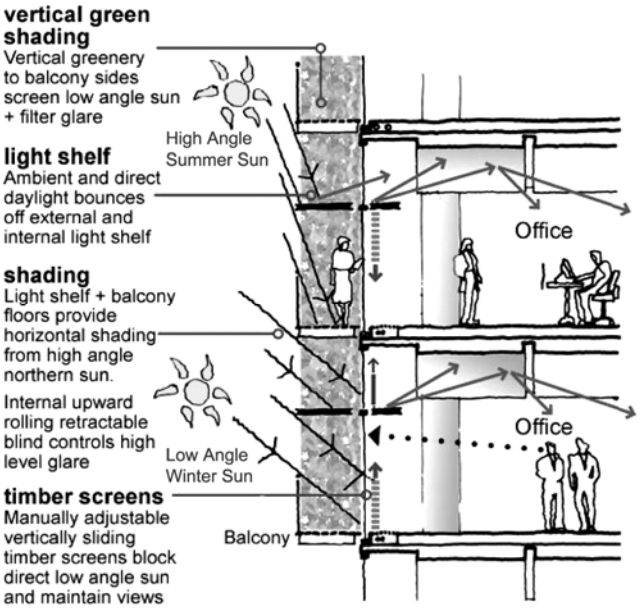

Figure 4. An example of successful daylight design

The Figure exemplifies the daylighting strategy and the use of shading and light-distributing devices applied in the North Façade (solar-facing) of the CH_2 building in Melbourne, Australia.

(Image courtesy of City Council of Melbourne; adapted)

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Life-cycle Environmental Friendly Construction of a Large Scale Project: A Case Study of the Shanghai World Expo 2010

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Abstract

Environmental friendly construction is one of the key tasks for the construction professionals. Large projects, which have great environmental and social impact, should act as the models of environmental friendly construction. In this paper, the authors have concluded some measures which are taken to promote positive impact of the World Expo Shanghai 2010 on environment and human health. The findings of this case study can be referred by construction professionals when conducting large scale projects

Keywords: Sustainable construction, Environmental friendly construction, Green building

1. Background

As one of the largest important projects in China recently, the Shanghai World Exposition 2010 uses "Better City, Better Life" as its theme. The main theme includes “Blending of Diverse Cultures in the City”, “Economic Prosperity in the City”, “Innovation of Science and Technology in the City”, “Remodeling of Communities in the City” and “Rural-urban Interaction”. Since 1851, the World Exposition has attained increasing prominence as grand event for economic, scientific, technological and cultural exchanges. Many creative inspirations and thoughts of human being have been shown and promoted through cross-country, cross- culture and cross-technology interaction. The Shanghai World Exposition 2010 is the first registered world exposition in a developing country. During the 184 days of exposition, the participants will use this important platform to explain urban civilization to the full extent, as well as display historical experience, exchange innovative ideas and demonstrate perspectives in the future, especially learning from each other how to create an environmental friendly society and realize the sustainable development of human being.

The Expo 2010 Shanghai program consists of many sub-projects such as the major pavilions, the public utilities, the transportation infrastructures, the park, as well as the logistic facilities etc. The main pavilions can be further divided as participants’ self-built pavilion, rent pavilion, and joint pavilion. Most of the buildings are temporary, except the Theme Pavilion, the China Pavilion, the Expo Center and the Performance Center. These four buildings are permanent which will not be demolished after the exposition. All of these sub-projects make the Expo 2010 Shanghai program as a large, complicated and multi-stakeholders system.

In order to manage so many sub-projects and present to the world a successful, splendid and unforgettable exposition, the organizer has made a set of systematically management ideas for this large program. Environmental friendly construction is among one the management ideas which mainly concentrates on the environmental protection and human healthy across the life-cycle stage of this large program.

2. Related research

To realize environmental friendly construction in the Expo 2010 Shanghai, the organizer refers to the related research and practice in both construction management and sustainable development fields. Literatures review of environmental friendly construction shows a fruitful result. The definition of sustainable development is described as: “those paths of social, economic, and political progress that meet the needs of the present without compromising the ability of future generations to meet their own needs” (Steele 1997). Based on the concept of sustainable development given by United Nation, the implementation plan has been made in different industrial field. Sustainable construction is the result of the application of sustainable development in the construction field. Wim Bakens (1997) put forward the trend in building and construction fields after concluding the former research. In his paper, sustainable development and construction is

regarded as one of the six main trends in the future. Afterwards, many sustainable tools and guidelines have been established to promote sustainable construction, such as GBTool (Cole, J., and Larsson, N 2002), LEED (United States Green Building Council 2002) and BREEAM (Dickie, L. and Howard, N 2000). Furthermore, Wim Bakens emphasized that sustainable development and construction were expected to have a marked effect on topics and priorities in construction research program. After nearly ten years of research and practice, Kimberly R. Bunz, Gregor P. Henze, P.E, and Dale K. Tiller (2006) deliver their survey of sustainable design practices in North America, Europe and Asia. This survey includes how to realize sustainable design in all the phase of the life-cycle of a building, such as programming, design, building construction, building operation and finally demolition. The authors also make a comparison between different countries and regions. Tables comparing programs from different regions are provided for each phase in the life cycle of a building that can be used by building design professionals as a reference guide to sustainable design around the world. The tables presented by Kimberly R. Bunz et al. also highlight specific requirements or concerns that are applicable in a particular region. They also provide a body of knowledge for the construction professionals to realize sustainable construction by means of making a systematic plan.

Environmental friendly construction is a branch of sustainable construction that concentrates on environmental protection and human health. Life-cycle assessment (LCA) is regarded as a useful method for analyzing and assessing the environmental impact of a material, product, or service throughout its entire life cycle, usually from the acquisition of raw materials to final disposal. Kwangho Park et. al.(2003) use LCA to assess the environmental impact of highway projects. As mentioned in the former paragraph, Kimberly R. Bunz, Gregor P. Henze, P.E, and Dale K. Tiller(2006) analyze the sustainable guidelines based on the project life-cycle. All of the above research can be referred to when implementing environmental friendly construction in the World Expo Shanghai 2010.

3. A framework of life-cycle environmental friendly construction for a large project

Project life-cycle is the definition of a project from cradle to crave. In order to realize environmental friendly construction, the project should be not only environmental friendly in the programming phase, but also in the design, building construction, operation and demolishing phase. Due to the fact that the owners, the designers, and the end users (sometimes they are not the owners) do not involve in the whole life-cycle of a project, it is always difficult for each part to contribute throughout the project life-cycle. As a result, who should be responsible for the life-cycle environmental friendly construction of a project usually has no answer. In the technical research of life-cycle project construction, the main topics usually concentrate on the technical issues which emphasize the technical guideline of sustainable design and construction. As mentioned above, Kimberly R. Bunz , Gregor P. Henze, P.E. , and Dale K. Tiller(2006) have conducted a systematic survey about the situation of sustainable building design practices in North America, Europe, and Asia. Based on the comparison of the application of sustainable construction across different countries, we can find out the main concept and the approach to use sustainable construction tools and techniques is following a technical line. The international sustainable building guidelines and standards, both national and regional, such as LEED, ASHRAE, GreenGuide from the United States, C-2000 IDP, CBIP and GBTool from Canada, BREEAM from the United Kingdom, Guideline for sustainable building from Germany, GreenCalc from Netherlands, CASBEE from Japan, and GBRS from Korea, are presented and compared according to their main indicators. By using these guidelines and standards, the construction professionals may have a technical consultant in order to realize the concept of sustainable construction.

The common tendency of the research and practice of environmental friendly construction is toward the life-cycle oriented direction. That is, environmental friendly construction should not only be considered in the construction phase, but also in the operation phase. In addition, the demolishment should also be considered as an important aspect. Therefore, to realize environmental friendly construction in Shanghai World Expo 2010, the construction, operation and post-exhibition issues should all be concerned .

4. Case study of the Shanghai World Expo 2010

4.1 The Characteristics of Shanghai World Expo 2010

In order to realize environmental friendly construction, the project management team of Shanghai World Expo 2010 decides to apply the concept of environmental friendly construction in this large specific program. The characteristics of Shanghai World Expo 2010 lie in three parts:

- A huge amount of construction work should be finished in a short time
- Different organizations from all over the world take part in this large program
- Most of the buildings are temporary buildings that are going to be demolished after the exhibition.

According to these three characteristics of Shanghai World Expo 2010, the application of environmental friendly construction should address the following issues:

- How to make a systematic plan at the early stage of the whole project?

- How to establish a uniform standard to regulate the management process of project?

4.2 Environmental friendly construction of Shanghai World Expo 2010

To answer the above two questions, based on the international sustainable construction guideline as well as the characteristics of Shanghai World Expo 2010, the implementation of environmental friendly construction of this large program includes the following aspects shown in table1.

The environmental friendly construction of Shanghai World Expo 2010 mainly concentrates on the following aspects:

- General requirement
- Oversight of the organizer
- Management of hazardous items
- Sanitation
- Waste disposal

The "general requirement" has pointed out the basic elements to implement environmental friendly construction. The "oversight of the organizer" has mentioned authority and responsibility of the organizer to make sure the project will be conduced in an environmental friendly way. The "management of hazardous items", "Sanitation", "Waste disposal" has emphasized the issue of human health, which can also be regarded as one part of environmental friendly issue. All these requirements are written in the document of project management of the Shanghai World Expo 2010. It undoubtedly acts as the regulation to drive all the official participants to conduct the project in an environmental friendly way.

5. Conclusion

The implementation of environmental friendly construction is the responsibility of construction professionals. Large projects, which have great impact on environment and human society, should act as the models of environmental friendly construction. In the Shanghai World Expo 2010, much effort has been given to promote the positive impact on environment and human society throughout the project life-cycle. In this paper, we have concluded some measures taken to implement environmental construction in this large project. Actually, environmental friendly construction is one of the most important tasks of the Shanghai World Expo 2010. Many measures are continuously added or improved with the progress of the project.

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References

Cole, J., and Larsson, N. Green Building Challenge 2002: GBTool user manual, International Initiative for a Sustainable Built Environment, Ottawa, 2002.

Cole, R.J. and Larsson, N. GBC 2000 Assessment Manual: Volume1: Overview 2000.

Cole, R.J. Building Environmental Assessment Methods: Clarifying Intensions, Building Research & Information, Vol.27, No.4/5, pp230-246 1999.

Dickie, L. and Howard, N. Assessing environmental impacts of construction: Industry consensus, BREEAM and UK Ecopoints, BRE Digest No.446, May. Building Research Establishment, UK. 2000.

http://www.expo2010china.com/ last accepted 12/12/2007.

Kimberly R. Bunz, Gregor P. Henze, P.E, and Dale K. Tiller , Survey of Sustainable Building Design Practices in North America, Europe, and Asia, Journal of Architectural Engineering, Vol. 12, No1. 33-62 , March , 2006.

Kwangho Park; Yongwoo Hwang; Seongwon Seo and Hyungjoon Seo, Quantitative Assessment of Environmental Impacts on Life Cycle of Highways, Journal of Construction Engineering and Management, Vol.129, No.1 , 25-31 January / February , 2003.

United States Green Building Council, Green Building Rating System for New Construction and Major Renovations (LEED-NC) version 2.1, Washington, D.C. 2002.

Wim Bakens, International trends in building and construction research, Journal of Construction Engineering and Management, Vol123, No.2 , 102-104 June, 1997.

Table 1. The content of environmental friendly construction

Item	Content
General requirement	● Official participants shall take necessary measures of environmental protection with regard to the use of water, electricity, and air conditioning within their exhibition zones. The Organizer may recommend further environmental protection measures to official participants. ● Official participants shall ensure that their sites, pavilions and exhibition space consistently comply with environmental protection, health, radiation protection and security requirements as well as limits stipulated by the Laws and Regulations. Official participants shall, in particular, avoid causing water and air pollution, soil contamination, generation of harmful noise and vibration, and the production of hazardous waste. They shall properly manage, store and dispose of hazardous waste. ● Official participants shall bear all liabilities for disturbing residents or damaging the environment as a result of breaching the Laws and Regulations in their construction
Oversight of the Organizer	● The Organizer has the authority to order official participants to stop actions that damage the environment at the expense of official participants. Should official participants fail to obey the order, the Organizer has the authority to stop the activities causing pollution and restore the polluted area to what it was at the expense of official participants ● .Officials from the competent departments of the Chinese Government will be sent to the Expo Site to work closely with the Organizer to ensure compliance with the relevant regulations on environmental protection and guarantee full protection of the environment.
Management of Hazardous Items	● Should official participants need to store hazardous items (including radioactive materials) on the construction sites, they shall, with the approval of the Organizer, set up warehouses for hazardous items in compliance with radiation protection and other requirements. The warehouses shall be clearly marked and shall be under the management of designated staff to prevent hazardous items and radioactive materials from endangering human health and damaging the ecosystem and surrounding facilities.
Sanitation	● Official participants shall take measures to ensure adequate ventilation, natural illumination and lighting within their exhibition zones and take necessary anti-moisture, anti-noise, anti-quake and deodorization measures. ● Official participants shall ensure the normal and safe functioning of the facilities for water supply, drainage, and sanitation as well as equipment for ventilation, air conditioning, etc. within their exhibition zones.
Waste Disposal	● Official participants shall keep their exhibition zones clean, place waste receptacles, separate waste for recycling and remove waste. ● Official participants shall not dispose of waste within their exhibition zones without the approval of the Organizer. Official participants shall comply with the laws and regulations with regard to waste disposal. ● When waste disposal service is provided by the Organizer, official participants shall bear the cost of such services based on the size of their exhibition zones and the nature of their commercial activities.

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Research on Geo-environmental Compensation Mechanism in Sustainable Development of Three Gorges Reservoir Area

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Abstract
Geo-environment deterioration, which caused by Three Gorges reservoir area development program, is leading to frequent geological disasters and seriously hampering the sustainable development of the reservoir area. This article expounds the geo-environment's compensation status quo and existing problems in the reservoir area at first. Then it explains that geo- environment were underestimated or even loss of status, and analyses its performance and the relationship between the geo-environmental compensation mechanisms improving and sustainable development of Three Gorges reservoir area. Finally, it points out that the Government need appropriate institutional arrangements immediately, and makes relevant policy recommendations to improve the geo-environment compensation mechanism for the sustainable development of the reservoir area to provide important protection system.

Keywords: Three Gorges reservoir area, Geo-environment, Compensation Mechanism

1. Introduction

Three Gorges reservoir area Development Program is one of the largest world's artificial water conservancy projects. She plays a flood control, irrigation, farming, etc., in particular to support China's huge population and industrial power consumption of electricity problems. But at the same time, from the Three Gorges Project started in 1993 to final completion in2009, the Three Gorges reservoir water level elevates to 175m has brought increasingly serious geological problems, such as the mountain landslides, mud-rock flow, collapse, which are serious threat to the reservoir area people's lives and property, restricting the sustainable development of the reservoir area. But the people in this area always has been in a passive state.

2. Three Gorges Reservoir area's geo-environment and compensation status quo

2.1 Three Gorges Reservoir area's geo-environment status quo

From 1990 to now, the Department of Geology and Mineral Resources, Ministry of Water Resources, Third Construction Committee, the Ministry of Land and Resources, to allocate special funds for the Three Gorges reservoir area's geo-environment and geo-disasters. The "Yangtze River Three Gorges Project reservoir banks stability " total volume seized more than 100,000 cubic meters of landslide 404, the total volume of 2.936 billion cubic meters and cracked mud-rock flow Ditch 90."Yangtze River Three Gorges Project reservoir submerged treatment and the resettlement of migrants overall plan for dealing with landslides in the report "have uncovered 175 meters following landslides in 1302 (including the mine in situ" 175 "seized of the slump), the total volume of 3.334 billion cubic meters. Completion of the reservoir area 19 counties (districts) of geological disasters investigation, the establishment of 19 county-level monitoring stations, the group completed a preliminary measurement monitoring and forecasting network; completed the risk of geological disasters in Three Gorges area zoning; built a Yangtze River Three Gorges reservoir area of geological disasters monitoring and forecasting model zones.

2.2.1 Three Gorges Reservoir area's geo-environmental compensation status quo

Although the Three Gorges geo-environment and geological disaster management work to solve the geological disasters in the reservoir area to ensure security and safety of people's lives and played a positive role can not be questioned, but the Three Gorges reservoir area of environmental compensation has not yet to perfect the mechanism and implementation. The so-called geo-environmental compensation refers to the geo-environment pollution or destruction of the compensation and the geological features or geological value of the compensation. Including: the

geo-environment for their own compensation; use of economic means to damage the geo-environment of conduct be punished, the economic activities of the internal and external costs; regional or personal protection of geo-environment, or to give up the opportunity to develop the practices of compensation, reward or compensation; great value to the regional geological targets for the protection of the input of over-exploitation and use of resources once the practices of restrictions on the recycling economy and environmental protection industries, and other resource-saving and environment-friendly mode of development, and other economic activities be encouraged.

Environmental Protection in the Three Gorges reservoir area can be divided into two categories. First, the Three Gorges Project for Environmental Protection include 11 projects, about 923 million Yuan (see table 1). Other is the reservoir submerged in dealing with the resettlement of Environmental Protection Compensation expenses, including the reservoir resettlement environmental protection, protection of species resources, the protection of migrant population health, water quality protection, environmental detection and management of the project, about 300 million Yuan.

3. Lacking of geo-environmental value is the system obstacles for the reservoir area sustainable economic development

On the road to development as a strategic turning point, the Chinese government in 2004 put forward a concept of sustainable development as the core of the "scientific concept of development" of the 16th National Party and the Fifth Plenary Session. The development of recycling economy is building a resource saving and environmentally friendly society to achieve sustainable development and an important way. However, restricting the sustainable development of the Three Gorges reservoir area there are many factors, including geological resources of economic value was not fully aware of and are not reflected, resulting in the geo-environment value is undervalued or even loss of the system is an important factor.

3.1 Geo-environmental property rights is not clear

Many environmental resources are not sustainable by the development and utilization of an important reason for this is due to the lack of clear property rights. In the traditional economy and society, people have always been the geo-environment as a public goods, commons (Commons), can be opened (Open Access) no property rights of the property, is access to means of subsistence production, the emissions from waste sites. As the general market will not property rights for transactions of goods, making the scarcity of natural resources and the geo-environment can become a free for all mining and use of public goods, any person at any time can be free possession and consumption. When people can abuse the geo-environment to avoid the cost of production and life, the pursuit of profit maximization objective will enable the rapid spread of such abuse, the consumption of natural resources over natural regeneration capacity and natural purification capacity, leading to damage of the geological, Resource depletion and environmental pollution. Due to the lack of economic incentives, the operators engaged in environmental protection and engage in clean production and green consumption, recycling, the producer and consumer rights are not achieving ecological benefits, rights and obligations in relations between the states of imbalance.

3.2 Natural resources and the geo-environment is obviously not the external economy

Pigou founder of welfare economics study found that in commodity production and consumption process, there are social costs and private costs of inconsistency, the gap between the cost of two on the outside of the composition. Outside of the "external" is relative to the terms of the market system, referring to those who have been excluded from the market mechanism outside the by-product of economic activity or side-effects; more strictly speaking, the price system has not been reflected in that part of the economy Activities of the by-products or side effects. These by-products or side effects may be useful, as are external, such as Marshall referred to the growers on bee beekeeper of the benefits. However, the vast majority of the outside is harmful, not as an external economic or negative externalities. The reality of economic life, the use of natural resources only reflects the prices of resource extraction or acquisition costs, without taking into account the ecological costs, resulting in the use of cost far less than the cost of ecological community, with obvious negative externalities. Environmental capacity are public property, when used with open access and use the results of exclusive, personal use of the proceeds are always stronger than the cost sharing. China's environmental capacity has not been strict regulation, enterprises and the public to pay the sewage charges far below the compensation for pollution damage and pollution control costs, so that waste emissions have significant negative externalities, such negative external constraints of a resource-saving and environment-friendly production, lifestyles implementation.

3.3 Price formation mechanism unscientific

For a long time, there are resources in China has been invaluable, low-priced raw materials, high-priced products of the distorted pricing system, raw materials production and processing enterprises with the environmental resources of free or low-priced possession may reap excessive profits of environmental resources without compensation. The current system based on market conditions and from re-use and environment-friendly raw materials not only not dominant performance, price is often not an advantage, therefore, recycling and environment-friendly production methods

intended to achieve reductions, recycling and sound of Most links are unenviable choice. This caused a number of reasons: First, because the initial resources and renewable resources of different price formation mechanism, such as in mining production in the prices of mineral resources and environmental costs of production low pay, low-cost equivalent to the misappropriation of public resources, raw materials The price significantly low. Second, in the international division of labor in the provision of raw materials and energy prices are obviously unfavorable factors. Third is a large-scale, for the characteristics of the modern intensive production system makes most of the raw material extraction and processing costs of increasingly reduced, and all kinds of waste products, waste due to varieties, complex, isolated scattered, their collecting, collating, transport costs The high cost of renewable technology development lags behind, the poor economies of scale. Fourth, it is biodegradable, environmentally friendly sound of the production technology and product development costs than traditional propaganda production costs. In this way, with the use of traditional production techniques and the use of one-time resources compared to the operating mode, resources recycling and the use of environment-friendly raw materials prices higher, the general will increase the operating costs of enterprises, reducing their market competitiveness of the enterprises do not want to bear. This constitutes the promotion of recycling and environment-friendly production methods of price barriers.

4. The establishment of the geo-environment compensation mechanism is to achieve sustainable economic development of the reservoir system needs

Ecological Economics from the point of view, the geo-environment as a resource, it is the carrier of economic activity, but also a production factor. Geo-environment as a resource is a price or value of its scarcity value by the size and extent of the impact of development and utilization of conditions, the value of a once with the interests of the people seek, can bring on a value of the value of the capital was. As a reflection of the capital, Environmental capital has a natural attribute of the capital. In accordance with the operating capital of the attributes that certainly is for making money, it must be in accordance with the rules of the market operators, the inevitable competition laws are subject to the domination of the other On the one hand, with ecological and environmental capital of the basic attributes, and we must follow ecological laws. In the development and construction of the Three Gorges reservoir area, we must to follow both the capital of diminishing returns and ecological balance. With the scarcity of geological products have become increasingly prominent, people can not always aware of the natural obtain, and to invest in the natural, but with the proliferation of ecological capital, if the geo-environment operators and protectors cannot get the return on their enthusiasm Will be seriously hurt. Government adopted an urgent need compensation to make the geo-environment in the economic value reflected in reality, to resolve the geo-environment operators and protectors of a reasonable return. We can create the Three Gorges reservoir area of geo-environment and sustainable development of resources economic momentum, Reservoir provide an institutional guarantee for sustainable development, achieve environmental, economic, and the reservoir area of sustainable development.

Geo-environment is a compensation mechanism for the coordination and implementation of ecological compensation system and a series of policy arrangements. Its purpose is to establish or support the Three Gorges reservoir area of the geo-environment resources property rights and vigorously promote the natural and geo-environment of compensation for the use of the system to correct economic activity in the geo-environment of negative externalities, the geo-environment of the mining and use of resources is no longer free. Guide the economy through the main "cost-effectiveness of a" choice to actively engaged in geological and environmental construction, the implementation of the economic cycle "reduction, reuse, recycling" (that is 3 R) principle, so that the reservoir area geo-environment protection, rational use of natural resources by.

Improving the geo-environmental compensation mechanism has the important strategic meaning for achieving sustainable development as following:

(1) The establishment and improvement of geo-environmental compensation mechanism helps the Three Gorges reservoir area to integrate utilization of resources and economic and social development process by useful economic incentives and social macro-management tools. To achieve purposes on the whole reservoir area on the economic and social Activities of macro-regulation, the destruction of geological, environmental pollution and ecological functions of the recovery and treatment systems management. Geo-environmental compensation mechanism will allow the protection of geological outcome of the "beneficiaries" to pay the cost, and "damage" to some compensation, to resolve this particular geological products in the consumption of public goods "free-rider" phenomenon, to resolve Ecological investors a reasonable return. Encourage people engaged in geological and environmental protection and management, geological and environmental capital proliferation.

(2) The establishment and improvement of geological environment compensation mechanism is conducive to safeguarding social equity and achieving the coordinated development of the Three Gorges reservoir area. It is well known, and safeguard social fairness is the responsibility of the Government. Equitable and sustainable development is consistent with the other hand, does not lead to the development of the fair is not sustainable. If the ecology of the areas not to change the reality of poverty, the survival of the enormous pressure eventually will lead to ecological damage,

ultimately affect the entire society's sustainable development. From the vertical equity, in order to allow future generations to have equal opportunities in resources from the ecological environment in wealth and welfare, we now cannot be arbitrary destruction of these natural resources; the sustainable use of natural resources must find a way. Geological environment compensation mechanism can be properly resolved due to ecological protection and the protection of regional and other non-protected areas between the increasingly widening social inequalities.

(3) The establishment and improvement of geo-environment compensation mechanism, the source of production help from the Three Gorges reservoir area on the promotion of economic development in harmony with environmental protection, geo-environment to overcome the cost of the external environment-friendly mode of development formed in costs and prices obstacles to sustainable development Provide an institutional guarantee. Environmental compensation mechanism can change the business permission to use the habit of geo-environmental resources, forcing enterprises in production when calculating the loss of geo-environment. This is the fundamental sustainable economic development and infrastructure.

(4) The establishment and improvement of geo-environment compensation mechanism is conducive to the financing of geo-environmental protection funds, but also conducive to establish a universal ecological awareness, to solve the geo-environment with the development of the conflict and confrontation. Geological and environmental construction of social welfare undertakings requires a large amount of capital input for protection.

5. Speed up establishing the geo-environmental compensation mechanism for the sustainable economic development of the reservoir area to provide protection system

Establishing the geo-environmental compensation mechanism adheres to the "polluter who governance, who destroyed who recovery, benefit pays" principle. Recommendations from the following aspects proceed accelerate the improvement of the geo-environment compensation mechanism for the sustainable development of the Three Gorges reservoir area to provide protection system.

5.1 Improve the geo-environment of economic compensation mechanisms

According to the environmental economics theories and the value of external economic theory, the use of the geo-environment should pay the corresponding compensation costs. At present, China has established some economic compensation mechanisms, such as the charging system, the collection of resources tax. However, the charging system only to enterprises discharge pollutants collection of sewage fees, and charges low efficiency in the use of poor, in particular, does not require the production and development to the destruction of the ecological functions of implementing any compensation. Thus affecting the environmental effects of the implementation of the policy; resources of the collection of fees has not spread, with the consent of the limited resources of the cost of not fully use the building of the geo-environment, resulting in compensation is not in place of the situation. Thus, the compensation mechanism needs further improvement.

First, to increase sewage charges to slightly higher than the cost of pollution control. Such as the acceleration of price reform, a comprehensive introduction of urban sewage treatment fees of accelerating the establishment of solid waste disposal charging system. The second is to expand the scope of resources tax, the levy of land resources for resources, the exploitation of mineral resources in implementing the progressive tax rate, strictly according to plan restrictions on mining of the super-exploitation of lesson plans to re-tax, to avoid over-exploitation and mining accidents from happening. Third, the introduction of the geo-environment tax as soon as possible, according to the geo-environment in the development and utilization of resources on the geo-environmental compensation. In a regulated way of compensation, fees levied based on strengthening the use of funds and management. 5.2 The establishment of the geo-environment of economic compensation mechanism

Financial compensation mechanism is that the virulence of environmental damage to the payment of compensation to the victims. Eco-saboteurs must pay compensation for ecological restoration projects completed or in the form of affordable and geo-environmental damage corresponding to the economic, social responsibility. Therefore, we should accelerate the establishment of geological damage to the environment responsible for the economic compensation system. Because of the geo-environment pollution led to the development of geo-environmental vulnerability, triggered geological disasters, should be given to residents in the reservoir area of the corresponding financial compensation. Project development, production and operation of enterprises, such as the environment surrounding the damage caused by the project developer, business owners bear the cost of environmental restoration, project approval to take joint and several liability. Gradually explore the establishment of the ecological environment of other factors responsible for the economic damage compensation system; the departments concerned should step up study of the development of ecological damage, environmental pollution in the implementation of economic compensation, the compensation law.

Is a fine of sanctions violations of laws and regulations of the common means, China's environmental laws and regulations having a more detailed provision? China, however, is in the low level of fines. At the same time, for different offences set a maximum fine limits. Effective economic and punishment mechanism should be based on the

nature of the offenders' offence, the offender of the proceeds from the offence and the offence caused by the loss to society to determine the amount of fines at the same time. Punishment from the proceeds of the adequacy of environmental pollution at all levels, training of special funds

5.2 Improve the geo-environment of economic incentive mechanism

Ecological environment-friendly products, using renewable resources, such as business, technical inputs and raw materials due to higher costs, need to bear part of environmental publicity obligations and the lack of price competition in traditional business advantage. Therefore, the three West reservoir area should strengthen planning guidance, and increase policy, funds, projects, etc., and the support. The ecological environment-friendly products, cleaner production enterprises, environmental industries, to take the recycling economy development model, can be differences taxation, credit offers, special funds to support environmental protection measures such as giving certain incentives.

5.3 Increase the financial transfer payment in compensation for environmental efforts

As the geo-environment with non-exclusive and non-competitive nature of public goods, and there is a "market failure." Therefore, need government intervention in the provision of public goods, make up for market imperfections. Fiscal policy is to achieve the main objective of the government's economic policy tools should be satisfied that the people of geo-environmental protection expenditure scope of public finance, financial commitment from the part of the ecological environment of the compensation responsibilities. China should improve the public finance system readjust and optimize the structure of financial expenditure, increase financial transfer payment in compensation for environmental efforts.

According to national economic growth and social development and financial situation, the state financial budget should be gradually increased, focusing on support for environmental infrastructure construction, environmental engineering and focus on water and soil conservation, natural resource protection, comprehensive treatment of urban and rural environment, such as ecological compensation benefits clearly the work.

5.4 Actively explore the market of the geo-environment compensation model

China should actively explore the use of resources, mining and other market-oriented trading compensation for the geological model, the use of market mechanisms to reduce pollution control costs and improve efficiency to prevent water pollution.

Actively guide domestic and foreign capital into ecological construction, environmental protection and resource development gradually establish a government guide, the market forward, and all sectors of society and benefit all parties to participate in the diversified, multi-level and multi-channel geo-environment compensation fund investment and financing system. Actively explore ecological construction, environmental regulation and integration of urban and rural land development and effective ways to improve the environment in improving efficiency of land development, land development and environmental protection funds in the accumulation of geological, forming a virtuous circle mechanism.

5.5 The establishment of resources, and environmental value of evaluation system

Speed up the establishment of natural resources and the geo-environment monitoring statistics index system, and actively explore the quantitative value of natural resources and geo-environment evaluation methods, the geo-environment for the establishment of a sound scientific basis for providing compensation mechanism. Actively carry out experimental work of green national accounts. "Green GDP" is from the traditional sense of the GDP in less production and business activities caused by the loss of environmental resources to that part of the cost. This new accounting system will enable the geo-environment and the economy have shown, can more precisely the economic and social development of the relationship between quantity and quality, thus contributing to improving all regions and departments of environmental awareness and the establishment of the geo-environment compensation Mechanism of enthusiasm. "11th Five-Year Plan" period, China should start in the above-scale industrial statistics in the introduction of the output value of the main raw material consumption million, 10,000 Yuan output value of energy consumption, water consumption of 10,000 Yuan output value, 10,000 Yuan output value, "three wastes", such as the total emissions of statistical indicators, A comprehensive evaluation of sustainable development.

5.6 The establishment of geo-environmental protection standards

Geo-environmental protection standards, including ecological protection and construction standards, environmental quality standards, the Three Gorges reservoir area protection and construction standards, pollution control in particular pollutant emissions control objectives, as well as the protection and resources development and utilization of standards. Geo-environmental protection standards must be based on scientific research, feasibility studies and estimates. In connection with the preparation of the Three Gorges reservoir area function zoning, environmental standards established geological reservoir system. Geological reservoir area will set standards for environmental protection standards in the regional Party and government leading bodies and leading cadres performance appraisal system,

included in Hubei Province, Chongqing Municipality building evaluation system.

References

Chen Jing-sheng, Cai Yun-long, Wang Xue-jun. (2001). *Human—environment and sustainability*. Shanghai:The Commercial Press.

Chen Gui-rong, Wang Jing-wu. (2002). A summary of urban construction and geological hazards in china.*Geological Disasters and Environmental Protection*, 2, 1-5.

Garrett Hardin. (2001). *Living Within Limits: Ecology, Economics, and Population Taboos.* Shanghai: Translation Publishing House.

Wang Qin-min. (2004). Establish Compensatory Mechanisms & Protect Pcological Environment. *Qiushi*, 13, 55-56.

Xiao Ya-cheng. (2005). China's Protection of the Ecological Environment Construction Investment and Compensation Mechanism Construction. *China's Sustainable Development*, 1, 1-4.

Xing Li. (2005). On the Establishment of China's Ecological Compensation Mechanism Countermeasures. *Financial Research*, 1, 20-22.

Zhang Hui, Zhang Jingao. (2007).Game Theory Analysis of Center and Local Governments in Geology Disaster Prevention Devotion. *Statistics and Decision-making*, 7, 45-47.

Zhang Hui, Zhang Jingao. (2008). Regional Geologic Disaster Resilience and Risk Management: A Case Study on Three Gorge Reservoir Region. *Industrial Technology Economy*, 1, 112-116.

Table 1. The Environmental Protection estimates for the Three Gorges Project(Million Yuan)

Item	Total funds	Compensation for environmental protection	State special	Power generation costs	Project
Water Quality Protection	24000	13000	11000		
Ancient trees protection	100	100			
Terrestrial plant protection	1500	1400	100		
Aquatic plants Protection	6500	4400	2100		
Ecological environment monitoring system	11300	9000	2300		
Ecological and environmental protection research	700	700			
Reservoir soil and water conservation	10000	10000			
Landslides and earthquakes	8000	8000			
Geo-environment	6000	6000			
Construction of the environmental protection area	9900	300	9600		
The middle reaches of the river erosion	8000		8000		
Total	92300	34900	18000	13500	25900

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Assessment of Surface Water through Multivariate Analysis

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Abstract

Multivariate statistical techniques such as factor analysis (FA) and Discriminant analysis (DA), were applied for the evaluation of spatial variations and the interpretation of a large complex water quality data set of two rivers (Juru and Jejawi) in Malaysia, monitoring 10 parameters at 10 different sites each. Factor analysis resulted in two factors explaining more than 82% of the total variance in water quality data set. The factors indicate that the possible variances in water quality may be due to either sources of anthropogenic origin or due to different biochemical processes that are taking place in the system. The first factor called pseudo anthropogenic factor explained 59.29% of the total variance. The second factor called anthropogenic explained 23.03%. DA gave the best result to identify the relative contribution for all parameters in discriminating (distinguishing) the two rivers affording 100 % correct assignations. This study illustrates the benefit of multivariate statistical techniques for analyzing and interpretation of complex data sets, and to plan for future studies.

Keywords: Discriminant analysis, Factor analysis, Water quality, Multivariate

1. Introduction

The rivers are the important sources of surface water and boon of nature to the human beings. They are the inseparable component of ecology on the earth. A river, with its tributaries, is a system that sustains fish and the other aquatic life. It does one way transport of a significant load of dissolved matter and particulate material from different sources (Shrestha and Kazama, 2007) in the direction of its flow. Rivers play a major role in assimilation or transportation of the municipal and industrial wastewater discharge of a constant as well as occasional or seasonal polluting source. The surface runoff is a seasonal phenomenon which is largely affected by climate within the river basin (Singh et al., 2004). The seasonal variation in precipitation, surface runoff, interflow, groundwater flow and pumped in and outflows have a strong effect on river discharge and subsequently on the concentration of pollutants in river water (Vega et al., 1998). Rivers constitute the main inland water resources for domestic, industrial and irrigation purposes; it is inevitable to prevent and control the rivers pollution and to have reliable information on quality of water for effective management. The possible variances in water quality may be due to anthropogenic activities, natural variances during months (season) due to various biochemical or chemical processes. Monitoring programs result in a huge and complex data matrix consist of a large number of physico-chemical parameters (Chapman, 1992).

The application of multivariate methods such as Cluster analysis (CA), principal analysis (PCA), factor analysis (FA), and discriminant analysis (DA) has increased tremendously in recent years for analyzing environmental data and drawing meaningful information (Vega et al., 1998; Lee et al.,2001;. Wunderlin, et al., 2001 ; Reghunath, et al., 2002: Saadia, et al.,2005). In this paper we report our findings of the study of water quality of two rivers of Malaysia and their statistical analysis. The analysis is done to explore the extent of resemblance among the sampling sites, to identify the variables responsible for spatial variations in river water quality, to locate the hidden factors explaining the structure of the database, and to quantify the influence of possible natural and anthropogenic sources on the water parameters of the two selected rivers.

2. Methods

2.1 Study area

The two rivers of Malaysia selected for the study are Juru and Jejawi located in the North West coast of peninsular Malaysia, in the state of Penang and within a coastal mudflat in the Juru and Bukit Tambun district (Fig. 1). The sites are located adjacent to industrial areas which were reclaimed from mangrove. The types of industry presently in operation include: electronics; textiles; basic and fabricated metal products; food processing and canning; processing of agricultural products; feed mills; chemical plants; rubber based industry; timber based wood products; paper products and printing works; and transport equipment. Other main activities that are operating in vicinity of the cultured area are a ships' harbour with petroleum unloading and a red earth quarry which extends right up to the coastline.

2.2 Analytical Methods

The water quality of monitoring sites comprising 10 water quality parameters were monitored monthly over one year (2006) and analysed as given below:

The temperature and conductivity were measured using HACH portable pH meter, Dissolves oxygen (DO) was measured with YSI 1000 DO meter. biochemical oxygen demand (BOD), chemical oxygen demand (COD), total nitrate and total phosphate concentrations were analyzed using Spectrophotometer (HACH/2010). Turbidity was measured using Nephlometer. Total suspended solids (TSS) were analyzed gravimetrically at the laboratory. APHA Standard Methods for the Examination of Water and Wastewater were applied for the analysis of concentration of above mentioned parameters.

2.3 Multivariate statistical methods

2.3.1 Discriminant function

Discriminant analysis is a multivariate technique used for two purposes, the first purpose is description of group separation in which linear functions of the several variables (discriminant functions (DFs)) are used to describe or elucidate the differences between two or more groups and identifying the relative contribution of all variable to separation of the groups. Second aspect is prediction or allocation of observations to group in which linear or quadratic functions of the variable (classification functions (CFs)) are used to assign an observation to one of the groups **(**Richard&Dean, 2002; Alvin, 2002**).** SPSS version 12 software was used for carrying out the statistical analysis of the data.

2.3.2 Factor analysis

Factor analysis (FA) is designed to transform the original variables into new uncorrelated variables called factors, which are linear combinations of the original variables. The FA is a data reduction technique and suggests how many variates are important to explain the observed variances in the data. Principal components method (PCA) is used for extraction of different factors. The axis defined by PCA is rotated to reduce the contribution of less significant variables (Vega et

al., 1998; Helena et al., 2000). This treatment provides a small number of factors that usually account for approximately the same amount of information as the original set of observations. The FA can be expressed as:

$$Z_{ij} = a_1 f_{1j} + a_2 f_{2j} + ... + a_m f_{mj} + e_{ij} \quad (1)$$

where z is the measured variable, a is the factor loading, f is the factor score, e the residual term accounting for errors or other source of variation.

3. Result and discussion

3.1 Factor analysis

Factor analysis was carried out on the data set (10 variables) to compare the compositional patterns between analyzed water samples and to identify the various factors that influence each of them. Two factors were extracted explaining more than 82 % of the total variance in the water quality data set. Eigenvalues >1 were taken as criterion for the extraction of the principal components required for explaining the source of variances in the data set .The eigenvalues for different factors, percentage variance accounted and cumulative percentage variance are given in Table 1. The Scree plot is shown in Fig.3 to clarify the method of extraction of different factors.

The factor analysis was actually performed on the correlation matrix between different parameters followed by Varimax rotation and the same has been used to examine their inter relationship.

The parameter loadings for the two identified factors from the factor analysis of the data are given in Table 2. The factor 1 accounts for 59.29 % of the total variance. It is positively correlated (loading > 0.75) with turbidity, temperature and nitrate concentration while negatively correlated with BOD, and phosphate concentration. This factor appears to be originated from the combined effect of anthropogenic activities accompanied with partial ecological recovery system of the river. So this factor may be called as *pseudo anthropogenic* factor.

Factor 2, on the other hand, explains 23.03% of the total variance and is positively loaded with conductivity and COD. Since the causes of these two parameters are based on excessive industrial activities and are not compensated/ removed instantaneously by the natural recovery system so might be termed as *anthropogenic* only.

3.2 Source Identification

An attempt was made to study the relationship between factor scores and the samples from different sites. The scores for the first factor are shown in Fig. 3. It is observed that turbidity and nitrate concentrations recorded were low where as BOD and phosphate concentrations were higher in Jejawi River for all sites. The high BOD and phosphate concentrations indicate relatively high waste dumping activity in the Jejawi river. Since the high value of BOD accounts for higher micro organism concentration which in tern may consume nitrate and can cause the precipitation of suspended and colloidal particles in water causing thereby reduction in turbidity. It also indicates that Jejawi river has low pollution than Jeru river due to probably lesser industrial activities and easy natural recovery process in the former river. The physical assessment of industrial area shows that more industries are located at Jeru River and thus provides more strength to the conclusion drawn above.

The scores for the second factor are presented in Fig. 4 and appear to show opposite behavior in the two rivers. The more pollution load from industrial activities in Jeru River probably weakens its natural recovery system which in turn is normal in Jejawi River. Thus the two rivers are almost opposite to each other in terms of industrial pollution and natural recovery system. For the same reason all parameters correlated with the second factor (Fig. 5) are exchanged their level among the sites in the two rivers.

3.3 Discriminant analysis (DA)

Variation in water quality parameters was evaluated through DA. The DA applied on raw data consisted of ten parameters. Only one DF was found to discriminate the two rivers as shown in Table.3. Wilk's Lambda test showed that DF is statistically significant as shown in Table 4. Furthermore 100% of the total variance between the two locations was explained by only one DF. The relative contribution for each parameter is given in Eq.2.

$$Z = 1.60\ Tem. + 0.97\ pH + 1.86\ Do - 1.48\ BOD + 0.83\ COD - 1.00\ TSS + 1.41\ Cod. + 2.18\ Tur. + 0.03\ phos. - 0.34\ Nit. \quad (2)$$

It can be seen that, Turbidity, Temperature, Do, BOD, Conductivity and Tss exhibited strong contribution in discriminating the two locations and account for most of the expected variations in water quality, while other parameters showed less contribution in explaining the variation between Juru and Jejawi River. The relative contribution for water quality parameters can be arranged in the order;

Turbidity > Do > Temperature > BOD > Conductivity > TSS > pH > COD>Nitrate> phosphate.

The classification matrix (Table 5) showed that more than 100% of the cases were correctly classified to their respective groups. The results of classification also showed that significant differences existed between these two rivers, which are expressed by in term of one discriminant function.

4. Conclusion

The multivariate statistical techniques, namely, cluster analysis and factor analysis are important analytical techniques for the processing of water quality parameters and power full tools for classification as well as identification of possible sources of pollution. The techniques are also helpful in providing the possible mechanism with justification, by simple reasoning, to the causes of variation in water quality parameters.

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References

Alvin, C. R., (2002). Methods of Multivariate Analysis. John Wiley & Sons.INC. USA.

Champan, D., (1992). Water quality assessment. In; Chapman, D. (Ed.), on behalf of UNESCO, WHO and UNEP, Chapman&Hall, London.

Lee, J.Y., Cheon, J.Y., Lee, K.K.,Lee,S.Y., Lee, M.H., (2001). Statistical evaluation of geochemical parameter distribution in a ground water system contaminated with petroleum hydrocarbons. Journal of Enviromental Quality 30, 1548-1563.

Otto, M., (1998). Multivariate methods. In: Kellner, R., Mermet, J. M., Otto, M., Widmer, H.M.(Eds), Analytical Chemistry. Wiley-VCH, Weinheim, Germany .

Reghunath, R., Murthy, T.R.S., Raghavan, B.R.,2002. The utility of Multivariate statistical techniques in hydrogeo-chemical studies: an example from Karanataka, India. Water research, 36, 2437-2442.

Richard A. Johnson and Dean W. Wichern, (2002). Applied Multivariate statistical analysis. Prentice-Hall, London.

Shrestha, S., Kazama, F., (2007). Assessment of surface water quality using multivariate statistical techniques: A case study of Fuji river basin. Japan. Enviromental Modelling & software, 22, 464-475.

Saadia R. Tariq, Munir H. Shah, N. Shaheen, A. Khalique, S. Manzoor, M.anzoor, M. Jaffar, (2005). Multivariate analysis of trace metal levels in tannery effluents in relation to soil and water: A case study from Peshawar, Pakistan. Journal of environmental management.

Singh. K.P., Malik,A., Mohan, D., Sinha, S., (2004). Multivariate statistical technique for the evaluation of spatial temporal variation in water quality of Gomti River (India): a case study. Water research 38,3980-3992.

Vega, M., Pardo, R., Barrado, E., Deban, L. (1998). Assessment of seasonal and polluting effects on the quality of river water by exploratory data analysis. Water research, 32, 3581-3592.

Wunderlin, D. A.,Diaz, M.P., Ame, M.V., pesce, S.F., Hued A.C., Bistoni, M.A., (2001). Pattern recognition techniques for the evaluation of spatial and temporal variations in water quality. A case study: Suquia river basin (cordoba-Argentina). Water Res. 35,2881-2894.

Table 1. Extracted values of various factor analysis for water quality parameters

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.93	59.29	59.29	5.93	59.29	59.29	4.79	47.90	47.90
2	2.30	23.03	82.32	2.30	23.03	82.32	3.44	34.42	82.32

Extraction Method: Principal Component Analysis.

Table 2. Results of the factor analysis for water quality parameters

	factor	
Parameter	F1	F2
Turbidity	0.97	0.09
Temperature	0.93	-0.09
BOD	-0.91	-0.40
Phosphate	-0.85	-0.45
Nitrate	0.75	0.26
TSS	-0.54	0.03
PH	-0.02	0.96
DO	-0.03	0.95
Conductivity	0.44	0.83
COD	0.63	0.70

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a Rotation converged in 3 iterations.

Table 3. Eigen-value of DF for the two locations

Function	Eigen-value	% of Variance	Cummulative %
1	416.779	100	100

Table 4. Wilks' Lambda for testing discriminant function validity

Test of Function	Wilks' Lamda	P-value
1	0.002	< 0.0001

Table 5. Classification results for discriminant analysis of the two rivers

Locations	%	Predicted group membership	
	correct	Juru River	Jejawi River
Juru River	100	10	0
Jejawi River	100	0	10

a 100% of original grouped cases correctly classified.

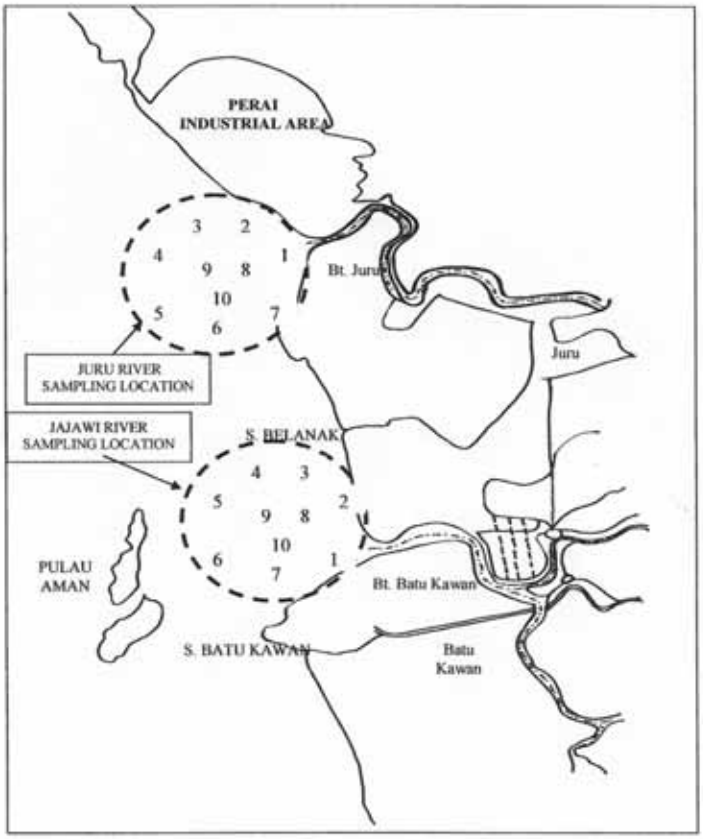

Figure 1. Map of sampling locations for study areas

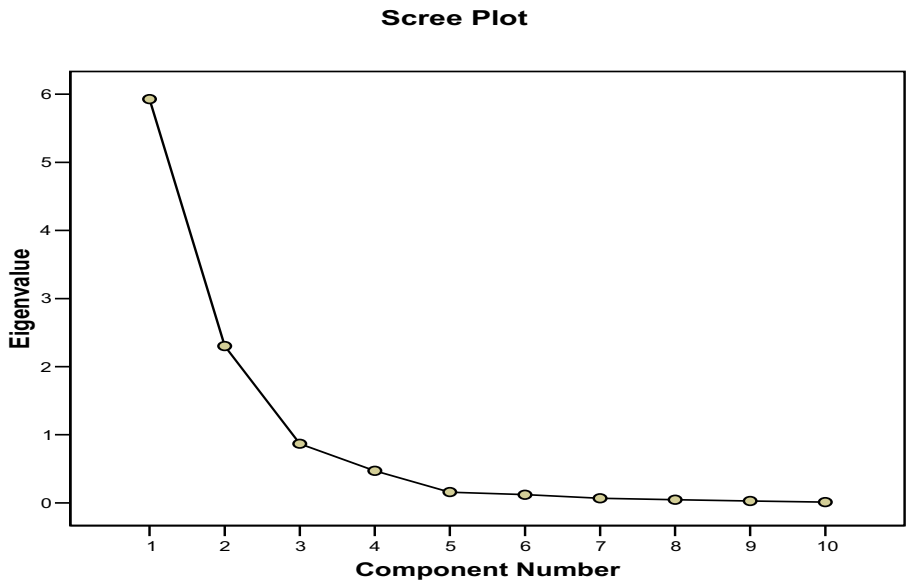

Figure 2. Scree plot of Eigen-values

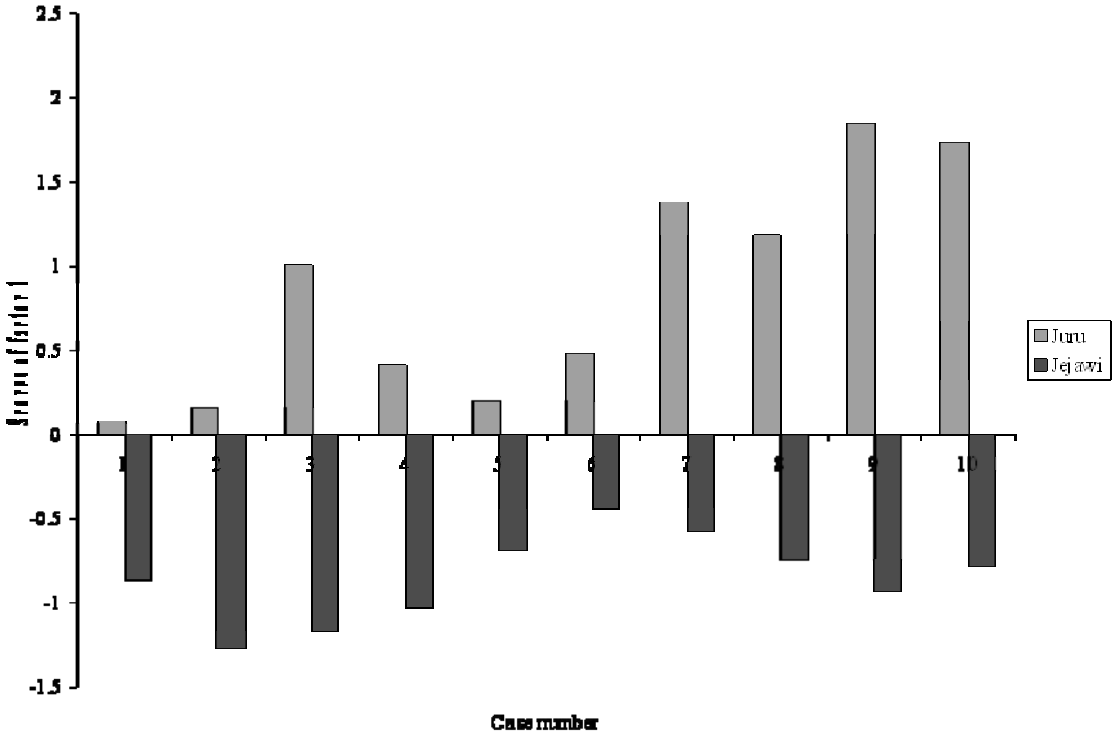

Figure 3. Factor score for factor 1 for different sites of Juru and Jejawi Rivers

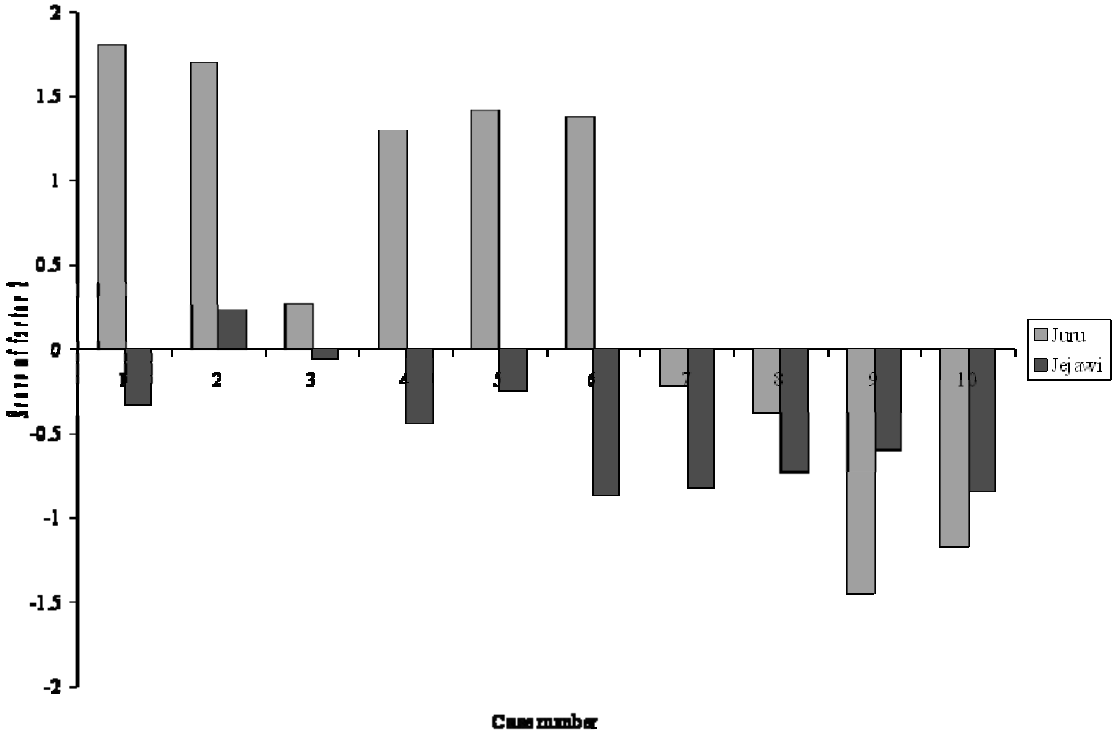

Figure 4. Factor score for factor 2 for different sites of Juru and Jejawi Rivers

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Research on Prediction of Shanghai's Population Development From 2008 to 2050

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Abstract

Based on the latest statistic data of Shanghai's population during 1952-2007, a grey model with the pretreatment of data is established for prediction and researching on the Shanghai's future household registration population up to the year 2050. This model's feasibility is illustrated compared with other grey models. The result shows that at the end of 2008, 2010, 2020, 2030, 2040 and 2050 Shanghai's population will reach 13.868, 14.047, 14.974, 15.962, 17.016, 18.138 million, respectively.

Keywords: Shanghai's population, Grey model, Population prediction

1. Summary of the development of Shanghai's population

Shanghai, the largest city in China, is the economic, financial, technology and communication centre of this country. It is not only one of the most important industrial bases, the major ports and trade centers, but also the flagship of the Yangtze delta city group. As the famous international metropolis, Shanghai's development is having an effect on the whole national economy and pushing it forward. As is well known, Shanghai has a large population and the highest population density in China. Based on the statistics data, by the end of 2007, Shanghai's resident population is 18,580,000, which is 429,200 more than last year, and its household registration population is 13,788,600, which is 2.6 times of the number in the early period after the founding of New China and 1% of national total population(NBS 2007). According to the household registration population, the population density is 2175 people / km^2, Shanghai has 1.04% population but only 0.06% land area of the whole country. Therefore, the research on prediction of Shanghai's population development not only has the important and realistic meaning to the native social and economic development, but also is pertinent and typical for the whole country.

At the beginning of 1950s, Shanghai's total population increased at a high speed. In the continuous 7 years from 1952 to 1958, the population natural growth rate has been keeping above 30‰s, and the highest record once reached to 45.6‰s. The main reason includes: Shanghai gets into the first five-year plan in 1953, the city needs large quantities of labor

force for some important projects. And because the population migration wasn't limited strictly in policy, the population in Shanghai grew fast in short term. By the end of 1950s, the natural growth rate of population in Shanghai City decreased sharply and kept gradually. It was at a period of low increase. Been influenced by the natural disaster, the natural fluctuation of population sunk to a low ebb, and then rallied slowly. Except 1969, population natural growth rates were annually below 10‰ from 1966 to 1980. Because of the baby boom in 1950s and the surplus period, the population natural growth rate had a certain raise in the early 1980s. But because the family planning policy was carried out strictly in 1970, it could still maintain at a low level. The population natural growth rate was basic stable and the total population rose slowly. It appears a negative population growth rate in Shanghai since 1993. This is inseparable with the result of the family planning policy. According to the statistics, from the starting of family planning policy to the beginning of 2005, the total population in Shanghai is born 7,000,000 less, nearing the half of total population in Shanghai, and it makes a great contribution for national population development and control. Based on the latest statistics data, this paper researches on the Shanghai's future household registration population development by building up the improved grey model dealt with the pretreatment of data, in order to provide reliable evidence for the social and economic sustainable development.

2. Prediction of Shanghai's population

2.1 Establishment of grey model

Supposing the original population time sequence is

$$x^{(0)} = [x^{(0)}(1), x^{(0)}(2), \cdots, x^{(0)}(n)]$$

and the time sequence $x^{(0)}$ through 1-AGO (accumulating generation operator) to get a newly-generated sequence $x^{(1)}$, namely,

$$x^{(1)} = (x^{(1)}(1),\ x^{(1)}(2),\ \ldots,\ x^{(1)}(n))$$

in which

$$x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i) \qquad (k = 1, 2, \cdots, n)$$

with which to make a general GM (1, 1) prediction model, namely, grey differential equation (image equation)

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = b$$

dispersing the above equation to establish grey differential equation

$$x^{(0)}(k) + az^{(1)}(k) = b$$

in which

$$z^{(1)}(k) = \alpha x^{(1)}(k-1) + (1-\alpha)x^{(1)}(k) \quad (k = 2, 3, \cdots, n)$$

where a and b are coefficients to be determined, called a development coefficient and grey actor, respectively. a has its valid limits (-2, 1) and is obtained through the following expression via the least squares method

$$\hat{a} = (a, b)^T = (B^T B)^{-1} \cdot B^T \cdot Y_{n-1}$$

in which

$$Y_n = \begin{pmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{pmatrix}, \quad B = \begin{pmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -z^{(1)}(n) & 1 \end{pmatrix}$$

The solution is the time response function in the form

$$\begin{cases} \hat{x}^{(1)}(k+1) = [x^{(1)}(m)d - \dfrac{b}{a}] \cdot e^{-a(k+1-m)} + \dfrac{b}{a} \\ \hat{x}^{(0)}(k+1) = (1-e^{a})[x^{(1)}(m)d - \dfrac{b}{a}] \cdot e^{-a(k+1-m)} \end{cases}$$

Not all raw data are used for establishing a gray model and different dimension (or length) produces different values of a

and b, leading to different predictions that constitute a prognostic gray interval. According to grey modeling theory, one-step forecast precision is above 98% and two to five step forecast precisions are above 97% as $|a| \le 0.3$, while one to two step forecast precisions are above 90% and ten-step forecast precision is above 80% as $0.3 < -a \le 0.5$ (Liu et al., 1999) . Thus, to improve the prediction accuracy we have to select a grey model of a suitable number of dimensions (Liu et al. 2004, 1999).

The grey system theories have two basic principles: new information priority and small-sampled and poor-information. Based on these two principles, we take $m = 1, 2, \cdots, n$ in turn to construct prediction equation and compute prediction error. We choose the value m from the models which has the smallest average error and then we establish the best grey optimal model (Zhang, 2002). When $m = 1$, the model we establish is general-type GM. If we apply one-order difference operation to the raw data, and then establish general grey model, this model we call: grey increment model (Men et al. 2004, 2005). In order to improve the prediction accuracy, this paper will first carry on preparing a processing to the original data before making use of above-mentioned models to carry on an estimate. Generally, there are two methods to prepare a processing, one kind opens the data square, another one turns data logarithm to make the data smooth and be suitable for grey model. After getting estimate values, we have to restore the data. This paper will make use of above methods to build up models respectively and carry on more analysis to the results we get.

2.2 Prediction and analysis of the future population of Shanghai

2.2.1 General grey prediction models and test

According to the data of table 1, this paper adopts nonlinear least squares fitting method, building up following GM models respectively.

(1) General-type GM (1, 1)

To select a suitable model, we single out 4-10 dimensions short series to construct models of general-type GM (1, 1) and carry on experimental prediction to the data of 2007 Shanghai City population. Test shows that the 5-dimension model gives the closest result, so we have general-type GM (1, 1) (2002-2006):

$$\hat{x}(k+1) = 209107.548391 \exp(0.0064k) - 207773.318391$$

(2) Grey increment model

To select a suitable model, we single out 4-10 dimensions short series to construct models of grey increment model and carry on experimental prediction to the fact value of 2007 Shanghai City population. Test shows that the 6-dimension model gives the closest result, thus we have grey increment model (2001-2006):

$$\hat{x}(k+1) = 386.945335 \exp(0.020115k) - 381.435335$$

(3) Grey optimal model

To select a suitable model, we single out 4-10 dimensions short series to construct models of grey optimal model and carry on experimental prediction to the fact value of 2007 Shanghai City population. Test shows that the 5-dimension model gives the closest result, thus we have grey optimal model (2002-2006):

$$\hat{x}(k+1) = 209107.566547 \exp(0.006400k) - 207773.318391$$

2.2.2 Grey model in which data is pretreated and test

(1) Turn data logarithm to construct GM (1, 1)

To select a suitable model, we single out 4-10 dimensions short series which are turned logarithm to construct models of grey model and carry on experimental prediction to the fact value of 2006 and 2007 Shanghai City population. Test shows that the 5-dimension model gives the closest result, which is thus taken for use.

Model for 2006: $\hat{x}(k+1) = 7870.735399 \exp(0.000914k) - 7863.544616$

Model for 2007: $\hat{x}(k+1) = 8105.660402 \exp(0.000888k) - 8098.464290$

(2) Open the data square

To select a suitable model, we single out 4-10 dimensions short series which is opened square to construct models of grey optimal model and carry on experimental prediction to the fact value of 2006 and 2007 Shanghai City population. Test shows that the 5-dimension model gives the closest result, which is thus taken for use.

Model for 2006: $\hat{x}(k+1) = 11573.104381 \exp(0.003142k) - 11536.750001$

Model for 2007: $\hat{x}(k+1) = 11435.194206 \exp(0.003189k) - 11398.764119$

The predictions of 2006 and 2007 population of Shanghai from the above models are listed in Table 2 and Table 3.

Comparison of tests in table 2 and table 3 indicates that if we carry on preparing a processing to the original data firstly,

the model has higher prediction accuracy than other grey models. Furthermore, it is superior to other models in some respects: ① Higher prediction accuracy is maintained in extended and long-range predictions (far exceed other ordinary models); ② No large quantities of data is demanded in collection [four to eight samples can be chosen for model establishing, which is especially fit for the occasion that data are difficult to get.]; ③ It is flexibility and handy in model operation [with small calculation]. Consequently, it is an ideal and economic new tool for population prediction.

According to table 2 and table 3, we prepare a 5-dimension grey model after opening the data square on the data from 2003 to 2007 because this kind of model has the highest accuracy,

$$\hat{x}(k+1) = 11487.621011\exp(0.003196k) - 11450.990707 \qquad (*)$$

Tests show for Model (*) at $C = 0.05, P = 1$ we have the mean fitting precision $q = 99.949\%$. The effect of prediction is quite satisfactory. Therefore, this model satisfies first-grade accuracy requirement for the use of the extended and long-range prediction of the population of Shanghai, with the predictions shown in Table 4.

3. Conclusions and discussions

(1) The accurate estimate of population is the basis of a city's development program. There's an erroneous view that a good model must be complicated. In fact, the simple and practicable model awarding with facts is the best one for prediction. In this paper, the raw data series are dealt with the extraction while building up the prediction model of Shanghai's population, in order to improve the precision of prediction. It's proved that, precision of prediction model raises consumedly after the extraction of the initial series. It is a kind of more viable way to predict. The demonstration proves that this is an effective way with economical and practical facilities on population prediction, because it's agility, convenient, small calculation amount and small sample. It can be predicted in this paper that, household register population in Shanghai will grow smoothly and slowly in the coming 40 years, and annually the population net growth won't over 100,000. While holding the World's Fair in 2010, population in Shanghai will attain 14,047,000 or so; and in 2050, the population is about 18,140,000.

(2) The development of Shanghai is open, and the floating population comes out at the top of the list in major cities. It attracts more and more domestic and international population since 1992, a great deal of labor force come from other parts of country gets into Shanghai for the employment opportunities. Because the population natural growth rate has continuously presented a negative growth for 15 years, the estimate result in this paper points out that, the growth of household register population will be stability. As a result, now and in a long period of time to come, the key factor which will influence the population scale and structure change in Shanghai is ab extra floating population. Ab extra floating population in Shanghai is 1,060,000 in 1988, which has already doubled to 2,510,000 in 1993. The fifth census data shows that, Shanghai's resident population is 16,400,000 in 2000, among which, the ab extra floating population is 3,870,000, 23.6% around. Currently, floating population who live in Shanghai for more than half a year is about 1/4 of the permanent population(Xinhua, 2006). It is predicted that, in 2010 Shanghai's population will be 20,000,000, and then the ab extra floating population will be 6,000,000 or so. The elements which can influence the floating population are: ① The upsurge of infrastructure construction caused by the World Fairs; ② The urbanization strategy of countryside which is needed by the economy development of Yangtze River delta and manufacturing industry belt; ③ The pressure and responsibility which is brought by urbanization of cities in China; ④ The need of labor force in some service industries caused by the reduction of labor force and aging population in Shanghai around 2010. Therefore, we must tightly hold the strategic opportunity of development to make the full use of the human resource in ab extra floating population, in order to strengthen the comprehensive competition ability of Shanghai and promote the great-leap-forward development of Shanghai in the new century.

(3) Population is the foundation of a city's development. When investigating the relationship between population and social development, there is the chief question that how many are the optimum population and the limitation of Shanghai population with the total area 6340.5 km^2? The latest research of the population institute in Fudan University replies: the limitation of Shanghai population is about 28,000,000-30,000,000, and around 2020 the population will be 22,000,000-24,000,000. Since the middle of 1990's, many research centers and experts study up on the optimum population in Shanghai by various ways. Although the results of research are different, but on the whole, the optimum population of Shanghai should be 18,000,000-20,000,000 in 2010. Shanghai locates in the lower end of Yangtze River delta, natural resources and environment would not restrict the capacity of population. Without consideration of other social factors, the population in Shanghai attaining 20,000,000 wouldn't bring any negative influence to the citizen's living quality(Peng, 2002). However, if there is not large addition of new population, it will weaken the adjustment of the quality and structure of population and the competitive of sustainable development in Shanghai. To consider the composition of population, the negative factors of city development are: ① The structure of labor power in Shanghai is increasingly aging. The relevant personage points out many times that the labor force population in household register population in Shanghai will descend gradually after 2005, and hit the lowest level around 2010, then, the economic activities population of Shanghai will reduce from 8,500,000 to 6,500,000. ② The society evolves from aging of

population to aging of the aged, Shanghai will face double pressures from the aging society and old aged society. ③ The age structure of population is characterized by Multi-Peak-Valley form. ④ The quality of population is relatively weak, which is not correspond to a modern international metropolis.

Zhang Rongzhou (Population, 2003) in Shanghai population information center said that the discussion of the population in Shanghai should not only consider the need of Shanghai's social economic development and capacity of "resources", but also consider it in the urbanization of China.

First, we should have a full understanding of Shanghai's position in the progress of the urbanization of china. Urbanization, it appears to be a huge process of population gathering first, accompanying with the gathering of industries and various resources. Since the industrial revolution, the development of modern city experienced 3 stages: First stage: urbanization; Second stage; especially big urbanization; Third stage: especially big urbanization groups. Today, the development of urbanization and metropolitan area is the common phenomenon in many developed countries. Take an example, Tokyo's population is 11,000,000 in 2000, which is less than Shanghai's population. But it constitutes 8.8% of the Japanese population, much higher than Shanghai. And the population of metropolitan area in Tokyo is 32,000,000, 25.6% of Japanese population. The population of Tokyo is less than Shanghai, but in fact, the degree of its dense population is far above Shanghai.

Second, "Resources" isn't the bottleneck of Shanghai's population development. According to the data of Chinese urban net, a per-capita floor space in Shanghai is 48.3 m^2, and it is 64.3 m^2 in Tianjin, 70.9 m^2 in Beijing, 76 m^2 in Guangzhou. In the world, it is 195 m^2 in Hamburger, 136 m^2 in Munich, 116 m^2 in London. The experts suggest that the indicator of urban construction land should appropriately rise along with the development of Shanghai economy, and accelerate the process of urbanization. Concern about the problem of water, many researches point it out early that Shanghai isn't in a water shortage, but is in need of clean water. Shanghai should improve its ability of water resources protection and wastewater treatment. Now, Shanghai's resources are conditioned by three main factors: technique, management and devotion ability. "Resources" will not become the bottleneck of Shanghai's population development in the foreseeable future.

(4) To sum up, Shanghai has to keep the social and economy developing continuously, and raise comprehensive ability of competition. It has to build a good population environment, speed up favorable recruiting and population flowing within the next 10 years, steadily carry out and adjust the family planning policy, and program its future development on the strategy of Shanghai metropolis area. It should take the expansion of population in short time as the cost of social and economy development. In the course of the city population's exchange and adjustment, Shanghai will promote its comprehensive strength and competitiveness, and accelerate the social and economic development. Shanghai will be striding toward the modern international metropolis with a completely new shape.

References

Liu Sifeng, Dang Yaoguo, and Fang Zhigeng, (2004). *Grey System Theory and Its Application* (3rd edition)*,* Beijing: Science Press.

Men Kepei, Guan Lingling and Jia Lingyun, (2005). China's future population: predictions and prospects. *Population Review,* 44(1), 1-10.

Men Kepei and Zeng Wei, (2004). Study on the Prediction of the Population of China over the Next 50 Years. *The Journal of Quantitative& Technical Economics,* (3), 12-17.

National Bureau of Statistics of China, (2007). *China Statistical Yearbook-2007*. Beijing: China Statistics Press.

PRC State Council, (2000). *Population and Development for the 21st Century in China.* [Online]

Available: http: //news.xinhuanet.com (Oct18, 2007)

Peng Xizhe and Ren Yuan,(2002). Population factor and city synthesize a competition ability-aresearch developed to city in Shanghai. *Chinese Population Science*, (6), 33-39.

Population, (2003). The increase of total population in Shanghai is the result of the development of economic and city. [Online] Available: http: // www.popinfo.gov.cn (Feb1, 2008)

Shanghai Statistics Bureau,(1991-2007). *Statistical yearbook of Shanghai.* Beijing: China Statistics Press.

Shanghai Statistics Bureau, (2008). *Statistical Communiqe of Shanghai on the 2007 National Economic and Social Development.* [Online] Available: http: // www.stats-sh.gov.cn (Feb4, 2008)

Xinhua News Agency, (2006). Shanghai: "floating resident population" is a quarter of resident population. *Jingling Evening Paper*,(Nov19, 2006)

Zhang Dahai, Jiang Shifang and Shi Kaiquan, (2002). Theoretical Defect of Grey Prediction Formula and Its Improvement. *Systems Engineering-Theory & Practice,* 22(8), 140-142.

Table 1. Statistics of Shanghai's population in 1952-2007 (Unit: 10^4 Persons)

Year	Household Registration Population	Birth		Death		Natural Growth	
		number	birth rate(‰)	number	death rate(‰)	number	natural growth rate (‰)
1952	572.63	21.98	39.1	4.93	8.8	17.05	30.3
1953	615.24	25.61	43.1	5.26	8.9	20.35	34.2
1954	662.71	33.70	52.7	4.55	7.1	29.15	45.6
1955	623.10	27.20	42.3	5.28	8.2	21.92	34.1
1960	1056.30	28.91	27.7	7.16	6.9	21.75	20.8
1965	1093.79	18.58	17.0	6.20	5.7	12.38	11.3
1970	1072.55	15.10	13.9	5.41	5.0	9.69	8.9
1971	1066.82	13.03	12.2	5.6	5.2	7.43	7.0
1972	1064.11	11.54	10.8	5.93	5.6	5.61	5.2
1973	1070.01	10.94	10.2	5.84	5.5	5.10	4.7
1974	1073.78	9.85	9.2	6.25	5.8	3.60	3.4
1975	1076.72	10.14	9.4	6.47	6.0	3.67	3.4
1976	1081.30	11.04	10.2	6.63	6.1	4.41	4.1
1977	1086.47	11.72	10.8	7.05	6.5	4.67	4.3
1978	1098.28	12.36	11.3	6.82	6.2	5.54	5.1
1979	1132.14	13.76	12.3	6.81	6.1	4.41	6.2
1980	1146.52	14.31	12.6	7.39	6.5	6.92	6.1
1981	1162.84	19.38	16.8	7.44	6.4	11.94	10.4
1982	1180.51	21.68	18.5	7.35	6.3	14.33	12.2
1983	1194.01	17.80	15.0	8.19	6.9	9.61	8.1
1984	1204.78	16.38	13.7	7.82	6.5	8.56	7.2
1985	1216.69	15.43	12.7	8.10	6.7	7.33	6.0
1986	1232.33	17.75	14.5	7.93	6.5	9.81	8.0
1987	1249.51	19.02	15.3	8.27	6.7	10.75	8.6
1988	1262.42	16.53	13.2	8.47	6.8	8.06	6.4
1989	1276.45	15.91	12.5	8.43	6.6	7.48	5.9
1990	1283.35	13.12	10.2	8.63	6.7	4.49	3.5
1991	1287.20	10.08	7.8	8.56	6.7	1.52	1.1
1992	1289.37	9.37	7.3	9.10	7.1	0.27	0.2
1993	1294.74	8.40	6.5	9.40	7.3	-1.00	-0.8
1994	1298.81	7.63	5.9	9.42	7.3	-1.79	-1.4
1995	1301.37	7.11	5.47	9.79	7.53	-2.68	-2.06
1996	1304.43	6.79	5.21	9.77	7.50	-2.98	-2.29
1997	1305.46	6.42	4.92	9.57	7.33	-3.15	-2.41
1998	1306.58	6.17	4.73	10.13	7.75	-3.96	-3.03
1999	1313.12	6.56	5.01	9.54	7.28	-2.98	-2.27
2000	1321.63	6.95	5.27	9.45	7.17	-2.50	-1.90
2001	1327.14	5.76	4.34	9.34	7.05	-3.58	-2.71
2002	1334.23	6.20	4.66	9.67	7.27	-3.47	-2.61
2003	1341.77	5.73	4.28	10.07	7.52	-4.34	-3.24
2004	1352.39	8.09	6.00	9.65	7.16	-1.56	-1.16
2005	1360.26	8.52	6.08	10.23	7.54	-1.98	-1.46
2006	1368.08	8.12	5.95	9.80	7.19	-1.68	-1.24
2007	1378.86	10.08	7.34	10.22	7.44	-0.14	-0.10

Note: The above data are taken from the "Shanghai Statistical Yearbook" (1991-2007) and "Statistical Communique of shanghai on the 2007 National Economic and Social Development".

Table 2. Comparison of various models-based predictions for Shanghai's population for 2006 (Units: 10^4 persons)

Model	Statistics	Prediction	Residual difference	Relative error (%)	Predict accuracy(%)
General-type GM	1368.1	1369.5	1.4	0.101	99.899
Grey increment model	1368.1	1370.5	2.4	0.175	99.825
Grey optimal model	1368.1	1369.5	1.4	0.101	99.899
Turn data logarithm	1368.1	1369.5	1.4	0.102	99.898
Open the data square	1368.1	1368.7	0.6	0.044	99.956

Table 3. Comparison of various models-based predictions for Shanghai's population for 2007 (Units: 10^4 persons)

Model	Statistics	Prediction	Residual difference	Relative error (%)	Predict accuracy(%)
General-type GM	1378.9	1377.5	1.4	0.102	99.898
Grey increment model	1378.9	1376.8	2.1	0.152	99.848
Grey optimal model	1378.9	1377.5	1.4	0.102	99.898
Turn data logarithm	1378.9	1377.5	1.4	0.102	99.898
Open the data square	1378.9	1377.5	1.4	0.102	99.898

Table 4. The predictions of Shanghai's population for 2008-2050 (Units: 10^4 persons)

Year	Total	Year	Total
2008	1386.8	2018	1478.4
2009	1395.7	2019	1487.8
2010	1404.7	2020	1497.4
2011	1413.7	2025	1546.0
2012	1422.8	2030	1596.2
2013	1431.9	2035	1648.0
2014	1441.1	2040	1701.6
2015	1450.3	2045	1756.8
2016	1459.6	2050	1813.8
2017	1469		

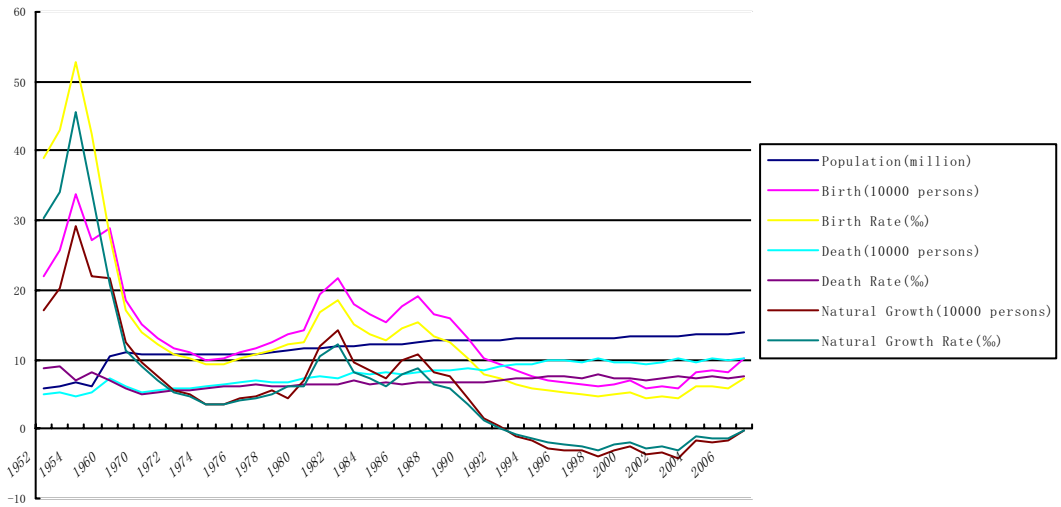

Figure 1. Natural change of Shanghai's population from 1952 to 2007

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Management of Safety for Quality Construction

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Abstract

An overview of construction quality and safety reveals many striking similarities for these two management concept. Programs that have been developed to improve quality and safety performance have many elements in common. In some cases safety is considered a part of Total Quality Management (TQM). The close relationship between quality and safety implies that benefits would be derived by applying some or all of the following propositions: (1) Consolidate the safety and quality functions; (2) Apply quality concept to safety; (3) Optimize the safety management concept; and (4) Apply the results of safety aspects to quality. Within these past few years, the Malaysian government has made an effort on executing safety and health policies through the enforcement of guidelines as well as conducting site safety seminars and certifications. Ranked as a second industry in Malaysia that contribute to highest percentage of accidents at the worksite, the impact of loss of profit and unhealthy workplace affect the construction industry. Currently, these topics are being widely implied and stressed out in Malaysia by the means of enforcement; for instance, through ISO certification and local regulations and guidelines. This paper aim to provide a basis framework, this seminar which titled "Safety Management towards Quality Construction" tries to delineate the relationship and the importance of these two areas. The concepts of safety management and quality management indeed are still new in Malaysia. A proposed model which is also a framework is seen as a procurable method on defining the basic concept of safety management meant to achieve the expected quality level. In the aspect of proposing safety application model, a directive method of the Total Quality Management is used. A basic management application model as suggested by Walker (1993), is proposed to be used as a generic model to highlight the key features. Findings from individual survey are used to delineate the key points or processes of the safety application model.

Keywords: Safety, Management, Quality, Construction, Industry

1. Introduction

The present Occupational Safety And Health (OSH) situation in the workplace is still very much adverse and below expectation. Accidents and diseases still occur and they are a cause for concern as the available statistics show that the percentage of accident occurs in the workplace is alarmingly increased (SOCSO, 2000) (Figure 1). Precedent analysis

done by Department of Occupational Safety & Health (DOSH) revealed that the number of accidents occur in this industry is very high. The management of health and safety is without doubt one of the most important functions within and throughout the construction process.

<Figure 1: Reported accidents in the construction industry from year 1995-2000 (SOCSO, 2000)>

A probe into the safety management system suggests that the current practise in Malaysia does have sound features and characteristics. However, it lacks the mission, vision and objectives of safety management system as well lack of awareness and drive for the realization of safety among management executives due to over-emphasis on productivity. It also requires more constructive and practical ideas towards safety management implementation. In contrast to the existing scenario, the quality practice in Malaysia is more developed and established in which the control measure can be seen from the enforcement of various guidelines, implementation of quality management and the establishment of specific body to monitor activities relating to quality management topic. Knowing the fact that improvement is vital and needed, a framework of safety management is formulated and adopted based on the intention of achieving quality construction. An integration of safety management and quality on brings forth a more comprehensive approach on safety practice whilst at the same time providing a quality construction.

The term 'safety management' actually is used for convenience and for brevity, and wherever it is used it should be taken to refer to the management of occupational health and the environment as well as safety. Safety management is concerned with, and achieved by, all the techniques which promote the subject. In addition, safety management is also concerned with influencing human behaviour and with limiting the opportunities for mistakes to be made which would result in harm or loss. As described in Occupational Safety and Health (OHSAS 18001), Occupational Health and Safety Management System (OHSMS) is:

"Part of the overall management system that facilitates the management of the OH&S risks associated with the business of the organization. This includes the organizational structure, planning activities, responsibilities, practices, processes and resources for developing, implementing, achieving, reviewing and maintaining the organization's OH&S policy." (Shamsul Efendi Dismal, 2002). The term 'safety management' as defined by World Health Organization (WHO) is: *"the process of enabling people to increase control over, and to improve their health." (WHO 1990)*

Quality has traditionally been interpreted as 'ability to satisfy needs' (BSI, 1971), 'conformance to requirements' (BRE, 1978), and 'fitness for purpose' (CIRIA, 1985). The recent trends have seen a more holistic understanding of quality emerging in terms of providing customer satisfaction. this orientation towards the customer has focused the attention of quality management as a process which links to the various stages of the total construction process and which underpins all activities and business of an organization involved in any of those stages. The development of formal quality management system has evolved from the need to comply with worldwide quality standards for instance, ISO 9000. Compliance with such standards implies that an organization follows documented procedures and working practices.

In the international construction scene, the inclusion of both the traditional quality and safety efforts within a TQM system is advocated by Dias and Curado (1996). They suggest that the TQM emphasis on the customer will lead to protection of the employee who is a vital customer, as mentioned previously. They write that safety record keeping, particularly in Europe, would be improved and a needed "safety culture" comparable to the existing "quality culture" would result. They suggest that an international standard for safety measurement be developed comparable to the models for quality management such as the ISO 9000 series. A research project done in collaboration with the European Construction Institute studied the state of integration of safety and quality altogether with environmental management (Coble, R.J.; The finding was that the systems generally remain independent of each other in spite of probable benefits that would accrue from closer integration. Some of the reasons for the lack of integration are perceived difficulties due to project-specific requirements, legislative requirements, and a general lack of understanding and commitment.

A study of the Hong Kong construction industry concluded that mere legislation of safety requirements had been inadequate to protect the workers (Lo 1996). It is suggested that safety would be greatly improved by including it as part of the existing ISO 9000 quality management system. ISO 9000 accreditation is required for bidding on work for the Hong Kong Housing authority and this has been a major incentive to obtain accreditation. The author contends that having safety included in the quality standard would insure that it be treated more seriously. In Hong Kong, requiring company initiated and independently audited ISO 9000 has proved to be a more effective approach than detailed safety legislation.

It is clear that quality and safety are complementary issues. They are distinct but similar The associated problems have common roots in the laws of probability, the indifferent universe and human nature. This is why the programs devised to manage these look so much alike. The value of including safety in TQM is recognized in the United States and in Europe. Given, then, that this close relationship exists, what are some possible implications? Each of the next four sections is a proposition based on the quality/safety relationship.

2. Similarities between construction quality and safety

It should be evident that the similarities between quality and safety issues in construction are striking. The similarities are discussed as follows:

2.1 Scope: constant and pervasive

Both quality and safety relate to the successful performance of the job and pervade the entire process from design to estimating to contract negotiation and throughout the construction process. Both quality and safety require constant vigilance and effort; everyone, including subcontractors, must participate in the effort. Another similarity in scope is that while many of the results are dear at the end of a project, both quality and safety have long term implications. Quality problems and chronic health problems may be discovered years after the project is completed.

2.2 Critically to success and goal: No failures (deviations or injuries)

Efforts to maintain quality and safety focus on a common objective: minimizing disruptions to the efficient process of completing a job. In both cases the disruptions are usually the result of human errors or adverse circumstances. In quality, the disruptions are called deviations; in safety they are called accidents. In fact, an accident can be defined as a type of deviation. If the requirement of a zero injury job is established, an injury is a failure to meet the requirement and therefore, by definition, a deviation. This approach places the safety function within quality management. "Doing it right the first time" can refer to the process (safety) as well as to the product (quality). To put it another way, both quality and safety efforts combat the seemingly universal principle known as Murphy's Law: if anything can go wrong, it will.

2.3 Obstacles and problem causes: Indifferent universe, probability and human nature

The real foe may be the laws of probability and an indifferent universe. If there are ten ways to do a task and two of them lead to the correct result but eight of them lead to the wrong result, it is probable that doing the task carelessly will lead to the bad result. There are many opportunities to fail. The element of chance tempts some to gamble with both quality and safety.

2.4 Detection: immediate or delayed

Detection of failures should be early planned. Risk analysis should be conducted in which probabilities of goal failures or problems that may arise can be detected before implementation. Through this risk analysis, the management can foresee the losses that may occur due to failures and alternative solutions can be planned. A delayed detection on problems may contribute to monetary losses and delayed in work programmes.

2.5 Effect of Failure

The immediate fallout from a newly discovered major quality problem and an injury causing accident looks the same. Work stops; management becomes involved; investigation is undertaken; blame is assigned; morale is eroded; and time and money are wasted. The results of a failure in either quality or safety may be immediately apparent; however, failures in either may not be apparent for some time. The latent quality failure may lead to warranty work; the hidden safety risk may lead to delayed chronic health problems. Either a poor safety record or a poor quality record can harm a company's reputation and may disqualify the company from bidding some jobs. The nature of the disruptions caused by failures of quality and safety are often the same in which they generate additional direct costs and indirect costs. Besides, reduction on productivity and hurt morale are also results of failure.

2.6 Response: systematic program

Maintaining quality and safety represents a great challenge to managers because of the variety and complexity of the factors involved. Seemingly, problems are caused in both areas by many of the same factors. Some of the contributing factors are poor design, poor management practices, improper equipment, untrained personnel, adverse working conditions, and a host of human factors such as distractions, indifference, and substance abuse. Fortunately, many of these problems can be successfully addressed through a quality or safety program. A further challenge in connection with the program is measuring and verifying its monetary value. A non-event cannot be measured; it is possible to gather enough statistical evidence to give adequate guidance for establishing an appropriate level of effort.

2.7 Difficulty in optimizing the program

Difficulty in optimizing a scheduled and outlined program for both safety and quality is another similarity. Both concepts require major management input and constant monitoring is necessary. Back-up plans are also necessary in case the outlined program goes awry during implementation. Management team should be back-up by professionals who really practice their skills, knowledge and diligence.

Some of the major similarities between quality and safety issues are indicated in Table 1. In view of what is indicated above, it is not surprising that quality and safety programs have so much in common.

<Table 1: Construction quality and safety programme components comparison.>

3. The interaction of construction quality and safety

Although there are differences between quality and safety, as has been pointed out, they are neither mutually exclusive nor contradictory. The fact that some sort of positive relationship exists between quality and safety is recognized in TQM programs. Safety is included as one of many elements of TQM. The cover of the October, 1993, Constructor, AGC's management periodical, proclaimed that safety is a key to TQM. Krause (Coble, 2000) lists eight TQM continuous improvement principles that he says apply directly to safety. In addition to the continuous improvement concept, the TQM concepts of teamwork and customer focus relate to safety. The employee is a vital part of the team as well as an important customer; therefore, worker well being and satisfaction are important. Quality management says "do it right the first time"; TQM adds new emphasis to the idea that "doing it right" includes doing it safely. Thus, under TQM, safety is a quality issue. Even apart from TQM, quality management is important to safety. For example, materials testing, which is a function of quality management, may have a profound influence on safety. Determining the maturity of concrete is the job of quality management. As another example, certain kinds of double connections for steel member assembly are unsafe. These may be discovered and rejected by quality management while checking submittals. Thus, quality leads to safety (Coble, 2000).

In a very practical way, safety is also important to quality. A safe work environment which allows a worker to concentrate on the job surely increases the probability that the job will be done correctly; this is the definition of quality. At the very least, danger is an unnecessary distraction. Thus, safety leads to quality. It is difficult to think of a situation in which working safely could do anything but enhance quality. Putting it the other way, since quality is always desirable, the employee should have a safe environment to work in. It's difficult for a mason to lay brick in a straight line if one hand is needed to hang onto the scaffold. There are other ways in which quality and safety intersect. Even if management thinks of employees as mere tools of production, it is only good management to protect the means of production. It is becoming increasingly difficult to find qualified construction employees, especially in the crafts. Since quality requires well trained, well motivated workers, it is in the best interests of quality to support safety efforts merely to reduce losses of company quality assets.Not only do quality and safety support each other, they can be synergistic, actually increasing their mutual effectiveness. A good quality program by its mere presence should enhance the safety program and vice versa. A zero defects program should help with the zero accidents program. Figure 2 depicts the interaction between safety and quality.

Figure 2: Interaction of quality and safety.

4. Consolidation of safety and quality functions

The similarity of the safety and quality functions and the fact that they operate simultaneously in the same environment leads to the conclusion that it might be beneficial to combine or at least closely coordinate the management activities. Some economies of operation might result, and making safety and quality a seamless whole in the employee's experience could have a positive effect. In a sense, this is done when safety is included as an element of a TQM program, but a greater emphasis on the nature and importance of safety and quality is warranted. One approach would be to combine the programs using a workable management framework. The mission of this program would be to achieve the company construction goals in the most efficient and humane manner. This means that the goals would be achieved without any quality, safety, or efficiency related losses. A review on quality and safety concepts will be discussed before further elaboration on framework design to be adopted is proposed.

4.1 Safety management concept

In general, Safety Management is a concept that brings forth a more comprehensive approach, allowing participation and contribution of all levels of management and workforce. This management approach is developed from the conventional safety management (CSM), taking all the characteristics and actual on-site risks into consideration. In fact, it has the potential to increase competitiveness and improve productivity for an organization. Effective safety management has three main objectives, namely to (a) make the environment safe, (b) make the job safe, and (c) make workers safety conscious. The concept of Safety Management grew out of a need to transform safety and health management from a strict compliance orientation to performance orientation in which compliance is an important issue but not the only issue (Geotsch, 1998). Safety and health should be a key element in an organization’s plan for gaining a competitive advantage in the global marketplace. Its purpose is to give organizations the sustainable competitive advantage of a safe and health work environment. Basically, safety management concept is similar to quality management.

The concept of Safety Management is based on a well-planned system in which the main pillar for this system is the roles and responsibilities of the consultants or participants involved within specific project. The creation of safety programs comes in a very wide scope and there is just no limitation on the strategies that can be taken to provide an efficient health and safety planning and procedures to be practiced. As construction site is the main source of fatalities and accidents in the construction industry, the concept of the safety management which stressed the importance of a well-defined organization

structure and the safety planning, eventually, this concept is seen as having the potentials on eliminating the hazard risks that normally occur on the construction site.

4.2 Quality management concept

Quality Management may be defined as the optimization of efforts to make sure that the requirements are met efficiently and on the first attempt. Things should be "done right" the first time and "rework" avoided. Optimization of effort implies that the most efficient level of effort is sought. This is done by minimizing the total costs of quality, a concept discussed later. Quality does not happen automatically. Even if every participant in the construction effort has the best intentions, human factors such as haste and ignorance, management decisions such as sequencing and crew composition, and "uncontrollable" events such as vendor incompetence and adverse weather necessitate the creation of a system to make sure that tasks are accomplished correctly. This is the domain of quality control. Also, the owner and sometimes the public needs assurance that the contracted product has been delivered. Providing this is often called quality assurance. The meanings of the terms "quality control" and "quality assurance" as used in the construction industry are sometimes blurred, but, however defined, they are both included in quality management. To accomplish quality assurance and/or quality control generally requires designated personnel and equipment. The preparation of a quality program, a general document, and specific quality plans, as required by some contracts, constitute one level of quality effort. The implementation of the quality plan requires specific quality activities such as materials testing, submittal checking, equipment recalibration, and general inspection of work. Employee training may also be classified as a quality activity. It is obvious that there are many specific quality related expenditures.

Quality programs are formal written systems for achieving quality. They typically include a policy statement, which states the support of top management. They also define quality-related responsibilities and include directions about such things as documentation, training, and general process control. The term "quality plan" usually refers to a job-specific application of the quality program. It will outline disciplined and detailed control and assurance activities such as vendor evaluation, plan checking, submittal reviewing, and materials testing. Some typical components of quality programs are listed in Table 7-1. In this case, the items indicated above as being in a quality plan would be under process control. Program performance refers to some method to determine if the program is successful or profitable. This might be done by measuring owner satisfaction or by financial results, as in the method described in the following section.

4.3 Propose application model

Project Quality Management model is used as a basis of safety management model. The Project Quality Management model conceptually is divided into 3 major elements or processes. Under each of these elements, the concept of management as theoretically defined by Walker is adopted. Basically, the model defines the process of "input - conversion process - output" as the method on achieving the achievement of management's goals and objectives. 'Input' is considered as the planning effort, the strategies or the approaches used in achieving the output whilst the 'conversion process' is the measuring and conversion process which is also known as 'tools and techniques' that should contribute to expected result. 'Output' is the result of systematic implementation or input and conversion process to make sure the program is achievable and workable. In determining the processes for integration management concept, several procedures are taken such as using similar processes as featured in quality management model and comparing and evaluating safety management key elements and making comparison with processes of quality management.

A generic application model will be discussed for this research paper. The application model concentrates on determining the processes to use. Determination is done by making comparison between safety key elements and quality management processes. Restriction to the development lies in the imposition of guidelines and regulations regarding the OSH management for construction. Evaluation and comparison between quality and safety management shows that quality and safety is based on similar approach concept, as proven by precedent studies (Coble, R.J). The Project Quality Management model consists of three components; i) planning, ii) assurance, and iii) control. As for safety management, the key elements that build the whole safety management consists of 5 areas, i) policy, ii) organizing, iii) planning and implementation, iv) measure and v) review. However, analysis done on standards at international level and what applied here in Malaysia, shows a slight difference in the number of elements used to build up the whole safety management concept. The number of elements somehow does not mean that the approach is different as the components and contents of the elements are still based on what established in international standard. This model suggested that quality management should consist of 3 key elements – quality planning, quality assurance and quality control. Under each category, the 'input-conversion process-output' takes place. Achievement of positive result (output) under each category will ensure the success of safety practice and program's implementation.

The central idea of identifying the key elements is viewed as a process which depends upon continual feedback, certainly from reviews and audits, but also during the earlier stages, so that there is a continual, dynamic system in place (Holt, A.S.J.). This model is adopted in Malaysia with some variations to suit the existing practice and the early development of safety and health program locally (Dept. of Standards Malaysia; 2003). Taking similar concept, elements

and system, the safety management model is developed using the same basis as depicts in Figure 3. The main reason on suggesting Quality Management model as basis for designing the safety management model is due to its rational development and relevancy of one element to others.

5. Conclusion

The fact that OSH is still in its early development stage in Malaysia explains only selected guidelines and acts being regulated. It may take a couple of years before a final series of guidelines covering every inch of construction works can be regulated. A more comprehensive application model deriving from a fundamental model theoretically produced can be used as guiding principle for safety management. The application model in fact is a substitute for the non-existence of compliant guidelines or requirements of construction plant and machinery. Since no other application models both for construction plant management and safety management have been produced except for those two theoretical diagrams, these models can be used as basis for the development of the application model.

Based on the findings of the study, the provided information indicates that unsatisfactory safety culture and lack of responsibility towards safety in general are what happened in the real construction field in Malaysia. There was inadequate imagination and ideas in propagating safety at work. Lack of management control leads to a lowering of performance standards; these standards may be training, communication, program, etc. According to management theory, management's functions are to plan, organize, command, coordinate and control, and all managers are expected to fulfil these functions.

References

Coble, R. J.; Hinze, J. & Haupt, T. C.; (2000); *Construction Safety & Health Management,* Prentice Hall, Ohio.

Government of Malaysia; (2002);*Occupational Safety & Health Act & Regulations (Act 514);* MDC Publishers Printers Sdn. Bhd.; Malaysia.

Jaafar, M.J.; (June 2002); *Consideration In The Development Of HSE Management Systems In The Malaysian Context; paperwork for Mini Symposium*; NIOSH, Malaysia.

Project Management Institute; (1996*); A Guide To The Project Management Body Of Knowledge*, PMI Publication; U.S.A.

Pybus, R.; (1996); *Safety Management: Strategy & Practice*, Butterworth-Heinemann, U.K.

Walker, A.; (1993);*Project Management For Construction Site*; U.K.

Griffith, A. & Howarth, T.; (2001); *Construction Health and Safety Management*; Longman; U.K.

Table 1. Construction quality and safety programme components comparison.

Quality	**Both Quality and Safety**	**Safety**
Document Control	Policy/Mission Statement	Hazard Identification And Control
Vendor Selection	Organization Structure And Responsibilities	Hazardous Communication Program
Field Trials	Training	Substance Abuse Prevention
Quality Audit Procedures	Process Control / Work Rules	Emergency Procedures
	Investigations	Incentive Program
	Record Keeping	
	Program Performance	

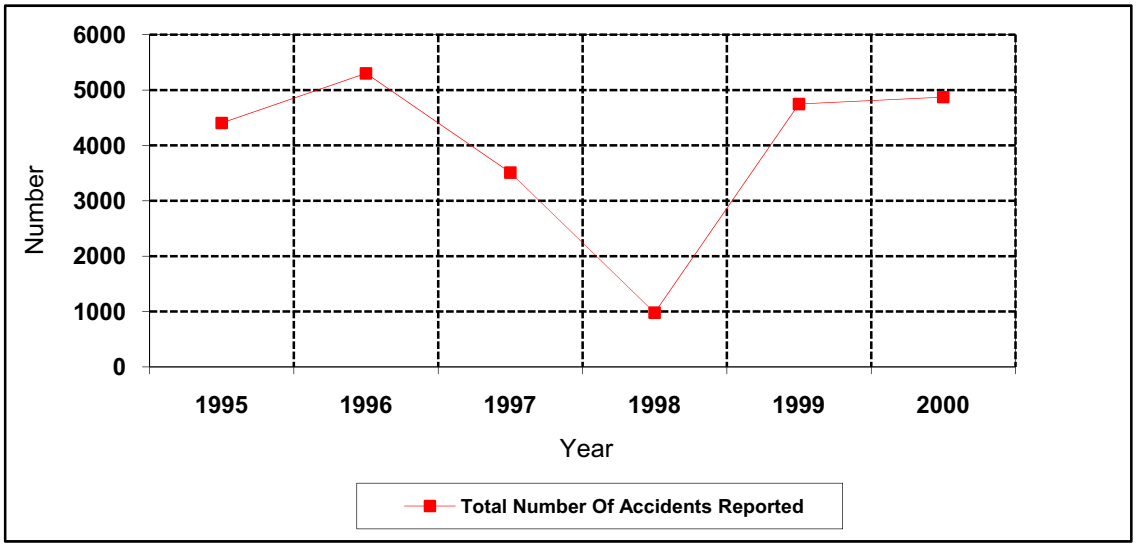

Figure 1. Reported accidents in the construction industry from year 1995-2000 (SOCSO, 2000)

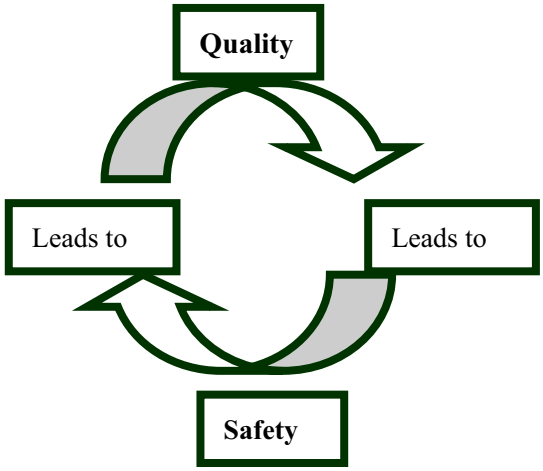

Figure 2. Relationship between safety and quality

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A Discussion on the Ecological Balance and Sustainable Development of Higher Vocational Education

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Abstract

With the development of economy and progress of society, the viewpoints of ecological balance and sustainable development have extended to lots of other fields. Educational ecologicalization and sustainable development are becoming more and more important day by day. As a type of higher education, higher vocational education has not only unique developmental advantages but also many disadvantage factors. Basing on the clarification of connotation of education ecologicalization and analysis of the ecological environment of higher vocational education, this paper discusses the thinking and method of sustainable development of higher vocational academies in the atmosphere of ecological consciousness.

Keywords: Higher vocational education, Educational ecologicalization, Ecological balance, Sustainable development

After Industrial Revolution, in order to realize rapid development and achieve the maximization of economic benefit, human adopted the value of conquering and plundering the nature and unilaterally pursued the economic development, which directly led to environmental deterioration, ecological imbalance, and various unharmonious relationships between the reallocation of non-renewable resources and human who demands sustainable development. The existence and development of human are being severely threatened. To solve the most difficult problem in human history, human should keep ecological consciousness in his mind, and realize that human is a natural organic system at higher level. Human should maintain harmonious relationship with nature and make benefit for the nature and human with the science and technology. It is the responsibility of modern education, especially the modern higher education, to promote the all-round development of human in the aspects of spirit, intelligence, creativity and appetency.

As a relatively independent subsystem in the large system of education, influenced by the social environment that shows the ecological crisis, higher education exhibited various phenomenons of ecological imbalance. Keeping the ecological balance of higher education system is the only rational choice to achieve the healthy and sustainable development of Chinese higher education. Ecology is a subject to study the dialectical unification relations between the biotic environment and abiotic environment, and is a scientific thinking method. The thinking method in Ecology will be a new angle and an effective tool to study the rule of education. Higher education should, from the angle of ecology, resurvey its value concept and construction system, timely regulate its developmental orientation and guideline, so as to establish a new educational system that accords with the ecological rule, create democratic, harmonious and assimilative school culture, and build beautiful, humanistic and harmonious ecological campuses (Zhang, 2006).

1. Educational ecologicalization

The concept of educational ecologicalization was firstly put forward in the “Public Education” by the famous American educationist Lawrence A. Cremin in 1970s (Zhang, 2006; He, 2005), which attracted much attention immediately. Marx pointed out that “The natural condition can be sorted as the nature of human and the nature around human” (Hong, 2007), i.e. “noumenal nature” and “external nature”. When the concepts of “noumental nature” and “external nature” are introduced into education, education ecologicalization means that education should, in accordance with the principle of ecology, make effort in solving the contradictions of “noumenal nature” and “external nature” themselves and the contradictions between “noumenal nature” and “external nature”, and realize harmonious development and benign cycle in education by the coordination and transcendence of the two concepts, finally promote the progress of society. From the aspect of ecology, educational ecologicalization can be taken as the mutual interactions between the factors in the inner of education system and the exchange relationship between education and the external environment in the aspects of material, energy and information.

Ecology and sustainable development are hot spots in recent years. The concept of ecology has been applied to many fields, such as politics, economy, culture, science and technology, with the purpose of realizing ecologicalization and

sustainable development. The fields mentioned above can be taken as the environment for educational development, which provides background, conditions and demands for the educational ecologicalization. Hence, educational ecologicalization is a new educational concept and the general trends; it is the inevitable requirement of social and educational sustainable development on education.

2. The ecological environment for higher vocational education development

In ecological system, ecological environment means the environment that influences the individual, population or community (including human) (He, 2007). The ecological environment of higher education system means the multidimensional space and plural environment that control and regulate the occurrence, development and existence of higher education, including the external natural environment, social environment and normative environment (Tian and Wu, 2001). The ecological environment of higher vocational education that belongs to the higher educational system has its special characteristics besides the common characteristics with higher education.

Education lays the basis for the long-term development. Chinese government always pays much attention to the higher education, and gives higher education much support in the aspects of policy, system, economy, publicity and public opinion. In recent years, Chinese government attaches much importance to the higher vocational education that is growing up gradually. Zhou Ji, the minister of Ministry of Education pointed out that "In the past short six years, the scale of higher education doubled, and has entered the stage of popular education. The scale of higher education in China is the largest in the world now. Chinese government made leaping development in education as it realized large-scale and high quality education with low investment (Zhang, 2007 a).

The good ecological environment created by the nation and society made great contribution to the rapid development of higher vocational education. Firstly, the higher vocational education has a good political environment. The putting forward of a series of policies, such as the Opinion about Strengthening the Construction of Teacher Team of Higher Vocational Academies (Education Department No.[2002] 5), the Decision of the State Council on Making Great Efforts to Push Forward the Reform and Development of Vocational Education (Decree No.[2002] 16), and the Decision of the State Council on Vigorously Developing the Vocational Education (Decree No.[2005] 35), provided sound political environment for the development of higher vocational education, and effectively guided the higher vocational education to develop towards a right direction. The policies indicate that Chinese government has resolution and confidence to develop higher vocational education. Secondly, the economic environment for the higher vocational environment is becoming better and better. Higher vocational education has cultivated many talents with special skills, and people are identifying with this kind of education. In order to encourage and guide the higher vocational education to develop healthily and continuously, the Ministry of Education and the Ministry of Finance implemented the Plan of Setting up the Demonstrative National Higher Vocational Schools and Colleges, and would support the construction of 100 higher vocational schools to improve the quality of higher vocational education. At present, two batches of higher vocational schools, totally 70, were being supported by the national program. During the eleventh five-year plan, Ministry of Finance will allocate at least 2 billion Yuan to support the implementation of the plan. Beside, various scholarships were established, such as National Scholarship, Encourage Scholarship, Government Scholarship, and National Grant-in-aid. The amount of scholarship has been increased and the scholarship is covering more students, further more, the state loan for college student provides opportunity for more students to go to college, which also promotes the benign development of higher vocational education. Thirdly, the socialist culture with Chinese characteristics provides good cultural environment for the development of higher vocational education. Education and culture depend on each other and influence each other, the rich material culture provides abundant material basis for the development of education, and the bloom of spiritual culture provides strong spiritual support for the development of education. The mainstream culture of China is the socialist culture with Chinese characteristics, which is based on the Marxism-Leninism, Mao Zedong Thought, Deng Xiaoping Theory and Three Represents. The characteristic of making progress in every new ear unceasingly of socialist culture provides good cultural environment for the development of higher education. As an important member of higher education, higher vocational education should follow the step of era, and try to make great achievement taking advantage of the cultural environment.

Although higher vocational education is developing at great speed because Chinese government is attaching much importance to it and is optimizing its developmental environment, it is a long-term process to establish an ecology-balanceable and environment-friendly developmental environment for higher vocational education. From the aspect of ecology, there are lots of urgent problems to be solved in the developmental environment of higher vocational education as follows: the first problem is that the higher vocational education is developing too fast. In the past a few years, the higher vocational schools come forth rapidly, and they expanded the enrollment every year, but the developmental speed of teacher team is far fall behind that of student, so the teaching quality shows an trend of decrease, the qualities of students are different, and the good and the bad are intermingled, accordingly, it is difficult for students to find a job because the supply exceeds demand. The second problem is that the vocational education simply copies the model of higher education. Every species has unique attributes and ecological behaviors, which make it occupy a

position in the fast changing boundless universe, or else, it will be inundated and washed out easily. It is accepted by the mass that higher vocational education is one type of the higher education, but many scholars didn't grasp the ecological behavior of higher vocational education, they just copied the school running model and teaching model of colleges and universities, which make them get lost and go to the dead end.

3. The sustainable development of higher vocational education in ecological consciousness

Sustainable development is an important concept in ecology, which is put forward in Our Common Future approved on the 43rd General Assembly of the United Nations. It is put forward in the report that sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Zhang, 2007 b). The strategy of sustainable was firstly used to maintain the balance and the benign cycle of ecological system. With the progress of society and development of economy, the value and developmental concept in the strategy are more and more embodied and used in other fields. It can be seen that there are still lots of severe problems in the higher vocational education system, which will influence the sustainable development of higher vocational schools, so we think that the problems should be solved in the follow aspects:

3.*1 Transform the development thinking*

In the nature, any population can not grow without limit. The unlimited growth of a population will lead to the imbalance of ecological system. Similarly, the number of higher vocational schools should be controlled within a certain scope. The over development of higher vocational education and large number of students will put great pressure on the teaching quality, teacher team and employment rate, which will be bad for the development of higher vocational education. Hence, we should pay attention to the quality but not quantity when developing the present higher vocational schools.

3.2 Define correct self orientation

It is narrated in the above text that higher vocational education is a young educational model, before which, Chinese higher education is mainly composed of junior colleges and universities, and relatively mature teaching model and school running model have formed. Staring from scratch, higher vocational schools will definitely learn from the junior colleges and universities. But the higher vocational schools that are upgraded from technical secondary schools still have the characteristics of technical secondary school in many aspects. Hence higher vocational schools should find other ways, exert their characteristics, and orient themselves correctly so as to achieve healthy and sustainable development.

3.3 Improve the teacher team and the overall quality of student

Higher vocational schools have poor background and lack high quality teachers. In recent years, higher vocational schools introduced many talents; they have got many graduate students who have at least a master degree, which improved the joint of teacher team in the ecological chain. The high quality teacher team will make great contribution to the teaching, scientific research and management of the school. We expect that the graduate students could inspire the depressive high vocational schools, and benefit all the students just like a blast of academic breeze, and essentially improve the quality of students who have poor background. Attention should be paid to the construction of both teacher team and student, so as to achieve an ecological balance of mutual benefit and symbiosis.

References

He, Zubin. (2007). A discussion on the ecological balance between higher educational system and environment. *Higher Education Research & Evaluation*, (5): 5-10.

He, Zubin. (2005). A study of higher education ecology. *Journal of Guangxi Normal University (Philosophy and Social Sciences Edition)*, (41) 1: 123-127.

Hong, Shimei. (2007). On educational ecology and the ecological trend of university education. *Journal of Higher Education*. (28) 6: 50-52.

Tian, Zhen and Wu, Mingfang. (2001). A preliminary analysis of the ecological environment of education. *Journal of the Chinese Society of Education*, (4).

Zhang, Jian. (2007a). Environmental Friendliness: the "ecological engineering" of higher vocational education development. *Vocational & Technical Education Forum*. (12): 20-22.

Zhang, Jian. (2007b). Measurement analysis on higher education's deviation from environment and its sustainable development. *Heilongjiang Researches on Higher Education*, (10): 89-92.

Zhang, Xiaoqin. (2006). Education ecologicalization: the rational choice of universities in the 21st century. *Tribune of Social Sciences*, (6): 109-113.

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Energy Savings Benefit from Passive Architecture

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Abstract

Passive Architecture is a climate responsive building that provides comfortable indoor conditions, naturally. In hot and humid tropics, this can be achieved by strategising the building elements namely: orientation, form, opening and sun shading devices to avoid solar radiation, promote ventilation from the prevailing wind and ensure daylight into the building. Consequently, the building operation would require less mechanical cooling and artificial lighting to be independent from commercially supplied energy. The resultant "savings" in the operational energy is termed as Energy Savings Benefit. This idea was demonstrated by comparing the energy use of a house built without any consideration of Passive Architecture (Actual Case) and a simulated version that incorporated Passive Architecture design strategies (Improved Case). It was found that the living/dining area in the Improved Case claimed significant Energy Savings Benefit from mechanical cooling and artificial lighting. Such information can be used to anticipate the long term benefits of a property that applies Passive Architecture design strategies.

Keywords: Passive Architecture, Energy and Energy Savings Benefit

1. Energy Requirement in Building

In hot and humid tropics, building needs Operational Energy (OE) mainly to cool the living space besides generating artificial lighting. This is captured as operational cost and exists throughout the building lifetime which can be up to 50 years (Fig. 1).

Building's OE varies from one property to another depending on its design, use and occupants. The bulk of OE supply comes from fossil fuel energy or commercially supplied energy (Buchanan, 2005). In time, the cost of OE will rise due to tariff hike and this can be a burden to the owner, tenant or operator. Unfortunately, information on OE is hardly available to the buyer when committing to a purchase and most buyers only become aware of building's OE when they are paying the energy bill.

There are several ways for building to reduce its operational cost. A sustainable approach is to utilise natural resources such as solar power, wind power, etc., or commonly known as Renewable Energy (RE) (Szokolay, 2006). Solar power is a popular RE but it requires high capital investment. Its main component, namely silicon, is still relatively expensive (Smith, 2005). Inevitably, the payback time is too long and the return on investment is hardly recouped by the building's first owner.

Another method to reduce operation cost is by using Energy Efficient (EE) equipment (Smith, 2005). EE equipment has high coefficient of performance such that it needs less energy to run when compared to other typical equipment. However, comprehensive application of EE products could be too expensive for building owners. For example, a typical EE compact fluorescent costs several times more than the incandescent bulb. The construction cost will eventually rise as more EE products are applied.

Building should be sensibly designed to be independent from commercially supplied energy by way of Energy Conservation (EC). This is a step before RE or EE.

2. Passive Architecture

Passive Architecture is a climate responsive building that provides comfortable indoor conditions, without relying on mechanical cooling or artificial lighting. In hot and humid tropics, the aim of Passive Architecture is to avoid solar radiation, promote ventilation from the prevailing wind and ensure daylight into the building. The maximum impact can be achieved by strategising the building elements such as orientation, form, opening and sun shading devices to achieve the said goals (Olgyay, 1963, Hyde, 2000).

Passive Architecture is not a new idea. Local traditional houses in the tropics have exemplified Passive Architecture by means of raised floor, low thermal mass envelope and raised/jacked roof to facilitate ventilation (Fig. 2).

Generous openings like windows, doors and ventilation outlets are deliberately positioned to encourage natural ventilation (Olgyay, 1963, Hyde, 2000). Traditional house also put emphasis in encouraging daylight as much as possible into its rooms. Nonetheless, the openings are well shaded, thus reducing heat gain.

Other studies found that in the hot and humid tropics, building with shallow rooms elongated from east to west and facing north performs better in achieving comfortable indoor conditions (Hyde, 2000). It was also found that natural ventilation is more successful in slender room since prevailing wind in the tropics does not have high velocity (Olgyay, 1963). Generally, Passive Architecture is elementary as it asserts Energy Conservation (EC) at the design stage to reduce OE in building (Fig. 3).

3. Thermal Comfort and Visual Comfort

A building can be made independent from mechanical cooling when the occupants feel thermally comfortable. There are two components of variables that influence thermal comfort, namely microclimate and occupant's personal adaptation (Auliciems & Szokolay, 1997). Meanwhile, to be independent from artificial lighting, occupants must sense visual comfort. Good amount of daylight enables occupants to carry out their activity in the house without resorting to artificial lighting. Generally, too much daylight may cause glare and too little may be too dark for a particular task; and both instances cause visual discomfort (Majoros, 1998).

Having said that, comfort encompasses both thermal and visual performances; each is a broad and complex subject. Comfort variables affect the indoor conditions differently at various times and these factors do not work in isolation (Table 1). For example, alleviating the heat gain using sun shading devices can affect the amount of daylight entering a room.

Despite the complex relationship, it is important to present the potential of Passive Architecture with reference to the combined effects of both thermal and visual comforts. This is because in reality, the shifting balance between getting thermal comfort and attaining visual comfort happens at any time in relation to all variables, simultaneously.

4. Energy Savings Benefit

The consequent effect of Passive Architecture is "savings" in the operational energy, termed as Energy Savings Benefit. This could be made tangible by comparing the energy consumption in buildings of similar type. For the purpose of this study, a house had been chosen as a sample of a building. Theoretically, a house designed for maximum daylight needs less artificial lighting, hence uses less commercially supplied energy when compared to another that has no consideration for daylighting (Baker & Steemers, 2000). In this instance, the Energy Savings Benefit claimed by the former occurs when it does not need to use artificial lighting (Fig. 4).

Similarly, a house with good natural ventilation would require less mechanical cooling as compared to the one with poor ventilation. Nonetheless, such comparison is only valid when it is made on a levelled platform, whereby the two houses must be of the same locality and size. In addition, the behaviour of the occupants in both houses has to be the same.

5. Methodology

The sample house for the study was a newly completed detached double storey house in Bangi, Selangor that did not have much consideration for Passive Architecture. It had a built up of 3000 sq ft (279 sq m) and sat on a land area of about 4800 sq ft (446 sq m). It was constructed using post and beam concrete with brick and mortar wall infill.

This sample was labelled as Actual Case. The total effect of orientation, form, openings and sun shading devices was treated as one cause for one definite value of indoor comfortable conditions.

As a comparison, Passive Architecture design strategies were being simulated onto the Actual Case to create an Improved Case (Fig. 5). As suggested by the name, the Improved Case is actually a design enhancement of the Actual Case; specifically with regards to the orientation, form, opening and shading devices. The Improved Case, nonetheless, maintained all other construction elements such as method of construction, material, etc. so that both the Actual and Improved Cases have the same construction cost.

The value of Energy Savings Benefit in the Improved Case was determined by comparing its resultant energy requirement with the Actual Case. For this paper, the study area was limited to the living/dining area only.

6. Measurement

The two scenarios had the occupants, microclimate, and material as constants. The simulation readings in the two houses were taken on every 15th day of the month for a year. Based on Auliciem's equation, $T_n = 17.6 + 0.31T_m$, where T_n is Thermal Neutrality and T_m is the mean temperature for the study area, i.e., 27.4°C; T_n is 26.1°C (Sh. Ahmad, 2004). It was assumed that when the building offers Comfort Zone in the region of 2.5K from T_n (for 90% acceptability), the occupants would not require the aid of mechanical cooling.

The illuminance (lux) readings for visual comfort were compared with recommendation by the International CIBSE (Chartered Institution of Building Services Engineers) Standard; for living/dining area is 300 lux (CIBSE, 1994). It was assumed that when the space gave such illuminance reading, it would not require artificial lighting and that personal adaptation would not involve any operational energy.

6.1 Actual Case

The form of Actual Case house was a square and rooms were arranged in a concentric manner. This is distinctive of Malaysian detached houses as it reflects the optimum use of the usual square-shaped land area (Fig. 6). Important rooms such as living area and master bedroom normally faced the main access road, regardless the sun path (Fig. 7).

The openings in the Actual Case house were of the same size, regardless the elevation. It was also observed that the Actual Case had only roof eaves to shade the rooms, and these were not effective at west and east elevations.

It is a fact that by adding sun shading elements and adjusting the size of openings of the Actual Case house, a better reading on the indoor comfortable conditions would be obtained (Auliciems & Szokolay, 1997). However, an important aspect of the study was that the application of Passive Architecture design strategies should be done holistically and should not effect for any additional construction cost.

6.2 Improved Case

Improved Case was simulated from Actual Case with reference to the literature review on Passive Architecture and an actual Passive Architecture house in the vicinity (Fig. 8). The living/dining area in the Improved Case was drawn to match the measurement of the living/dining area in the Actual Case but has the following variations (Fig. 9):

- North orientation;
- Slender form elongated east-west;
- Large openings on the north facade; and
- Recessed floor plan on the north and south sides.

7. Results of Solar Shading Analysis

Both cases were tested for solar shading on their elevations. For Actual Case, most part of the living/dining area faced west. As a result, it was well shaded in the morning but received direct sunlight every afternoon (Fig. 10). At this point, it was deduced that without intervention, the living/dining area in Actual Case would be fairly shady and cool in the morning and rather bright and hot in the afternoon.

On the other hand, the Improved Case did not get much solar gain because of its orientation. In addition, the less important rooms placed at the east and west sides "insulated" the living/dining area from solar gain. Consequently, the space received direct sunlight for only two hours early in the morning and appeared to be well shaded throughout the day (Fig. 11). The large openings on the north and south facades promised ample daylight into this space.

The simulations of solar shading on every 15th day of the month showed that the Actual Case received direct sunlight in the living/dining area for five hours in the afternoon. Meanwhile, the Improved Case received only few hours of direct sunlight in the early morning (Table 2).

It appeared that the Actual Case would require substantial intervention via mechanical cooling to reduce the effect of heat gain due to inappropriate orientation of the house. Furthermore, the Actual Case appeared to need assistance from artificial lighting in the morning hours.

8. Results of Daylight Analysis

The illuminance reading measured daylight opportunity under standard overcast sky as defined by the CIE (Commission Internationale d'Eclairage). The duration was approximately 12 hours from 7:00 a.m. to 7:00 p.m. every day, except during winter solstice. The daylight analysis was carried out onto an imaginary working plane of 0.85 metre-high in the living/dining area to reflect the operational level.

Generally, it was found that the illuminance readings in the space were not consistent. For example, on 15th June, area closer to the window had high illuminance reading compared to the centre of the space. In this instance, even if one-third of the space read 300 lux, it was assumed that the occupant would still need artificial lightings in order to compensate for the insufficient luminaire at the other part of the space. When this happened, the area would be generalised as having inadequate daylight (Fig.12 and Fig.13).

On the other hand, when two-third of the space gave illuminance reading exceeding the minimum requirement of 300 lux, the living/dining area would be considered as well lighted and did not need artificial lighting (Fig.14 and Fig. 15).

The fluctuation in the luminance reading on the 15th June can be translated into the need for artificial lighting in the living/dining area (Figure 16).

On this particular day, both the Actual and Improved Cases required artificial lighting at night time. However, during daytime the Actual Case needed artificial lighting several hours longer in the morning and late afternoon when compared to the Improved Case. Assuming that in both cases the living/dining area was unused after midnight till 6:00a.m., the Energy Savings Benefit claimed by the Improved Case occurred when it did not require artificial lighting for five hours as compared to the Actual Case. When simulated for every 15th day of the month, the Actual Case had insufficient daylight for no less than five hours per day (Table 3).

On the contrary, the Improved Case had inadequate daylight for a minimum of two hours per day. The simulation showed that the lighting level in the living/dining area of Actual Case was always too dim in the morning; thus, required artificial lighting even if the sun was shining bright outside the house. Meanwhile, the daylight illuminance reading in the living/dining area of the Improved Case had maintained to be above 300 lux for most part of the daytime. Assuming readings on every 15th day represent a typical day of the month; Improved Case could claim Energy Savings Benefit up to 155 hours per month or 1158 hours per year.

9. Results Of Thermal Comfort Analysis

The reading on 15th June showed that the minimum indoor air temperature in the Actual Case was 28.9^{o}C and this had exceeded the thermal comfort range of 2.5K from Thermal Neutrality, T_n of 26.1^{o}C (Fig.17).

It was assumed that when the space temperature exceeded the comfort range, occupant would require mechanical cooling. Inevitably, the Actual Case would be highly dependent on mechanical cooling throughout the day and night to bring the room air temperature down into the thermal comfort zone.

Meanwhile, the indoor air temperature of the Improved Case was in the range of thermal comfort in the morning. However, during post-meridiem the indoor air temperature only slightly exceeded the thermal comfort zone (Fig. 18). As the maximum indoor temperature was only less than 1^{o}C above 28.6^{o}C, the occupants may or may not require mechanical cooling at this time.

Simulations on every 15th day of the month showed that the Actual Case would require 24 hours mechanical cooling to bring the room temperature down into the comfort zone. Whilst the Improved Case appeared to need only 12 hours of mechanical cooling because the space was in the thermal comfort zone during ante-meridiem (Table 4).

Nevertheless, the above readings had to be ratified because generally no one uses the living/dining room after midnight till 6:00 a.m., hence both cases did not need mechanical cooling at that time. It was also found that the indoor air temperature appears to be fairly consistent everyday because of the little climate change in the tropics.

Based on the above, the Energy Savings Benefit claimed by the Improved Case happened when it did not need to use mechanical cooling for 6 hours per day as compared to the Actual Case (Fig. 19).

Taking 15th June to represent every day of the year, the Energy Savings Benefit from mechanical cooling claimed by the Improved Case could be up to 186 hours per month (i.e., 6 hours x 31 days) or 2190 hours (i.e., 6 hours x 365 days) per year.

10. Conclusion

A property that applies Passive Architecture design strategy would indeed become less dependent on commercially supplied energy and consequently offered Energy Savings Benefit. The study showed that the annual Energy Savings Benefit from mechanical cooling and artificial lighting could be 2190 hours and 1158 hours, respectively – and that was for the living/dining area only. It was also found that substantial gain was due to the form and orientation of the Improved Case and this was achieved without incurring any additional construction cost.

Energy Savings Benefit would appeal to building owner because it deliberates on the long term economic gain of owning or operating a property. However, information on Energy Savings Benefit is hardly offered for potential buyers' consumption. If such information is made available, it could affect the buyers' judgment. Thus, if all remain equal, it is commonsensical for one to opt for property that costs less to run. In addition, information on Energy Savings Benefit would enable potential buyers to cautiously exercise their purchasing powers against the present awareness of global warming and unsustainable energy consumption (Mustapa & Yusop, 2007).

References

Auliciems, A. & Szokolay, S. V. (1997). *Thermal comfort - PLEA notes no. 3*. Australia: The University of Queensland.

Baker, N. & Steemers, K. (2000). *Energy and environment in architecture – a technical design guide*, London: E&FN Spon Press.

Buchanan, P. (2005). *Ten shades of green: architecture and the natural world*. New York: The Architectural League.

Chartered Institute of Building Services Engineers (CIBSE) Code for Interior Lighting, (1994).

Hyde, R. A. (2000). *Climatic responsive design: a study of buildings in moderate and hot humid climate*. London: E&FN Spon Press.

Majoros, A. (1998). *Daylighting:PLEA notes no. 4*. Brisbane: PLEA International/University of Queensland Arch Dept.

Mustapa, S. I. & Yusop, M. Y. (2007). Mitigating the adverse impact of climate change through sustainable use of energy. *Energy Smart*, Issue 0021. Kuala Lumpur: Pusat Tenaga Negara.

Olgyay, V. (1963). *Design with climate: Bioclimatic approach to architectural regionalism*, New Jersey: Princeton University Press.

Sh.Ahmad, S. (2004). *A study on thermal comfort and energy performance of urban multistorey residential buildings in Malaysia*. Unpublished Ph.D, The University of Queensland, Brisbane.

Smith, P. F. (2005). *Architecture in a climate of change: a guide to sustainable design* (2nd ed.). Oxford; Boston: Elsevier/Architectural Press.

Szokolay, S. V. (2006). Proceedings from the International Symposium on Sustainable Energy & Environment (ISEESEE): *Passive Climate Control in Warm-humid Region*, Kuala Lumpur.

Table 1. Cause and effect of Passive Architecture design strategies in the tropics.

CAUSE	**EFFECT**		
Primary Design Strategies in Passive Architecture	**Get breeze for ventilation**	**Avoid direct heat gain**	**Get Daylight**
Orientation	✓	✓	✓
Form	✓	✓	✓
Openings	✓		✓
Sun Shading Devices		✓	✓

(Note: ✓ means relationship for favourable effect)

Table 2. Time and hours of direct sunlight into the living/dining area of Actual and Improved Cases on every 15th day of the month.

	15th Day	**Jan**	**Feb**	**Mac**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Actual	Time of direct sunlight / day	3pm to 7pm	3pm to 7pm	3pm to 7pm	2pm to 7pm	2pm to 7pm	2pm to 7pm	2pm to 7pm	2pm to 7pm	2pm to 7pm	2pm to 7pm	2pm to 7pm	2pm to 7pm
	Hours of direct sunlight / day	4	4	4	5	5	5	5	5	5	5	5	5
Improved	Time of direct sunlight / day	nil	nil	8am to 9am	8am to 9am	8am to 10am	8am to 10am	8am to 11am	8am to 10am	8am to 9am	nil	Nil	nil
	Hours of direct sunlight / day	0	0	1	1	2	2	3	2	1	0	0	0

Table 3. Time and hours when daylight illuminance below 300 lux in a third of living/ dining area of Actual and Improved Cases on every 15th day of the month and the resultant Energy Savings Benefit (ESB).

	15th Day	**Jan**	**Feb**	**Mac**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Actual	Time illuminance below 300 lux	7am, 8am, 9am, 6pm, 7pm.	7am, 8am, 9am, 6pm, 7pm.	7am, 8am, 9am, 6pm, 7pm.	7am, 8am, 9am, 6pm, 7pm.	7am, 8am, 9am, 5pm 6pm, 7pm.	7am, 8am, 9am, 10am, 5pm 6pm, 7pm	7am, 8am, 9am, 10am, 5pm 6pm, 7pm	7am, 8am, 9am, 5pm 6pm, 7pm	7am, 8am, 9am, 6pm, 7pm	7am, 8am, 9am, 6pm, 7pm	7am, 8am, 9am, 5pm, 6pm, 7pm.	7am, 8am, 5pm, 6pm, 7pm.
	Hours illuminance below 300 lux (A)	5	5	5	5	6	7	7	6	5	5	6	5
Improved	Time illuminance below 300 lux	7am, 8am, 7pm.	7am, 8am, 7pm	7am, 8am, 7pm	7am 7pm	7am 7pm	7am, 7pm	7am 7pm	7am 7pm	7am, 7pm	7am 7pm	7am, 8am, 7pm.	7am, 8am, 7pm
	Hours illuminance below 300 lux (B)	3	3	3	2	2	2	2	2	2	2	3	3
	Hours of ESB /day claimed (A-B)	2	2	2	3	4	5	5	4	3	3	3	2
	Hours of ESB / month (A-B) x days in a month	62	56	62	90	124	150	155	124	90	93	90	62

Table 4. Time and hours when air temperature in living/dining area of Actual and Improved Cases exceeding Thermal Comfort (TC) range on the 15th day of every month.

	15th Day	**Jan**	**Feb**	**Mac**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Actual	Hours exceeding TC range	24	24	24	24	24	24	24	24	24	24	24	24
Improved	Time exceeding TC range	12pm to 12am	12pm to 12am	12pm to 12am	12pm to 12am	12pm to 12am	12pm to 12am	12pm to 12am	12pm to 12am	12pm to 12am	12pm to 12am	12pm to 12am	12pm to 12am
	Hours exceeding TC range	12	12	12	12	12	12	12	12	12	12	12	12

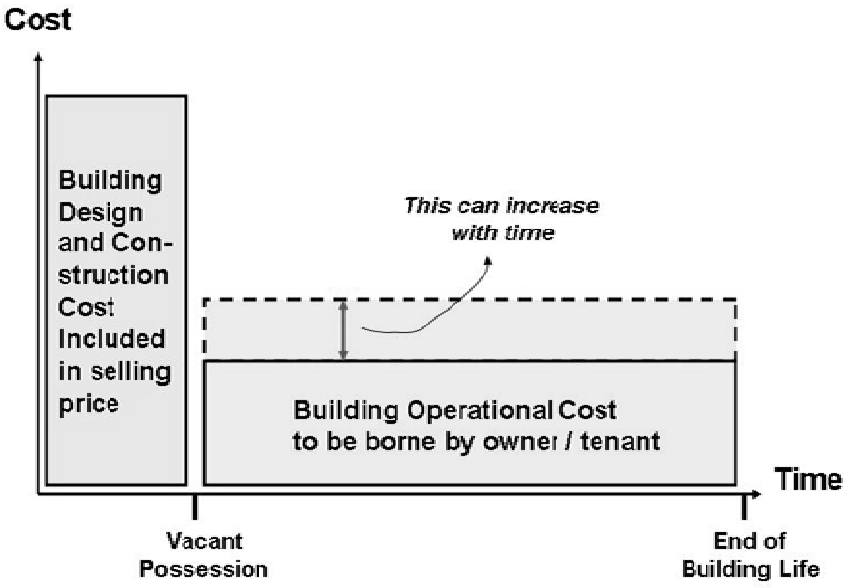


Figure 1. Building operational cost lasts throughout its lifetime.

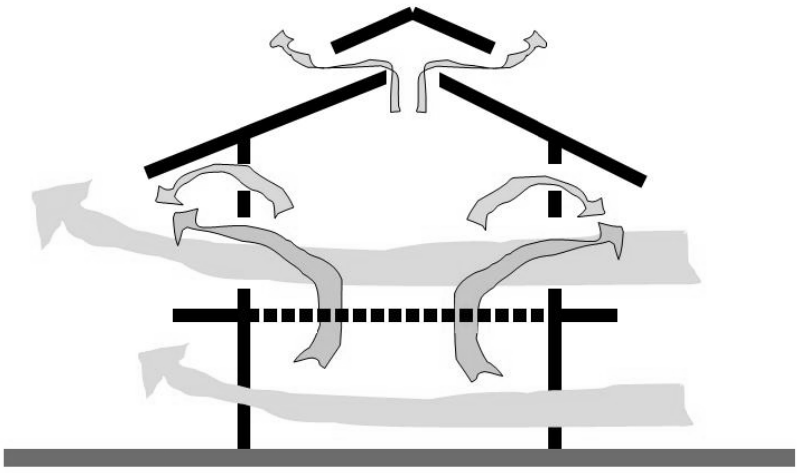


Figure 2. Ventilation concept of traditional house in cross-section

whereby the arrows depicted the flow of air.

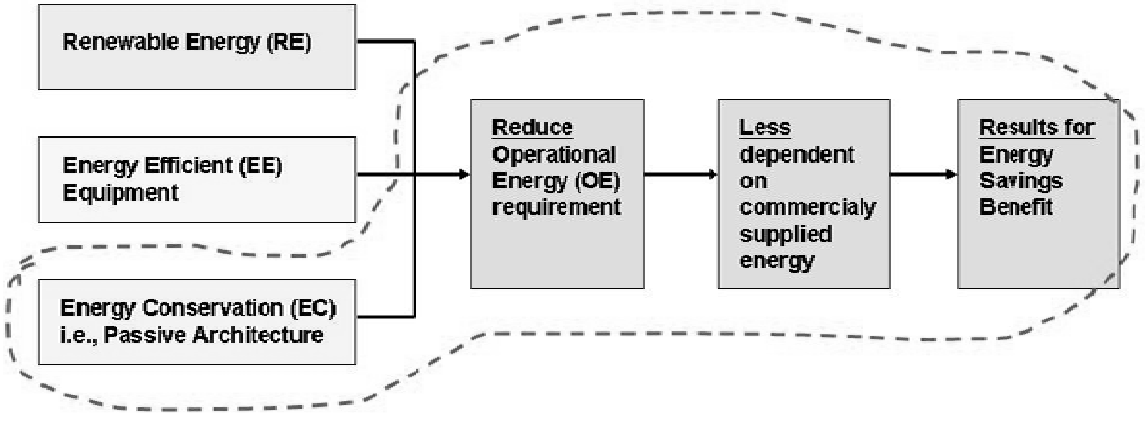


Figure 3. Passive Architecture asserts Energy Conservation that reduces Operational Energy in building.

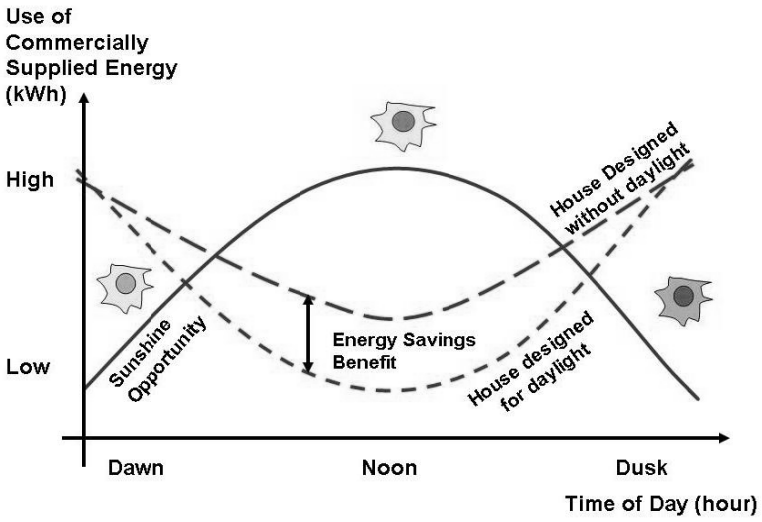


Figure 4. Use of commercially supplied energy.

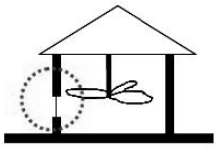
SAMPLE	CAUSE	EFFECT
A local detached house disregards Passive Architecture  **Actual Case**	Building elements were merely construction elements with no consideration for Passive Architecture design strategies	=> short period of comfort => need mechanical cooling => high operational energy => need more commercially supplied energy
Improvement on the Actual Case incorporating Passive Architecture design strategies  **Improved Case**	Building elements (orientation, form, openings and sun shading devices) were simulated to achieve Passive Architecture goals	=> long period of comfort => need less mechanical cooling => low operational energy => need less commercially supplied energy => claims Energy Savings Benefit

Figure 5. Cause and effect of Actual and Improved Cases.

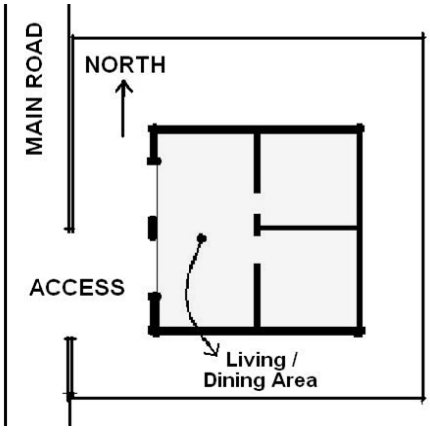


Figure 6. Actual Case - conceptual site plan showing concentric space arrangement.

Figure 7. Actual Case - living area, family room and master bedroom facing west.

Figure 8. A Passive Architecture precedent in the vicinity.

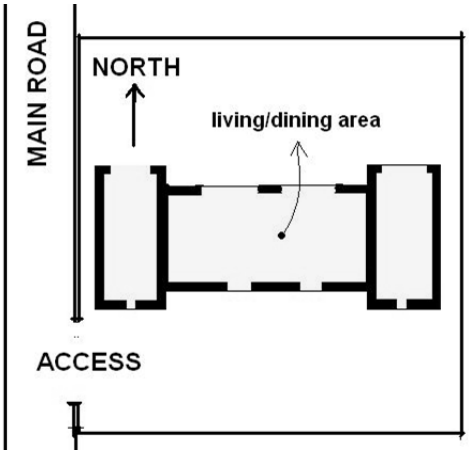


Figure 9. Simulated site plan of Improved Case showing elongated form.

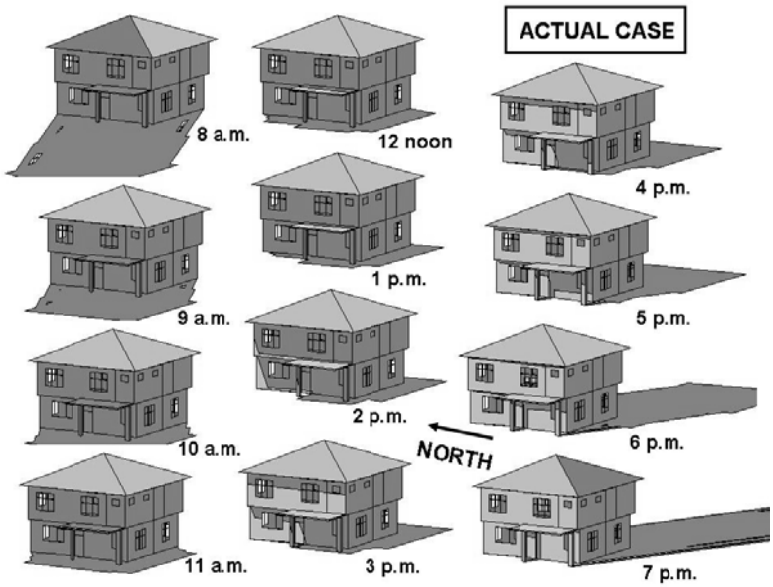


Figure 10. Actual Case - solar shading on 15th June.

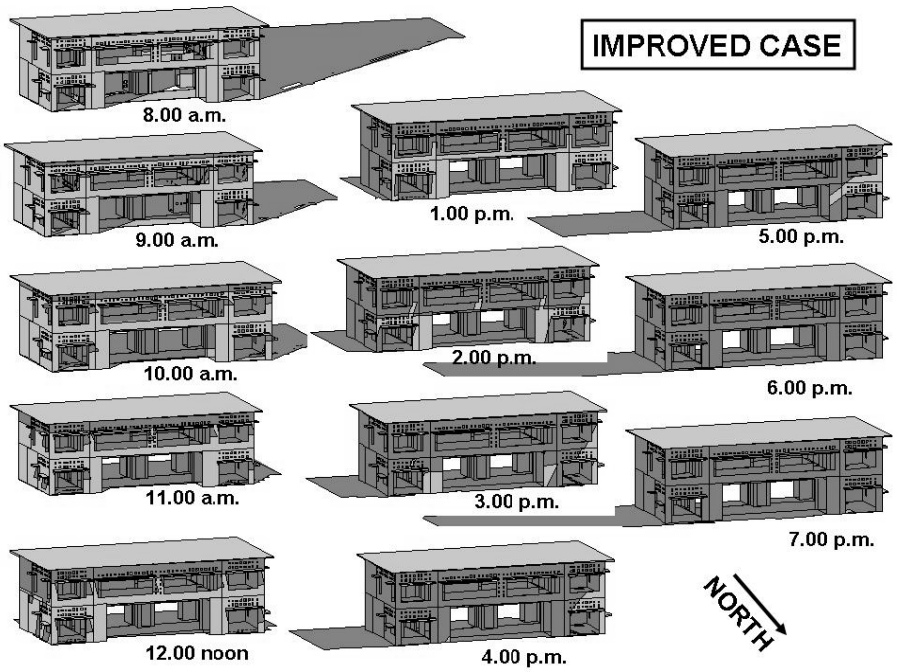


Figure 11. Improved Case - solar shading on 15th June.

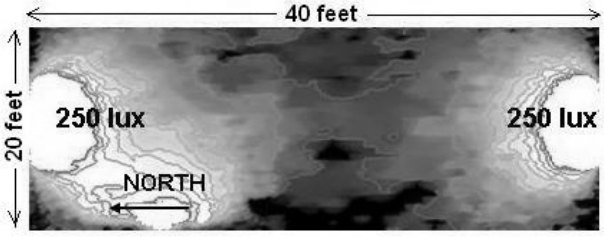


Figure 12. Inadequate daylight in Actual Case - room plan showing illuminance reading averaged at 250 lux in the living/dining area at 9:00 a.m. on 15th June.

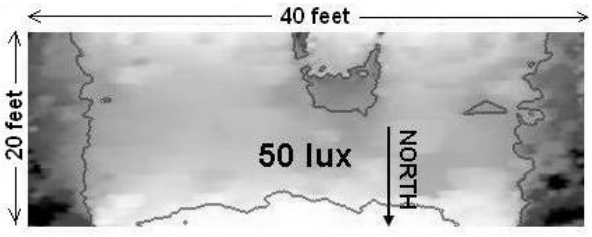


Figure 13. Inadequate daylight in Improved Case - room plan showing illuminance reading averaged at 50 lux in the living/dining area at 7:00 p.m. on 15th June .

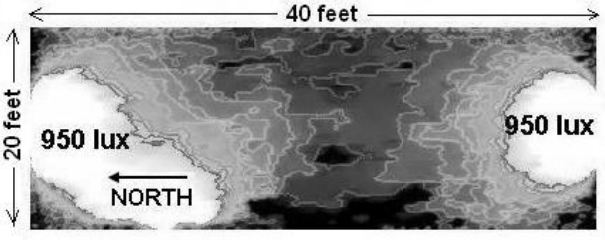


Figure 14. Adequate daylight in Actual Case - room plan showing illuminance reading averaged at 950 lux in the living/dining area at 3:00 p.m. on 15th June.

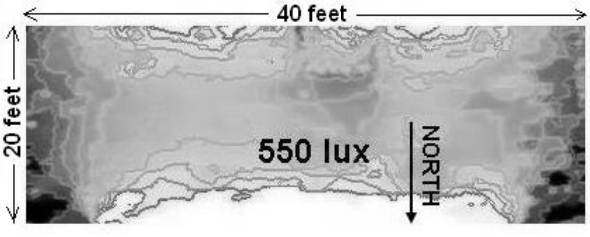


Figure 15. Adequate daylight in Improved Case - room plan showing illuminance reading averaged at 550 lux in the living/dining area at 3:00 p.m. on 15th June.

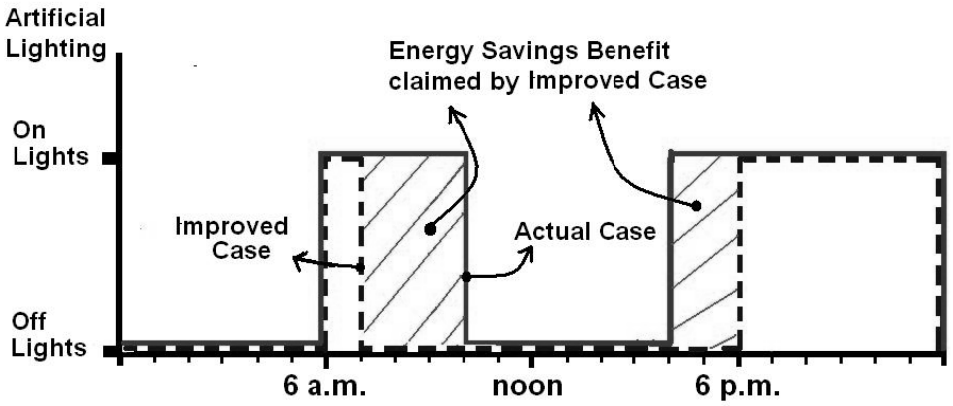


Figure 16. Use of artificial lighting by Improved and Actual cases on 15th June.

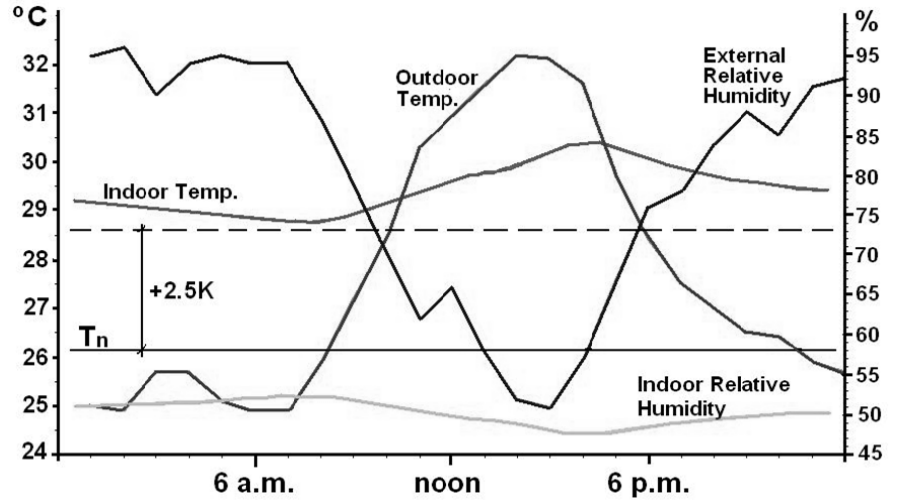


Figure 17. Actual Case - indoor thermal conditions in living / dining area on 15th June.

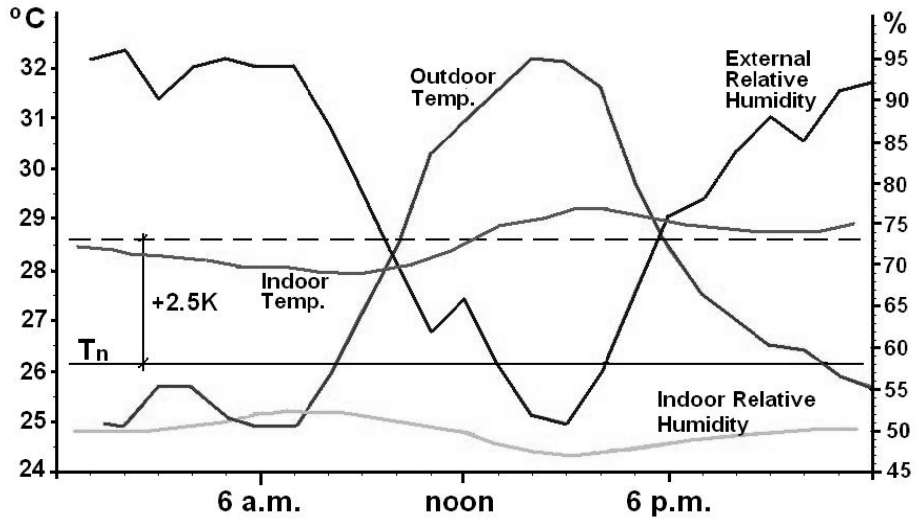


Figure 18. Improved Case - indoor thermal conditions in living/dining area on 15th June.

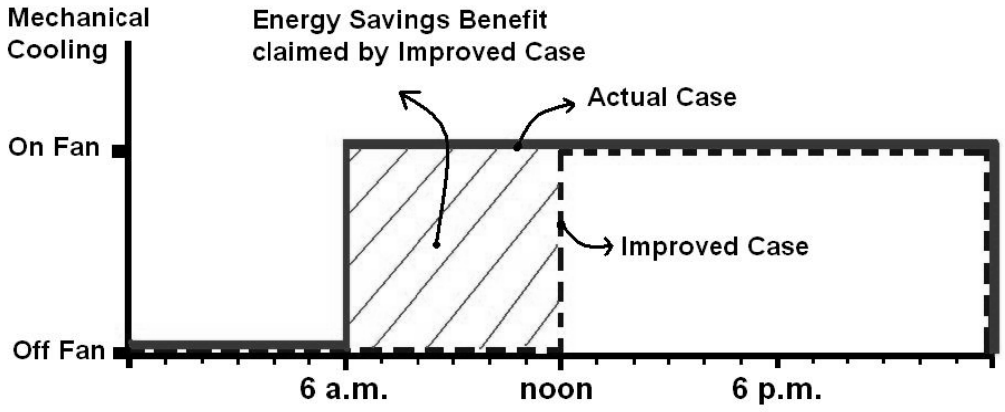


Figure 19. Use of mechanical cooling by Improved and Actual cases on 15th June.

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On the Problems and Recommendations of the Inland Port Container in the Inspection and Quarantine

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Abstract

Container transport with its high efficiency, convenience, security features becomes an important tool of China Foreign Trade Transportation. Container goods transport is also the main carriers of the inland port international logistics. This article discusses problems and improved measures of the inland port containers in the inspection and quarantine.

Keywords*:* Inland port, Container, Inspection and quarantine

1. Introduction

With development of export-oriented economy, the interior realized the import, export and offshore trade. A large number of goods needed to sea by boat, and to sea by boat need ports. Establishment ports in inland equivalent to achieve a shift from the ports to inland port.

Especially for containerized cargo, for inspection in the inland port when exports, then closed by the customs, and pay the transport (trains, cars, ships) of customs supervision shipped to the port, then transit embarkation the sea. If the form of multimodal transport consignments of goods, exports goods made by the carrier in the inland ports and issue bills of lading in local. Exporters clear costs by the bill of lading and then remove the risk of liability. Both of which reduce the hard work and expenditure of the exporters and people of deputy transport from the port, avoiding problems caused by unfamiliar to people, land, business of the port, cutting the risk of responsibility from inland to the port loaded before shipping, but more important is that a bill of lading is received as soon as possible, a guitar back to the purchase price, and speeding up the flow of funds, reduce the psychological burden on delaying the clearing costs of exports of goods.

International container transport is an advanced modern mode of transport, and compared to the traditional grocery casual way, its characteristics are the high efficiency, good economic efficiency and service quality superior. Because of this, container transport develops fast worldwidely, and become an important modernized transport and optimal mode of transport of ensuring international trade for all countries in the world.

However, with the entry-depth inland container transport, cooperative relations of the inland and coastal ports (edge) request enhancement, the importance of the Mainland inspection and quarantine institutions to health quarantine, animal and plant quarantine highlighted. How to improve the understanding of the container inspection and quarantine work, strict, good service, becomes the current problems.

2.The problems of the inland port container in the inspection and quarantine

2.1 The lack of understanding of the container inspection and quarantine and not enough attention

Over the past decades, the vast majority of our goods are applicated inspection and passed customs in imported ports. Transiting goods are very little, so container business is minimal and therefore the Mainland inspection and quarantine agencies in the container business, was unable to carry out very well, Have no relevant accumulated experience.

Especially road transport, the difference in time and scattered locations, and transportation companies receiving unit to the container handling time is limited, further increase in overtime costs, although the volume is not large, but worker on the inspection and quarantine to 24 hours Unattended, exhausted. All these circumstances, the Mainland authorities to increase the difficulty of monitoring, time-consuming effort, coupled with insufficient information, thereby relaxing the conduct of the business and management.

2.2 The lack of coordination mechanism between border crossings and the inland

(1)There are different procedures between inland ports and border ports, and the lack of mutual exchange of information and feedback result sthat in the inland container ports can not determine whether the health dealt with the fact that the situation there, and caused repeating inspection and missed inspection. Many inland container ports from the port, and some containers are qualified by ports inspection, and empty containers towed inland port loading cargo ship returned to port to export.

(2) "Entry-exit container inspection and quarantine management " require "containers of designated transport locations and clearance, after port entry inspection and quarantine agencies handled application inspection, inspect containers appearance (if necessary, to deal with health pesticides), handle transfer and signed Closure procedures, and transported to notice that inspection and quarantine agencies of designated transport locations , to refer to conduct inspection and quarantine in designated transport locations. "However, the border inspection and quarantine of the container is not in place measures to implement the segregation, some leakages container inspection and quarantine, resulting in the inland container port Identification can not be in place.

2.3 Legal basis of administrative penalties is not clear

"People's Republic of China Frontier Health and Quarantine Law" and its "implementation details and the" entry-exit inspection and quarantine management container" made clear: entry-exit containers must implement health quarantine. However, the entry and exit container omitted specific offences, such as defectors seized punishment, "the Regulations" Chapter 11 penalties are not clearly defined penalties to be imposed, resulting in the seizure container inspection and quarantine leakages can not use legal means to deal with and weaken the Inspection and quarantine laws and regulations of deterrence.

2.4 The follow-up health monitoring pesticide containers troubled inland port inspection and quarantine

(1)Health pest elimination business on the move most of the phytosanitary, health seizure operations, inland ports lack of health pest elimination methods of technical experts, can not meet the increasing health pesticide business. (2) Treatment of a single health pesticides, chemical spraying, no replacement fumigation pharmaceutical products, health quarantine, effectively moving the phytosanitary not a one-time pest elimination.

2.5 Difficulties in the scene practical ofcontainer inspection

(1)Handling locations of container cargo are dispersed widely, and container loading and unloading time can not be identified. The shipper, freight forwarding company handling time, customs clearance time are very nervous. When the containers are transferred to inland ports, consignee and shipper, freight forwarding companies organize working immediately, and even the factory side in the packing of goods, while still short of inland transport. Have no spare the time for container inspection and quarantine generally.

(2)Inspection and quarantine in the implementation of import and export commodities inspection and quarantine and inspection and quarantine of the container while the same can not be carried out, generally to a second inspection and quarantine. The general quality of goods produced in workshops, warehouses within the test. Commodity inspection and quarantine to be qualified, talented people for me shipping crates and containers to the loading point to the exact time can not be determined. So the quality of goods and container inspection and quarantine inspection of the time and place is a great difference, not a one-time completion of the inspection of import and export commodities inspection and quarantine with the container. Oxfam staff in the current seizure less heavy workload of the circumstances, the contradiction between the two very prominent, resulting in the efficiency of container inspection and quarantine lower.

3. Recommendations of standardized container inspection and quarantine work

3.1 High level of awareness of the importance of the container inspection and quarantine work

Containers are the major spread carriers of all kinds of vector insects, rodents, toxic and harmful substances, bearing on China's agriculture, forestry, animal husbandry and people's life and safety. Over the years, most of the work from

coastal areas (edge) ports commitment to inland ports have been established in recent years, the corresponding work should also play. Inland ports are actually relatively coastal (edge) ports, the port is the concept of location, its function and responsibility of the coastal and (while) at basically are the same. Inland ports should attach great importance to the work, understand the danger of invasion of the disease.

3.2 Acting in accordance with the law, the seizure in accordance with the standard application

Inspection and quarantine "Three Methods", "three ordinances" have corresponding provisions to container inspection and quarantine of a , inspection and quarantine standards in the industry have "SN/T1102-2002 immigration container inspection and quarantine protocols", "N/T0982-2000 security and the import and export containers Health examination of order "and other standards, and all six standards are developed for container . From a legal point of view or from their own responsibilities speaking, the Mainland authorities should strictly abide by the laws and regulations, a sense of responsibility, to seriously implement the "methods", earnestly carry out their duties.

3.3 Exchange of information, coordination and cooperation with the border ports

In accordance with the "fast clearance", the boundary crossing points, customs clearance speed more quickly, entry and exit inspection and quarantine agencies at the scene in accordance with the standard requirements of pumping me identification is impossible, container inspection and quarantine inspection should be transferred out to other places Can be effectively checked. Immigration control points on the border transit of container inspection and quarantine, as required to ensure segregation, the information transmitted to the work of inland ports, inland ports and border crossings to close collaboration, strengthening information communication and timely feedback inspection and quarantine issues.

3.4 Tthe entry-exit inspection and quarantine implementation of the Container dynamic classification management

(1) Category management for imported container

Grasp, the collection of human infectious diseases, animal and plant pests and pest outbreaks, the establishment of imported container inspection and quarantine database of area businesses imported goods, the type and quantity of packaging carefully mapping, with its declaration and the integrity of a comprehensive analysis and possible quarantine risk assessment, inspection and quarantine identified key. On imported goods and containers and related enterprises, classification and quarantine management, the container and its cargo quarantine risk factor has a small, fast issued in advance.

(2) classification managemen for the containert

Of the larger freight forwarding companies, container station, and foreign trade companies from the container dynamic classification management, inspection and quarantine institutions to work with day-to-day sampling of regular or irregular conduct the inspection and appraisal, inspection and quarantine agencies for the implementation of classified management of containers Business-related staff in professional training, the training of qualified job evaluation task commitment, Inspection and Quarantine, the enterprise must be carried out by inspection and quarantine requirements of some basic public health work, if we find that the container in question should be timely written report. Some of preventive pre-inspection and quarantine to enterprises to complete, so can better solve the heavy workload and the relative lack of power of inspection and quarantine issues, can change the situation that the inspection and quarantine institutions to each batch seized but not seized, and could not be recognized inspection and quarantine.

3.5 Strengthen the construction of sanitation units of inland ports

(1) Increase the health of inland ports pesticides technical team-building, non-organized business training courses, health pesticides to deal with the workload increased year by year the situation, found that the epidemic will be able to meet the fastest rate of pesticide health requirements.

(2)Strengthening health pest elimination of scientific research, as soon as possible to research and development of high efficiency, low cost, convenient, fast and safe method of fumigation of drugs and pesticides to meet one-time deal with the requirements of Health and pesticides.

3.6 Improve work methods, improve service quality, lower trading costs

Container is devided into empty and full. In accordance with the regulations, full containers are taken implementation inspection and quarantine together with the cargo. The Immigration containers, the inland port can be completed independent inspection departments, the container exit inspection and quarantine, should be realistic, goods seized by the department together with the cargo inspection and quarantine, or verify "container inspection and quarantine Results", "inspection and quarantine fumigation / disinfection Certificate ", released at verification. Thus, on the one hand inspection and quarantine institutions can play the role of various departments, saving a lot of manpower, material, on the other hand can save valuable time logistics, to monitor the scientific, standardized and effective, raise work efficiency. In addition, should take a variety of methods to strengthen the inspection teams of professional training and improve job skills and professional ethics, change our work style, enhance service awareness, improve service quality,

implementation of the reservation system of work for eight hours, shortening the clearance cycle, thus reducing costs , User-friendly.

3.7 landlocked inspection and quarantine agencies provide good advice and problem-solving

Environment for application test units andthe application test worker. Prosecution of the business sector has released ID cards to registered application inspection members, Rapporteur on the implementation of identification to application inspection members, and trurely realized application inspection by certificate. Port inspection and quarantine law enforcement worker found the illegal business in the identification process ,and should report departments on a timely. Take punishment and a combination of education to norm the acts of application inspection. Establish integrity of agent market of application inspection. To sum up, land crossings, Inspection and Quarantine to strengthen internal management and the building of the contingent, to ensure full implementation of functions at the same time the strengthening of external communication and cooperation, give full play to the functions of economic development services.

4. Conclusions

Based on discussing problems and improve the measures of the inland container port inspection and quarantine work, strengthen the inland container port management, speed up customs clearance, reduce the losses brought by inspection and quarantine.

References

Gao Caiyun. *Commodity inspection practices*. Machinery Industry Press .2006.12:234-245.

Ni Zhaoyong, Qian Yanyun, Shen Xiangde. The land crossings to China International Logistics Center mode of operation. *Conservation and storage and transportation of goods* .2004,6 (3): 1- 6.

Qi Ershi. Tianjin port container inspection and quarantine management. *Containerized*. 2005,3:12-15.

Zou Quansheng. "WTO accession" to the international logistics industry challenges and the corresponding [J]. *Economist* .2002:35-45.

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Corrosion Studies on Concrete Using Treated and Untreated Textile Effluent and Impact of Corrosion Inhibitor

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Abstract

An attempt was made to use the waste water from textile industry for construction purpose, so that the shortage in water can be greatly reduced and the waste water can be suitably disposed for safe guarding the environment. The basic properties of the treated and untreated water from the textile industry were tested and the results were found to be satisfactory such that it can be used for construction purposes. By using the waste water from the textile industry cubes, cylinders and beams were casted and tested for its mechanical properties (compressive strength, tensile strength, flexural strength etc) and the result was found to be satisfactory. Hence the experiment was continued on for durability studies where the corrosion attack was also studied. The results of other durability studies were found to be satisfactory. In this experimental study the results of specimen's casted using treated and untreated textile water were compared with the specimens casted with potable water. Since there was some corrosion, admixtures were added to counter act the same and the results were found to be satisfactory.

Keywords: Concrete, Calcium nitrate, Concare, Cempatch-R

1. Introduction

The term corrosion is defined as an act or process of gradual wearing away of a metal due to chemical or electrochemical reaction by its surroundings such that the metal is converted into an oxide, salt or some other compound. It indicates the deterioration and loss of material due to chemical attack.

In this study comparison was made between specimens (cylinder) casted using treated textile effluent, untreated textile effluent and potable water. There was deterioration due to corrosion attack and to counteract the corrosion attack concare and calcium nitrate was added on trial and error basis and it was found that 2.5% concare and 2.0% calcium nitrate was found to be suitable. In addition cempatch-R coating was done on the reinforcement bar and the effect was also studied. The experimental study was conducted for three grades of concrete i.e. M_{20}, M_{25} and M_{30}, but here only for M_{20} grade of concrete the corrosion studies were analyzed and discussed in detail. The results of other two grades M_{25} and M_{30} were also same as M_{20} grade of concrete. The specimens were tested after 28 days, 180 days, 1 year, 2 year and 2.5 years of curing.

2. Experimental

The natural river sand was used, tested and conforming to the specifications IS 2386 (Part II)-1963, IS 2386 (Part III)-1963, IS 2386 (Part IV)-1963 and IS 2386 (Part VI)-1963. The fines modulus of sand used is 2.80 with a specific gravity of 2.54. A good quality crushed granite coarse aggregates was used and the coarse aggregate was tested as per the specifications IS 2386 (Part III)-1963, IS 2386 (Part IV)-1963, IS 2386 (Part V)-1963, IS 2386 (Part VII)-1963 and IS 2386 (Part VIII)-1963. The crushing value of coarse aggregate is tested as per IS 9376-1979, and its impact value is tested as per IS 9377-1979. The cement used was 53 grade PP cement. In addition few other properties were tested as per the procedure given by M S Shetty (2001) and Rangwala (1997). Concrete mixes were designed for M_{20}, M_{25} and M_{30} to study the mechanical strength properties and durability properties as per IS 10262-1982. Standard cylindrical steel moulds measuring 150mm diameter and 300mm height were used for the preparation of test specimen for splitting

tensile strength test and corrosion attack test as per IS 10086-1982. The admixture was selected and used based on the guidelines of the specifications IS 9103-1978 and ACI 212.

A reinforcement steel bar of 20mm diameter and 300mm long was weighed and noted down. A cylinder of 150mm diameter and 300mm height was used for preparing the specimen. The steel bar, explained earlier was held in position and concreting was done with 300 mm cover. Care should be taken so that the rod stayed in position while compacting. The specimen is allowed to cure for 28 days. The test setup that essentially measures resistivity of concrete consists of a constant DC supply providing constant voltage of 120 Volts through a shunt in a constant voltage mode and 80 million Ampere in constant current mode. The test was carried out in a 6% NaCl solution with an embedded reinforcement bar as a working electrode a shown in Fig.1 and a copper bar as a counter electrode. The variable parameter voltage was recorded at every 15 minutes interval for 6 hours in constant current study. The set up was kept for 5 days without disrupting the power supply. The solution turns to reddish brown in color due to the formation of rust. Then the specimens are removed from the set up, dried in air, visually inspected and carefully split open to access the corroded steel bar. The reinforcement bar was then cleaned as per ASTM G1 of 1981 by dipping it in Clark's solution (HCl of specific gravity 1019 litre + antimony trioxide 20gm + stannous chloride 50gm) for 25 minutes. Each bar was weighed again to the accuracy of 0.1mg to find out the change in weight. Figure 2 shows the view of test setup.

3. Result and Discussion

There is a continuous loss of weight of reinforcement bar embedded in the concrete with respect to age of concrete from 28 days of casting of concrete to 2.5 year of casting of concrete. Initially after 28 days of curing, the loss of weight reinforcement bar is approximately 5% for potable water, 5.5% for treated textile water and 6.0% for untreated textile water. The loss of weight of reinforcement bar gradually increases along with the time and at the end of 2.5 year the loss of weight reinforcement bar is approximately 6.25% for potable water, 6.5% for treated textile water and 7.0% for untreated textile water.

When 2.5% of concare admixture is added, the loss of weight of reinforcement is slightly reduced. Initially at the beginning (after 28 days), the loss of weight of reinforcement bar is less than 1.25% and at the end of 2.5 year the loss of weight of reinforcement bar is less than 2.25% for all the specimens cast using potable water, untreated textile Water and treated textile water. When 2.0% of calcium nitrate is added the loss of weight reinforcement bar is same as that of adding 2.5% concare admixture.

In order to reduce the corrosion further, the reinforcement is coated with cempatch-R. There is a great loss in weight of reinforcement i.e even at the end of 2.5 year; the loss in weight of reinforcement is less than 0.25% for all types of water. In addition when 2.5% concare and 2.0% calcium nitrate is added along with cempatch-R coating, the loss in weight is less than 0.03% at the end of 2.5 year for all types of water which is almost very negligible. All the comparisons are given in figure's 3 to 8.

4. Conclusion

From the discussion it is clear that the treated and untreated textile water can be used for construction purpose after adding concare and calcium nitrate admixture. It will be a boon for the environment if the industrial water is used for construction purpose. The problem of disposal of the waste water will be greatly reduced.

References

ACI Committee 212 (2002), Classification of Admixtures, ACI manual of concrete practice, American Concrete Institute, Farmington Hills, USA.

IS 2386 (Part II)-1963 (1963), Indian Standard Methods of test for aggregates for concrete: deterious materials and organic impurities, VIII reprint April 1996, Bureau of Indian Standard, New Delhi-110 002.

IS 2386 (Part III)-1963 (1963), Indian Standard Methods of test for aggregates for concrete: Specific gravity, density, voids, absorption & bulking, VIII reprint March 1997, Bureau of Indian Standard, New Delhi-110 002.

IS 2386 (Part IV)-1963 (1963), Indian Standard Methods of test for aggregates for concrete: Mechanical properties, IX reprint June 1996, Bureau of Indian Standard, New Delhi-110 002.

IS 2386 (Part V)-1963 (1963), Indian Standard Methods of test for aggregates for concrete: Soundness, VIII reprint November 1996, Bureau of Indian Standard, New Delhi-110 002.

IS 2386 (Part VI)-1963 (1963), Indian Standard Methods of test for aggregates for concrete: Mortar making properties of fine aggregates, VIII reprint April 1997, Bureau of Indian Standard, New Delhi-110 002.

IS 2386 (Part VII)-1963 (1963), Indian Standard Methods of test for aggregates for concrete: alkali aggregate reactivity, IX reprint June 1996, Bureau of Indian Standard, New Delhi-110 002.

IS 2386 (Part VIII)-1963 (1963), Indian Standard Methods of test for aggregates for concrete: Petrographic examination, VII reprint August 1991, Bureau of Indian Standard, New Delhi-110 002.

IS 9376-1979 (1979), Indian Standard Specification for Apparatus for measuring aggregate crushing value and 10% fine value. I reprint May 1997. Bureau of Indian Standard, New Delhi-110 002.

IS 9377-1979 (1979), Indian Standard Specification for apparatus for aggregate impact value. I reprint July 1990. Bureau of Indian Standard, New Delhi-110 002.

IS 10262-1982 (1982), Indian Standard Recommended guide lines for concrete mix design V print march 1998. Bureau of Indian Standard, New Delhi-110 002.

IS 10086-1982 (1982), Indian Standard specification for moulds for use in tests of cement and concrete-V Reprint December 1995, Bureau of Indian Standard, New Delhi-110 002.

IS 9103-1978 (1978), Indian Standard Specification for addition of admixtures, Indian Standards Institution, New Delhi-110 002.

Rangwala. (1997), Engineering Materials, Charotar publishers., pp 150-158.

Shetty, M. S. (2003), Concrete Technology Theory and Practice – S.Chand & Company Ltd, pp 399-400,429-438, 449-501.

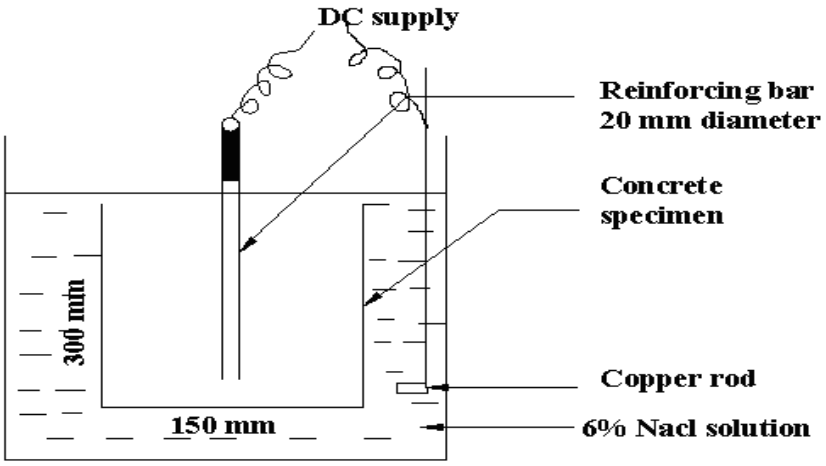

Figure 1. Accelerated Corrosion Test Setup

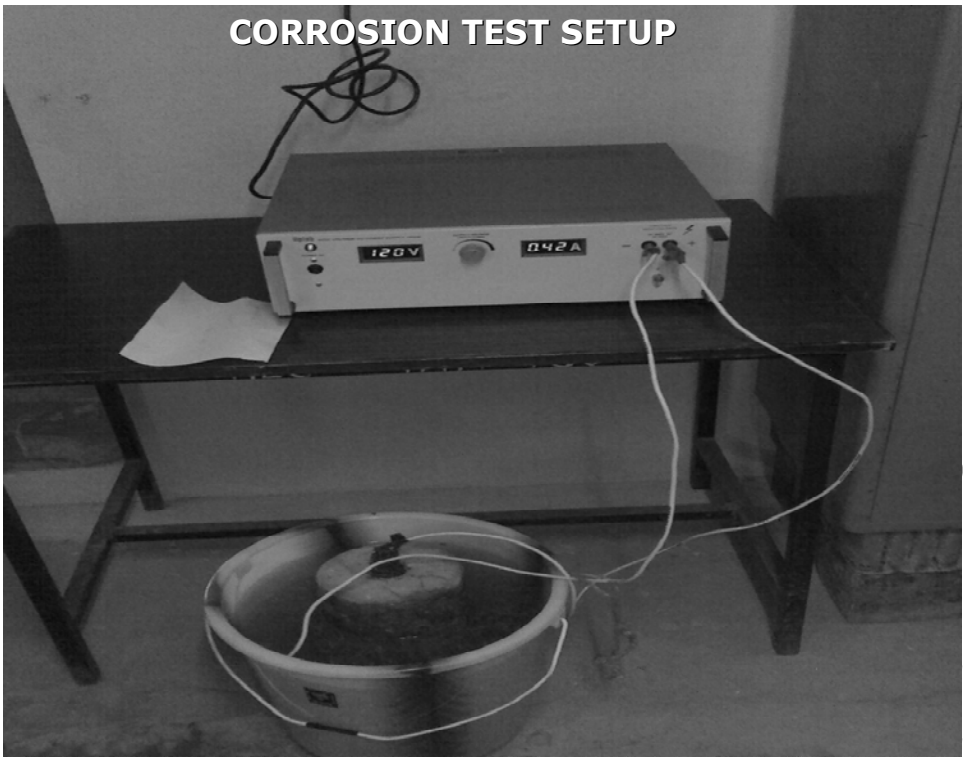

Figure 2. Corrosion Test Setup

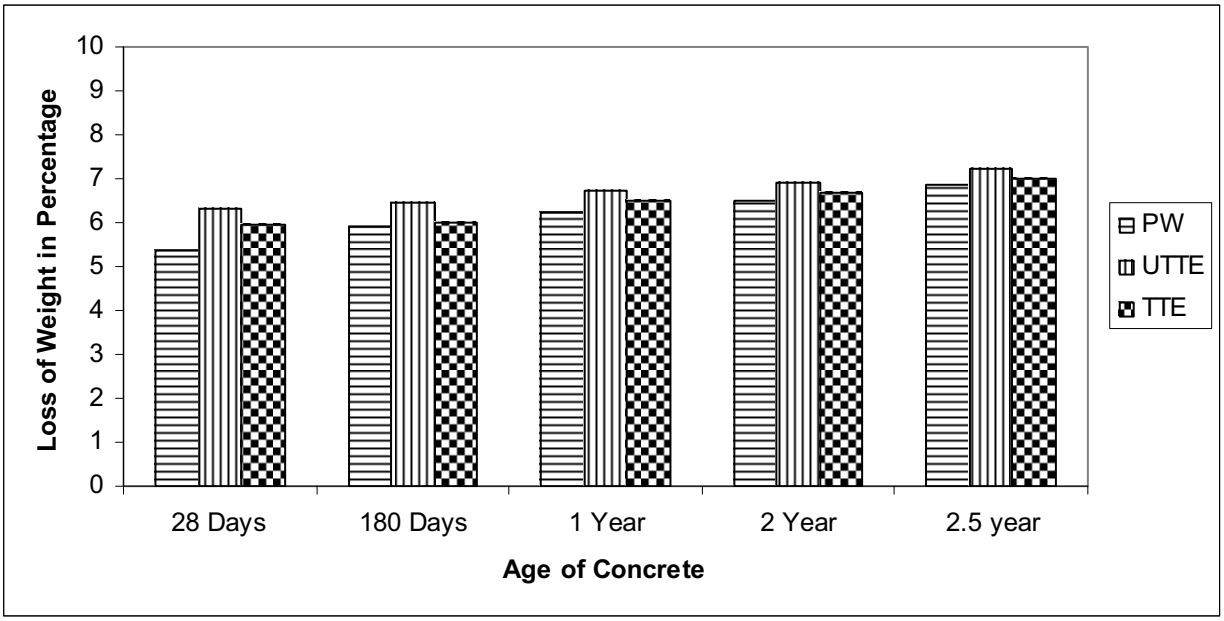

Figure 3. Comparison of loss of weight of reinforcement bar due to corrosion for potable water, untreated textile Water and treated textile water for M_{20} grade of concrete without adding admixture

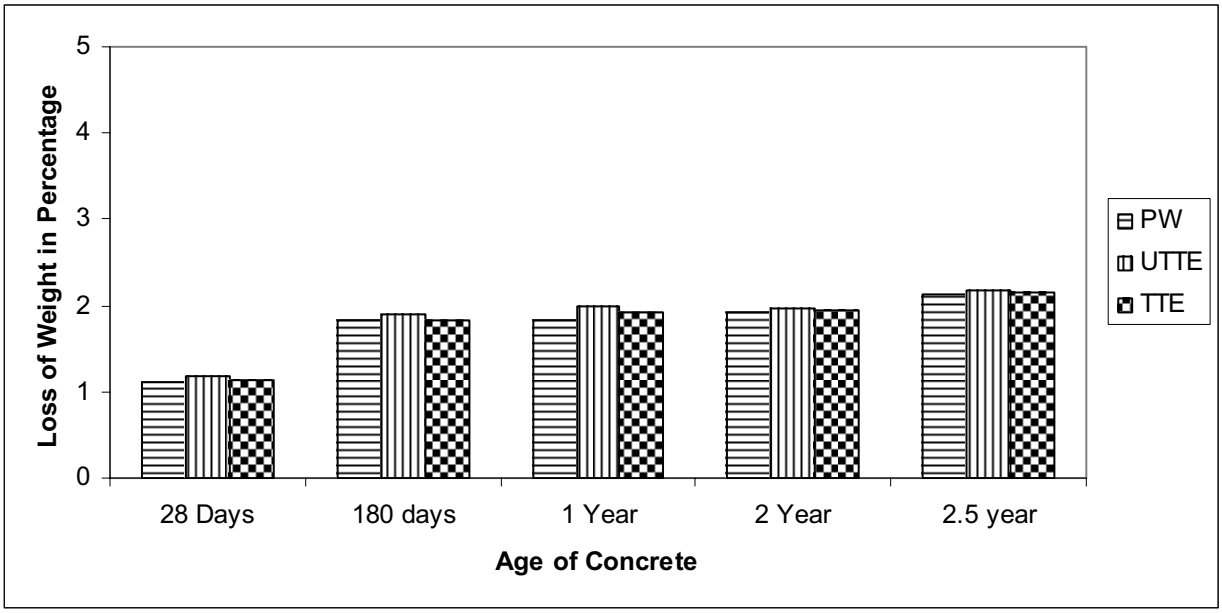

Figure 4. Comparison of loss of weight of reinforcement bar due to corrosion for potable water, untreated textile Water and treated textile water for M_{20} grade of concrete adding 2.5% concare

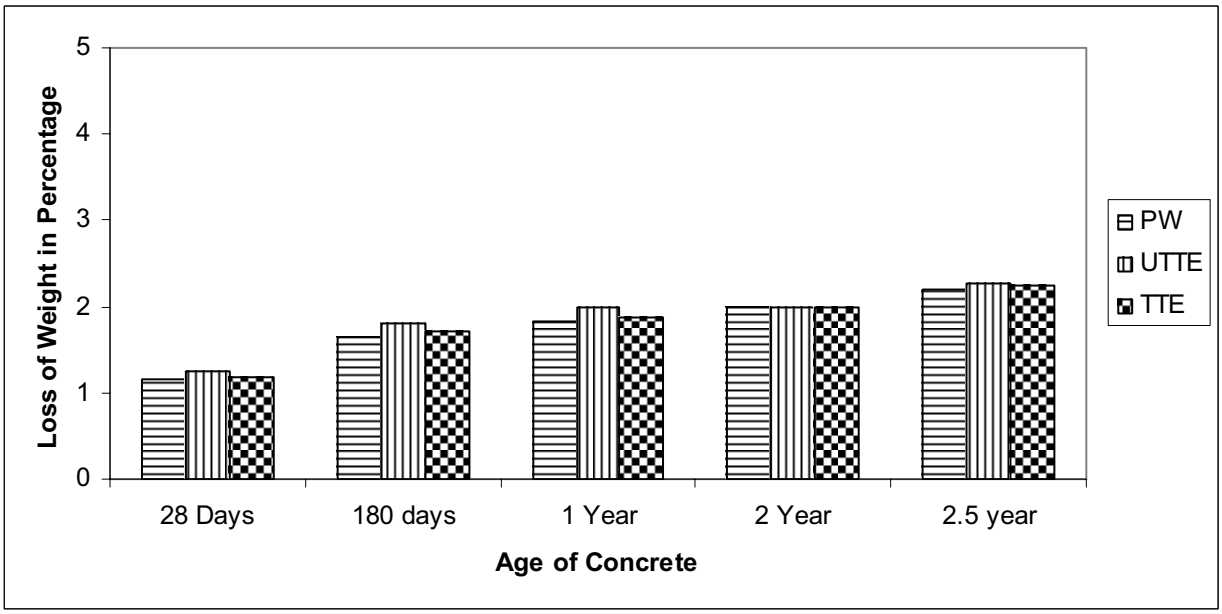

Figure 5. Comparison of loss of weight of reinforcement bar due to corrosion for potable water, untreated textile Water and treated textile water for M_{20} grade of concrete adding 2.0% calcium nitrate

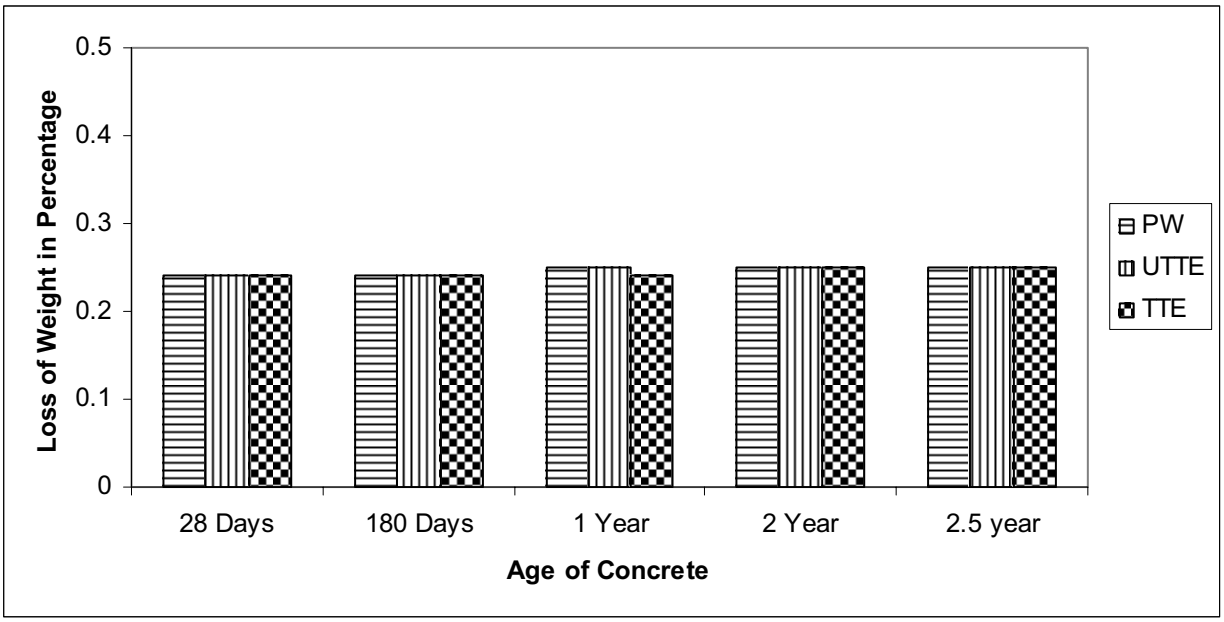

Figure 6. Comparison of loss of weight of cempatch-R painted reinforcement bar due to corrosion for potable water, untreated textile Water and treated textile water for M_{20} grade of concrete without adding admixture

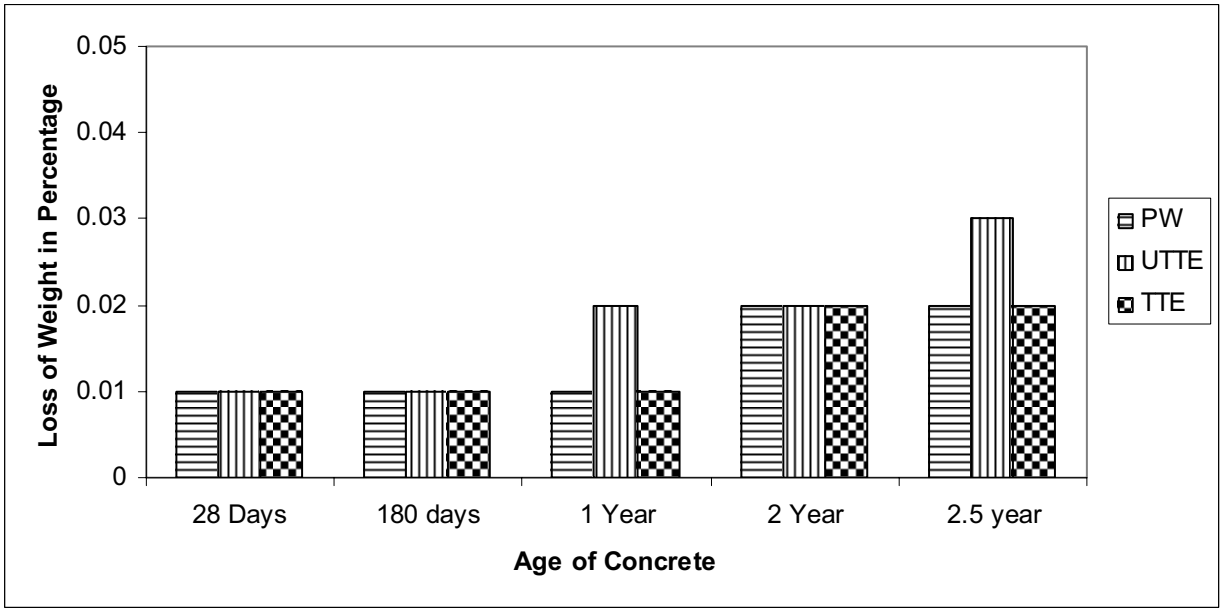

Figure 7. Comparison of loss of weight of cempatch-R painted reinforcement bar due to corrosion for potable water, untreated textile Water and treated textile water for M_{20} grade of concrete adding 2.5% concare

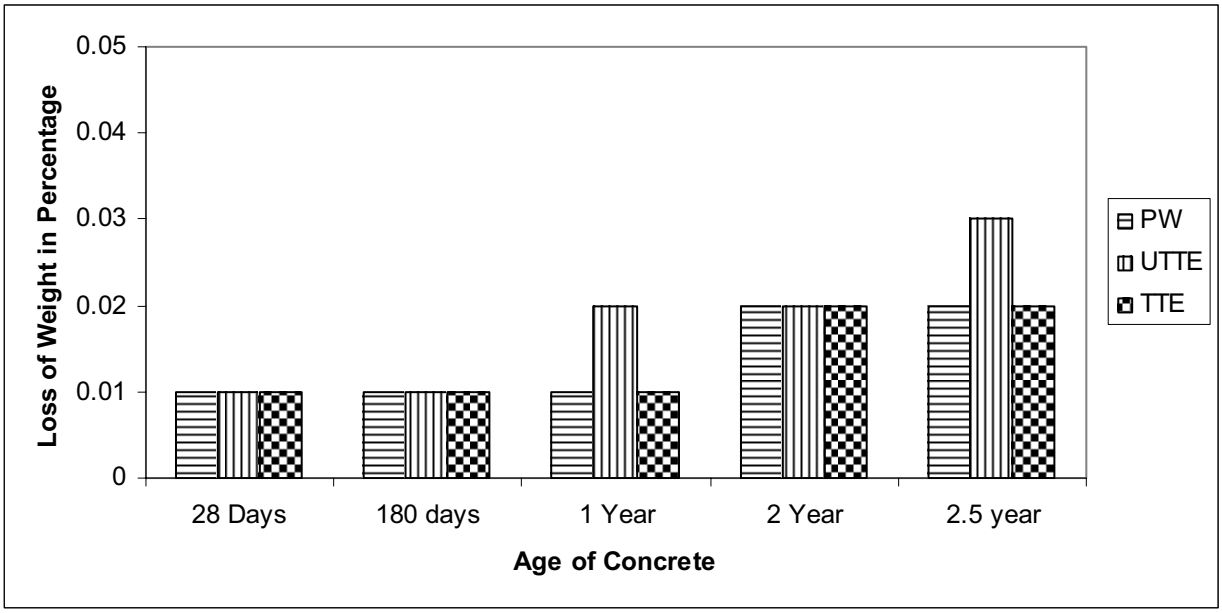

Figure 8. Comparison of loss of weight of cempatch-R painted reinforcement bar due to corrosion for potable water, untreated textile Water and treated textile water for M_{20} grade of concrete adding 2.0% calcium nitrate

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Study on Undeveloped Areas Sustainable Development: A Theoretical Framework of Place Marketing Strategy and System Analysis

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Abstract

Place marketing strategy plays a key a key role for the success of regional/local especial undeveloped areas in gaining competitive edge, optimally allocate economic resources, and make long term economic development strategy and policies. To discover the behavior and mechanism of organization, nowadays, more and more people have paid attention to the complexity theory such as self-organization, dissipative structure theory, synergetic theory, etc. The paper introduces the concept of self-organization theories and place marketing strategy firstly. Then enlightened by the systematical methodology, the paper puts forward the concept of sustainable development of urban on the basis of analyzing the characteristics of self-organization place marketing strategy. A thorough analysis of the mechanism of place marketing strategy sustainable development has been made accordingly. Finally, the paper adopts the strategy of Xian Yang as an example, indicating that the success of undeveloped areas is mostly due to its effective and efficient self-organized place marketing strategy.

Keywords: Complexity phenomenon, Undeveloped Areas, Self-organization, Sustainable development, Place Marketing Strategy

1. Introduction

The globalization with more diversified and frequent communion and an increase in business and culture make a chaotic and complex environment for regional especial undeveloped areas. Success or failure for most undeveloped regions is determined by how effectively and efficiently their strategy are planned or controlled in economic environment described "Complexity phenomena". Many new concepts have been put forward such as place marketing, marketing of city parts, local economic development and etc we called regional management mode for sustainable development. The essence of these researches is encapsulated in the development of a metamorphic, self-organizing architecture, which comprises planning, control and application agents that collaborate to satisfy both local and global objectives. The study points out that agility, reactivity, flexibility and autonomous place marketing strategy play a key role for the success of a undeveloped area in gaining competitive edge, investors markets demanding agility and quick market response in global competition. To discover the behavior and mechanism of organization in the complex environment, nowadays, more and more people have paid attention to the complexity theory such as self-organization, dissipative structure theory, synergetic theory, etc. These are all in accordance with theoretic foundation of self-organization mechanism. There are many articles about self-organization, but most of them focus on supply chain management and application of intra-organization system. To the best of our knowledge, past research has paid little attention to self-organization place marketing strategy, and empirical studies remain scarce.

Indeed, self-organization mechanism may be more prevalent in highly complex and uncertain environment such as local government strategy than in simple intra-organizational system. In other words, undeveloped areas organization may produce greater benefits and effectiveness by using self-organization mechanism.

The objective of this study is to propose a self-organization framework for place marketing strategy on the basis of the existing theories, and bring forward place marketing strategy structure. Firstly, the theoretical rationale and concept will be presented, the characteristics of self-organization place marketing strategy will be explained next, followed by the methods and mechanism of undeveloped areas sustainable development directed by self-organized place marketing strategy, finally, a case of place marketing strategy of a undeveloped area in west china is specialized for empirical research.

2. Concept Model of SOPMS (Self-organizational place marketing strategy)

2.1Place marketing strategy

Cities are created by a society of citizens, entrepreneurs, organizations, public and non-profit sectors, their ideas of a city direction differ. For other subjects it has a coordination importance. Place marketing strategy is a long-term conceptual activity of the city and it should help the city to sell it to given market segments for their different activities (housing, consumption, production), to differ the city from its competition, to use a competitive advantage of the city, e. g. natural conditions, historical and cultural heritage, to achieve satisfaction of citizens, entrepreneurs, visitors, etc.

During the process, the undeveloped areas compete and cooperate with the external circumstance constantly. Management and marketing researchers alike contend that the environment is in a constant process of change, so the adaptation behavior of place marketing strategy is very important, which has been well proved in many relevant articles. Specifically, the structural adaptation and strategies of undeveloped areas to environmental conditions have been shown to be positively related to local government performance.

In another aspect, there has been a growing interest in the issue of place marketing strategy focused on the coordination of business activities, resources allocation, and living condition improving, which brings the essential of structure of strategy and also is concerned with the trust and cooperation relationship among government units members. The objective of this study is to improve the efficiency of marketing strategy in complex developing environment.

2.2 Concept of self-organization

Self-organization is a key concept in complexity theory. According to Tharumarajah, self-organization is defined as the ability of an entity (or a system as an entity incorporating a collection of sub-entities) to adapt itself to prevailing conditions of its environment. Self-organization is also known as the relative agility of an entity, which ensures its optimal function through minimum help or intervention from external (e.g. human operator) or internal (e.g. other entity) components of the system. The Intelligent Manufacturing Systems World Project defines self-organized system as a system that is not coordinated by the exterior. Entities are autonomous and execute the tasks together. Through interaction and mutual comprehension, the sum or the combination of individual tasks allows managing an order, a good or a service which is more global.

Self-organization system must have two aspects. One is spontaneity of internal diversity, the other is instability of internal selectivity in mutual commuting with external environment, maintaining the open state of organization inside or outside. Then the diversified subsystem of organization will compete and cooperate with each other and as a result, a sequence parameter, which coincident with the sequence parameter produced by environment of organization, is produced. The development of self-organization system keeps consistent with the change of environment, which means self-organization has acclimatization.

From the above points, we can view that the associated characteristics of self-organization are (1) autonomous, (2) cooperative, (3) transformative. Term of "autonomous" refers to the possible capability to remain its quality or state without outside control; “cooperative” means to maintain stability relationship among subsystem of inter-organization and with the external environment; “transformative” means the existing independent capability.

2.3 Conceptual model of self-organization place marketing strategy (SOPMS)

I.Prigogine, the founder of dissipative structures theory and K.J.Arrow, the Nobel economics prize winner put forward that economic activity is a continuous evolutive complexity system. Subsystems in organization check each other as the external strength to promote each function to be carried out: Design function and framework of organization according to business procedure, every link puts forward the requirements to the upper region and is appraised by lower member at the same time, forming a “self-organized system” characterizing “function coupling” with internal key motivity at last.

2.3.1 The Structure and the Mechanism of undeveloped area.

The composition principle of the undeveloped areas governs and operation process can be simply summarized and shown as a pursuing structure in figure 1. Real line means the connections of inner local government members and city customers. The output of place is determined by whole organization, and the performance of each member or satisfaction of city customer is determined by place marketing strategy in advance. The connections among each unit are single and the relationship is stiff. Therefore, each unit individual is lack of the right of autonomy and the behaviors

of member depend on control management of the governors instead of the relationships with other members and external environment condition.

Self-organization requires changing the relationships among government unit and customers and external marketing circumstance. It regards each member as an independent decision-maker, which has the nature of autonomy and can make decision according to one's own interests and environmental change. On the other hand, due to the inseparability of working cost and transaction cost, it is necessary to keep all units as one integrative organization, so as to form an organic whole connected with each other. Dotted line means to set up market relationships, which meets the flexible structure and adaptability to change in the government organization.

2.3.2 The Characteristics of Self-Organization Place Marketing Strategy

This study introduces the concept of self-organization place marketing strategy so as to make the sustainable development of undeveloped areas become reality. The characteristics of the self-organization place marketing strategy are concluded as follows.

(1) Self-adaptability to the environment. Self-organization system has the ability to reorganize its structure and interactive mode automatically, so as to firm new hierarchical structure and function to adapt to the changing of environment. There's no fixed system structure and equations but only the advanced learning capacity remained inside the place marketing strategy system.

(2) Key order-parameter slaved system evolution - In Haken's synergetic theory, there's a famous conception called "slaving principle", which means there always have some key parameters in the complex system, which are called "order-parameter" and change relatively slowly and manage the whole system evolution. The place marketing strategy system is open, in the process, inside mechanism arose entropy changing ($d_i s$) and the relationship between system and external circumstance produces system entropy changing ($d_e s$), so $ds = d_i s + d_e s$, $d_e s < 0$ in the open strategy system and $d_e s > d_i s$, the result is $d_s = d_i s + d_e s < 0$, the system becomes orderly from out of order.

(3) Cooperation - Self-organization normally means the existence of both emergence of individual unit behavior of entity and upward flow of behavior and information. The place marketing strategy system is an organic syntheses. Minimal degree of cooperation must exist among distributed system's entities to avoid total disorder, which can be provided by different mechanisms like communication, negotiation. The concept of m place marketing strategy self-organization refers to a variety of distinct systemic attributes, such as: self-creation, self-configuration, self-regulation, self-steering, self-maintenance, self-(re-)production, and at the same time, synergic mechanism make the activity of subsystems consistent with the objective of the place marketing strategy and the integer behavior will be much better.

(4) Environment consonancy -There is much difference among subsystems of undeveloped areas intra-organization, which is away from equilibrium. But the effectiveness among them are quite strong, which gather adequate favorable factors for self-renewing in the process of exchanging substance, energy and information with environment, which is away from equilibrium, to enable the development of self-organization place marketing strategy, which is supposed to be impossible, becomes possible. Many facts prove that objective of sustainable development of the places becomes true when mutual benefits are achieved and friendly relationships with the correlated government units and marketing circumstances are established.

3. The Mechanism of Place Marketing Strategy sustainable development

3.1 Concept of sustainable development

The concept of sustainable development is put forward based on the requirements of adaptability to environment for an organization in cruel competition. It refers to that organization should understand and master the characters of developing and changing environment, so as to make it have acclimatization and forecast the developing tendency of environment accordingly. Organization is required to have ability of self-learning and autonomy. The theory foundation is the synergetic theory of Haken, which has two values: masterdom principle and order-parameter. The mathematic formula is:

$$\xi_s(t) = f_s[\xi_u(t); t] \quad (1)$$

Thereinto, $\xi_s(t)$ means stable pattern, $\xi_u(t)$ means unstable pattern. The formula indicates that unstable pattern dominates stable pattern. $\xi_s(t)$ changes with $\xi_u(t)$ quickly, so the formula of movement process of system is:

$$X(s,t) = X_0(s) + \sum_u \xi_u(t) v_u(s) + \sum_s \xi_s(t) v_s(s) \quad (2)$$

$\sum_s \xi_s(t) v_s(s)$ is a gather of stable factors, which have a large number but normally disappear in short time, in the movement process of system. $\sum_u \xi_u(t) v_u(s)$ is a gather of unstable factors, which are few and change slowly, in the movement process of system. It keeps system away from equilibrium point, break up the old equilibrium point and establish a new one, pass the unstable point and form another new ordered state. ξ_u is called order-parameter. In this process, the system is restructured by itself, which makes the organization harmonize with the changing environment further. Harmonized relationship formed between organization and environment has mutual benefits, which makes the circumstance become reliable and stable for sustainable development of organization.

3.2 The sustainable development of place marketing strategy—mechanism of self-organization

According to I. Prigogine, It is fluctuation that makes the system away from instable state in the area near equation where system has the ability to anti-jamming. Departure deduced by fluctuation will disappear through self-attenuation and the stability of system will be recurred after interference. The negative feedback mechanism attenuates the fluctuation, as a result, the system remains in the original ordered stable structure and structure-function is optimized accordingly.

Away from equilibrium, in Nonlinear Dynamical Systems, the system is in a unstable stationary state. Some little stochastic fluctuation may be magnified through interactional activities and bring gigantic fluctuation of macrocosm. So the system will get new ordered state from instable state. When environment change strongly, the positive feedback mechanism will magnify the fluctuation and realize the transformation of different macro-stability states, so as to improve the adaptability of system to environment.

The relationship between government unit is solid reticulate relationship. Each member forms its own ordered structure in the process of competition, cooperation and self-organization showed in figure 2.

4. The empirical study——place marketing strategy of Xian Yang

The system of modern urban planning of Xian Yang began with the Director Plan in 1990. The strategic planning procedure changed its character and became more complicated concerning economic, social and policies. The fact that the Strategic Planning presented and developed as a part of a total development system was based on the participation and the contribution of the main public and private sectors organizations, operators and institutions on both municipal and metropolitan levels, was very important. Furthermore, the Strategic Planning constitutes an efficient toll of development and local actions achievement. The main five challenges that the strategic planning of Xian Yang has to identify concern the following: a) to improve accessibility and mobility within the city and its metropolitan area, b) to improve the environment and the cultural heritage, c) to modernize Xian Yang's economic base and to increase the economic competitiveness of the city, d) to increase social opportunities.

In the case of Xian Yang, the strategic planning presents differences. A specific Place/ marketing procedure is not mentioned anywhere but as main development strategies were presented: a) the partnerships between the local authorities and the scientific and technological agencies and institutions leading to a greater interaction between them and the city life and b) the modernization of city administration by acknowledging the need to improve the efficiency of service delivery within the local authority.

The Strategic Plan of 1992 has primarily been developed in order to present and to set up the images of the city in the future, focusing on four specific goals: a) Xian Yang to become attractive to live and work, b) to become competitive among the other western cities, c) Xian Yang to be consider as a metropolitan capital and d) to endow Xian Yang with a modern, participate and efficient administration.

The central scope of the Strategic Planning of Xian Yang has been orientated to the creation of Xian Yang regardless of the existing debate that comes forward recently, concerning the potential of the urban areas for vitality and their development across the western areas and furthermore to establish an effective development framework so that Xian Yang will become one of the most attractive western metropolitan areas in future. As we mentioned previously, the place marketing strategic planning in Xian Yang has not followed any particular place marketing structure. However, Xian Yang's development was supported by a variety of events that have taken place in the last decade.

5. Conclusions

Place marketing strategy plays a key role in the development of an urban, but the disorder, complex environment, and diversified objects in traditional government make the strategy inefficient. Lots of studies analyze strategy planning in order to improve the efficiency. The complexity theory includes self-organization and dissipative structure theories, which are applied to the management and economic science so as to bring new method for solving the problem, existed in enterprise or place, such as conflict. Through the interaction of the entities, self-organization behavior is firmed and

government becomes prosperous in disorder. Self-organization of place marketing strategy provides flexibility and agility in responding to customer demand shifts. The fundamental premise of this theory is the synchronization represented in multiple autonomous business entities. The paper introduces the self-organization theory into the undeveloped areas place marketing strategy planning, setting up the concept model of self-organization of place marketing strategy and concept of place marketing strategy sustainable development. Its mechanism is developed in the process of simulating the self-organization behavior of strategy planning. It puts forward a new methodology for the management of government. A paradigm is illustrated to show a successful change from the traditional planning to a new self-organization. Finally, an empirical study is given to prove the concept model of self-organization of undeveloped area marketing strategy sustainable development.

Se1f-organization principle is one of important theories in system theory domain, which will become a main methodology in the study of management science, whereas it is always thought to be a little far from the view of application. The paper introduces the new concept model of self-organization of marketing strategy planning, which has both theoretical and practical meaning and is tested by the example of Xian Yang, therefore, develops a new mechanism of marketing strategy sustainable development. In addition, more application research will be done after this to test the concept model further, so as to use it in a wider area.

References

Richard T Pascale, “Surfing the edge of chaos”, MIT Sloan Management Review, vol.40, 3, Spring 1999, pp.83~94).

Kumar, N., 1996. The power of trust in manufacturer–retailer relationships. Harvard Business Review 74 November–December , pp. 92–106.)

Camazine, S, et al. Self Organization in Biological Systems, Princeton University Press, Princeton, U.S.A, 2001.

A. Thanurnarajah “A Self-Organizing Model for Scheduling Distributed Autonomous Manufacturing Systems”. Cybernetics & Systems ISSN 0196-9722. Volume 29, N.5 (1998). pp461-480.

C. Sohier, B. Denis & Bourdet “Applying eco problem solving to the control of an adaptative manufacturing cell”. CESA’96: IMACS-IEEE Multi-conference on Computatiaonal Engineering in Systems Applications. July 9-12, 1996. Lille, France.

Pierre Massotte, Roland Bataille, “Future production systems: Influence of self-organization on approaches to quality engineering”, International Journal of Production Economics 64 (2000), pp.359~377

Zhang Lei, et al, “Self-organization simulation and output analysis”, IEEE 2000, pp.603~608

Tom Peters. Thriving on ChaosHandbool for Management Revolution. New York: Alfred A. Knopf, 1988.

H. Haken, Synergetics, Springer, Berlin, 1978.

J. Lorigny, Les, Systems Autonomes. Dunod, Paris, 1992.

H. Ulrich and G. J. B. Probst edited, Self-organization and Management of Social Systems, Insights, Promises, Doubts, and Questions, Springer - Verlag, 1984.

I Prigogine1, “Self - Organization in Non - Equilibrium Systems”.Wiley , New York , 1985. 168 - 1991

Herman Haken, Advanced Synergetics, Springer Verlag, 1983.

Wen-bin Zhang, Yun Pu “Supply Chain Management on Self-Organization”, Journal of Transportation Engineering and Information, No.1. Vo1.2. Mar.2004.

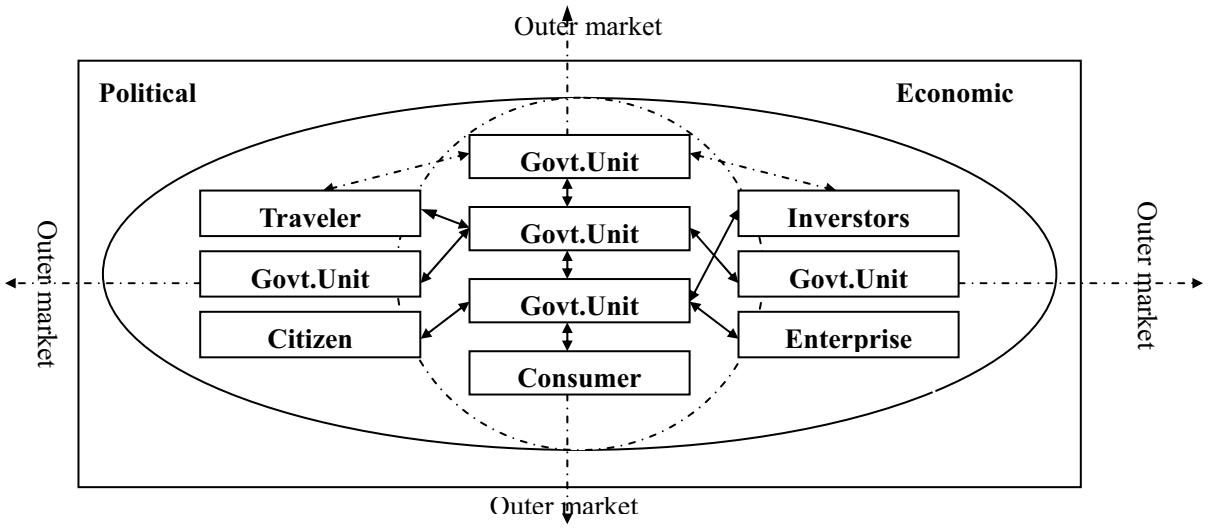

Figure 1. Concept Model of Place Marketing strategy

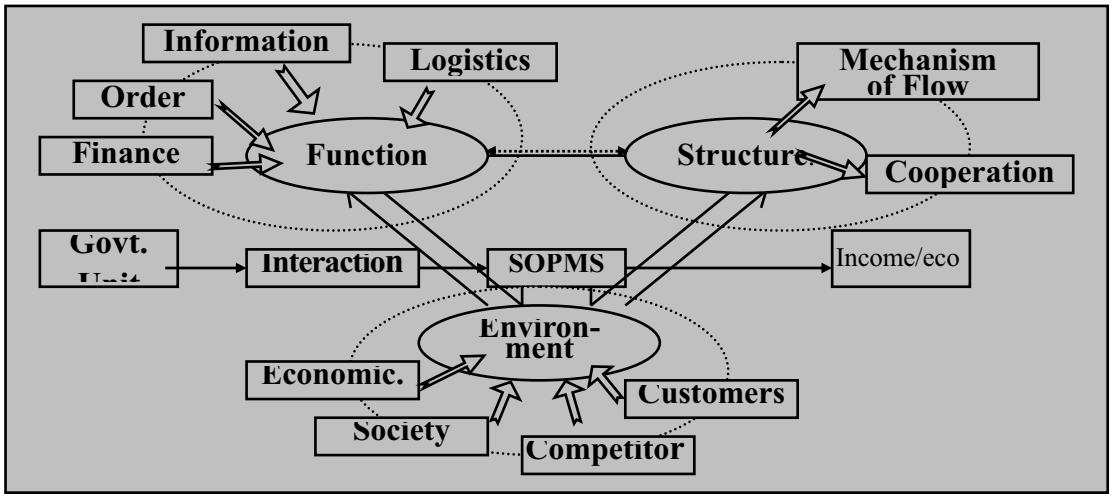

Figure 2. The Mechanism of Self-Organization Place Marketing Strategy

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TSA: An Expert System for Solid Waste Transfer Station

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Abstract

This paper presents the development of expert system to assist in the operation of solid waste transfer station. The knowledge based consists of a rule-based expert system for the diagnosis of site selection and problems of transfer station and subsequent identification of remedial control actions. Siting criteria are used to identifying and evaluating potential development sites. It is generally recognized that an expert system can cope with many of the common problems relative with the operation and site selection of solid waste transfer station. In this work an expert system is developed which supervises the site selection and problem of waste transfer station. The knowledge acquisition to develop this expert system involved an exhaustive literature review on waste transfer station operation plant and interviews with experienced plant operators. The development tool for this system is Kappa-PC.

Keywords: Expert systems, Knowledge acquisition, Solid waste transfer station

1. Introduction

Solid waste is a very general term which encompasses all waste materials except hazardous waste, liquid waste, and atmospheric emissions, although ‘‘most solid waste regulations include hazardous waste within the definition of solid waste’’ (Liu *et al*., 1997). Solid wastes are divided into three main categories: municipal, industrial, and agricultural. Municipal solid waste has several sources such as residential, commercial, institutional, construction and demolition, and municipal services (Tchobanoglous *et al*., 1993). In general, the amount of solid waste has been increasing in urban areas. The more urbanized the area is the higher amount of per capita waste generation.

A solid waste management system consists of prepared plans and plants that are built for final disposal of waste as well as recycling, reuse, composting, and incineration (Liu *et al*., 1997). The municipal solid waste management system deals with the municipal solid waste from its source of generation until its final disposal, which includes all the operations and transformation of this waste.

Transfer station is one of the elements in solid waste management system. It plays an important role in a community’s total waste management system, serving as the link between a community’s solid waste collection program and a final waste disposal facility. (Tzipi *et al*., 2007) While facility ownership, sizes, and services offered vary significantly among transfer station, they all serve the same basic purpose which is consolidating waste from multiple collection vehicles into larger, high-volume transfer vehicles for more economical shipment to distant disposal sites (US EPA, 2001).

The objective of the research is to develop an expert system for solid waste transfer station. It also expected can overcome most of the problems encountered in solid waste transfer station plant.

1.1 The Solid Waste Transfer Station

Transfer stations are an integral part of present-day in municipal solid waste management systems. The main criteria used to decide on the location of a transfer station has traditionally been the minimization of transport costs, since it is cheaper to transport great amounts of waste over long distances in large loads than in small ones (Bovea *et al*., 2007) Where the distance from the waste collection area to the waste treatment facility is large, a transfer station may be used to bulk up the waste for more efficient transport by a larger truck (Bovea *et al*., 2007).

According to Gil & Kellerman (1989), there are three reasons why transfer stations are useful. First, because small or medium sized communities may not generate sufficient waste to support a disposal facility. Second, if the distance to the disposal plant is long the use of small collection trucks may be unnecessarily high. Third, the location of a single disposal plant in a remote location to serve several communities will remove negative environmental impacts from residential areas.

The main criteria used to decide the feasibility of incorporating a transfer station into a waste management system has traditionally been the minimization of the economic costs of transport to and from the station, since it is cheaper to transport large amounts of waste over long distances in large loads than in small ones (Tchobanoglous *et al*., 1993). In its simplest form, a transfer station is a facility with a designated receiving area where waste collection vehicles discharge their loads. The waste is often compacted then loaded into larger vehicles for long haul shipment to a final disposal site usually a landfill (USEPA, 2001).

2. Expert System for Solid Waste Transfer Station

An expert system is a computer system that attempts to replicate specific human expert intelligent activities. Typically, expert systems enable users with a problem to consult a computer system as they would an expert advisor to diagnose what may be causing a problem and figure out how to solve a problem, perform a task, or make a decision. (Mockler & Dologite, 1992).

Expert systems are designed to solve real problems in solid waste transfer station which normally would require a specialized human expert to handle. Therefore, building of an expert system involves extracting the relevant knowledge from the human expert. Extracting heuristic knowledge from the expert in a way that can be used by a computer is generally a difficult task, requiring its own expertise. This knowledge extracting and expert system development was done by a knowledge engineer.

According to James (1990), expert systems have a number of distinct advantages as well as disadvantages when compared to other solution such as conventional software or human problem solvers. It can be beneficial for organizations that have clear objectives, rules and procedures. Expert systems can (James 1990): (1) Provide consistent answers for repetitive decisions, processes and tasks. (2) Hold and maintain significant levels of information. (3) Reduce employee training costs. (4) Centralize the decision making process. (5) Create efficiencies and reduce time needed to solve problems. (6) Combine multiple human expert intelligences. (7) Reduce the amount of human errors. (8) Give strategic and comparative advantages creating entry barriers to competitors. (9) Review transactions that human experts may overlook

Although significantly advantageous to many entities, limitations of expert systems may arise through (James 1990): (1) The lack of human common sense needed in some decision makings. (2) The creative responses human experts can respond to in unusual circumstances. (3) Domain experts not always being able to explain their logic and reasoning. (4) The challenges of automating complex processes. (5) The lack of flexibility and ability to adapt to changing environments. (6) Not being able to recognize when no answer is available.

3. Methodology

3.1 Components of Expert System

There are three basic components in expert system which are a knowledge base, a user interface and an inference engine (Jayawardhana *et al*., 2003). The knowledge base contains knowledge necessary for understanding, formulating and solving problems. It includes two basic elements: (1) facts in its various states, and (2) rules that direct the use of knowledge to solve specific problems in particular domain. Modification of knowledge base is important in most engineering domains, since knowledge is continually changing and expanding.

The user interface is the part of the program that controls the conservation between user and computer. User interfaces can be defined as the point where users interact with a computer system (Mockler & Dologite, 1992). The user interface determines whether the conversation consists of selecting items from menus, responding yes or no to question or filling in forms. The user interface is also responsible for the degree to which the system can explain its solution otherwise assist users (Meng & Frederick 1996). The inference engine is the heart of the expert system since this is the part of the program that builds the bridge between information and solutions.

According to James (1990), generally the stages of expert system development are: (1) Task analysis. The first stage of developing an expert system involved analysis of the tasks with the main objective was to identify and understand the problem to be solved. The scope of domain in this research is solid waste transfer station which consist tasks and subtasks as shown in Table 1. The tasks involved in waste transfer station are types of waste accepted, siting criteria, design of transfer station, and benefit of transfer station, problems and operations of transfer station. (2) Knowledge acquisition. Knowledge acquisition is the knowledge engineering job of acquiring and organizing the knowledge needed to develop an expert system. It involves organizing and representing the knowledge in a way that ensures an accurate replication of the knowledge and the decision situation in a form useful for transferring to a computer system. There are two stages of knowledge acquisition in this research. The first stage involved a knowledge acquisition from written sources. Table 2 shows a list of textual sources used to acquire the knowledge for the prototype. The second stage involved interacting with domain experts through unstructured interview and observation in the field. (3) Prototype development. In this stage, knowledge expertise will be transform into computer programmed. In developing prototypes, an effort is made to select only the most critical factors and show only their most basic relationship, in order to test the underlying structure and concept of the system. Rules are written for the knowledge base in this development stage. IF-THEN rules are the common way to represent knowledge in current expert systems. The rule contain premises or conditions in the IF clauses, and conclusions in the THEN clauses. IF-THEN rules in expert systems can be modified easily to meet changing needs. Hence, it was easy to update. It also has the capability to ask users questions about information needed to deal with specific problems during consultations. (4) Expansion and refinement. This stage required the expert to add more knowledge expertise into the knowledge base of the prototype. The prototype reviewed repeatedly and rapidly until a sufficiently satisfactory prototype is achieved. (5) Verification and validation. An important step of an expert system development process is the evaluation of the performance of the systems, which involves both verification and validation. It is very important that expert systems are verified and validated before their effective employment in the intended user environment. In consultation process, the performance of the system must be similar to the expert's prediction.

3.2 Development Tools

Expert system can be developed by using conventional programming and expert system shell. Expert system shells contain such components as inference engine programs, programmed control mechanisms for managing the knowledge base, facilities for explaining how and why conclusion was reached, and capabilities for storing and editing knowledge bases. For these reasons, expert system shells can be easier and quicker to use than programming language. The example of expert system shells are ESIE, VP-Expert and JAVA. For this research, Kappa-PC was selected as a development tool because it is suitable to be use in limited time and has substantial object capabilities.

4. Result and Discussion

The expert system in this research is called Transfer Station Advisor (TSA). The architecture of TSA is shown in Figure 1. The knowledge base of TSA consists of six modules: (1) types of waste accepted, (2) siting criteria, (3) transfer station design, (4) transfer station operations, and (5) problems of transfer station, as shown in the main interface (Figure 2). Below are discussions of main modules in TSA.

4.1 Types of waste accepted module

Some transfer stations also offer programs that manage specific materials separately to divert waste from disposal and to achieve recycling objectives. These materials could include construction and demolition debris, yard waste, household hazardous waste, or recyclables. The types of materials processed often vary depending on where the facility is located (urban, suburban, rural) and who owns and operates the operation at the transfer station. The types of waste that are commonly handled at transfer stations are municipal solid waste (MSW), residential, commercial, and construction and demolition.

4.2 Siting Criteria Module

Identifying a suitable site for establishment of a waste transfer station can be challenging. It is therefore useful to undertake a transparent site selection process to determine an appropriate site for development. This module has three components which consist of environmental, technical as well as community and social siting criteria. Under each components still have theirs subcomponents for user guideline and problem solver that user will face during site selection. Figure 3 shows user the main interface of the siting criteria. In order to locate transfer station, technical and environmental aspects must be considered.

4.2.1 Technical siting criteria sub-module

This sub-module provides specific engineering, operation and transportation conditions that should be taken into account to ensure that potential sites are suitable to build up a transfer station. For example: central location to collection routes. As a rule of thumb in urban area, transfer station should be less than 2 km away from the end of all collection routes. This is because the aim we build transfer station is to save money and transportation fuel. If we

broken this rule, the objective for build a transfer station for community cannot be achieve. Figure 4 show that the components in technical siting criteria interface.

4.2.2 Environmental siting criteria sub-module

Land use, geology, groundwater, surface water, ecology, visibility, traffic and topography are important in environmental siting criteria. This sub-module gives guidance to the user on how to reduce environmental impacts during the development of transfer station (Figure 5). As a result, site topography should be taken into consideration to reduce the prevalence of potential wind blown litter and to minimize the number of vantage points that the site is visible from (US EPA, 2001). The impact of site topography on construction requirements should also carefully considered because a transfer station with well equipped will reduce the amount of excavation works and additional fell requirements (US EPA, 2001).

4.2.3 Community and social sub-module

The third category of criteria to consider is impact that the facility will have on the surrounding community. These criteria are typically less technical in nature and incorporate local, social, and cultural factors. Examples of these criteria include environmental justice considerations (e.g.: clustering, cumulative impacts), impact on air quality, impact on the local infrastructure, proximity to schools, churches, recreation sites, and residences, number of residences impacted, impact on historic or cultural features, impact on neighborhood character and impacts on existing businesses.

4.3 Design of Transfer Station Module

Most activities at a transfer station occur within the main transfer building. A good site layout will ensure the operations of transfer station are more efficient. Two other factors should be considered were vehicles and technology used by the transfer station.

Site layout of the transfer station must include road entrances and exits, traffic flow routes on site, queuing areas, reception area, buildings, fence and gate, weighing bridge, holding area, unloading platforms and buffer areas. Lack of one component will cause the functions of the transfer station are not efficient. Figure 6 shows the layout of transfer station.

4.4 Transfer Station Operation Module

Although the basic function of a transfer station as a waste consolidation and transfer facility is straightforward, operating a successful station involves properly executing many different tasks. Some tasks are routine and easily understood, while others occur infrequently and might be difficult to conduct properly without step-by-step directions. This module provides guideline to the users that can assist in operating transfer station successfully which consist of operations and maintenance plans, facility operating hours, interacting with the public, waste screening, emergency situations, record keeping and guideline for emergency events.

4.5 Problem of Transfer Station Module

Traffic, noise and odor may exist around solid waste transfer station. Beside that, improper designed or operated of transfer station may cause air emissions, vectors and litter. A good design and positioning of transfer station can reduce all the problems significantly. This module provides possible solutions to overcome most of the problems encountered at the transfer stations.

4.6 IF-THEN Rules

The example of rules developed in TSA is described briefly in this section. Figure 7 show rules for emergency situation. If *power failure* occurs at transfer station, then the operator should have backup power generations so at least some operations can continue during power failure.

Other rule is *injuries to employee* which can effect the operation of station. If it happened, operator should have first aid procedures, emergency phone numbers and routes to nearby hospitals.

4.7 Case Study

The most challenging part of building an expert system is testing. The basic motivation behind testing is to control performance, efficiency and quality of the knowledge base. The goal is compliance with user expectations and system functioning. Validation of an expert system means to make certain that the advice given by the system will be valid in all of its applications. As a summary, TSA must act like a human expert.

In order to validate and verify the TSA, a case study has been carried out at Ampang Jajar Transfer Station situated at Seberang Perai, Pulau Pinang. The operation of this transfer station was started in 2002 and it using a vertical compactor system. Data such as generation rate, types of waste accepted, hauling distance, and disposal area are collected. From the collected data, this transfer station handled 350 tons of domestic and garden waste per day and

disposed at Pulau Burung Landfill. A validation has been carried out using those data and the final conclusion of the system was expected and consistent with the predictions of the domain expert.

4.8 End users

Persons who involved with transfer station operation and solid waste management are targeted end users of TSA. Typically, supervisors of transfer station are responsible for the operation of transfer station. Thus, the TSA expectantly can help them to make a quick solution of the problems encountered during the operation. The user-friendly characteristics of TSA make the system easily to use without any knowledge in computer programmed.

5. Conclusions

TSA is developed for the diagnosis of solid waste transfer station by using Kappa-PC shell. Hopefully, the prototype can overcome most of the problems encountered in transfer station design and operation. The knowledge base of TSA consists of expertise which is acquired from multiple sources. A secondary data are collected in order to verify and validate the prototype. As conclusion, expertise in TSA was expected and consistent with the predictions of the human expert.

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We would like to express our appreciation to the experts from Ampang Jajar Waste Transfer Station and Pulau Pinang Waste Transfer Station for their willingness to spare their time for the interview sessions and site visits.

References

Agamuthu, P. 2001. Solid Waste: Principles and Management. Institute of Biological Sciences, University of Malaya Kuala Lumpur, Malaysia.

Bovea, M.D., Powell, J.C., Gallardo, A. & Capuz-Rizo S.F. 2007. The role played by environmental factors in the integration of a transfer station in a municipal solid waste management system. *Waste Management* 27(4): 545-553.

Department of Environment and Conservation, NSW. 2006. Handbook for Design and Operation of Rural and Regional Transfer Station.

Gil, Y. & Kellerman, A. 1989. A multicriteria model for the location of solid waste transfer stations: the case of Ashdod, Israel, Mimeo, Department of Geography, University of Haifa.

James, P.I. 1990. A brief introduction to expert systems. *Computers & Operations Research.* 17(6):523-533.

Jayawardhana, L.C., Aruna Manipura, Ajith De Alwis, Malik Ranasinghe, Sumith Pilapitiya & Indrika Abeygunawardena. 2003. BESTCOMP: Expert system for Sri Lankan solid waste composting .*Expert Systems with Applications* 24(3): 281-286.

Liu, D.H., Liptak, B.G. & Bouis, P.A. 1997. Environmental Engineers Handbook, second ed. Lewis Publishers, New York.

Meng, S.W. & Frederick, W. 1996. An Expert System for Waste Management. *Journal of Environmental Management* 46(4): 345-358.

Mockler, J. & Dologite, D.G. 1992. Knowledge-Based System: An Introduction to Expert Systems. Mcmillan, New York.

Tchobanoglous, G., Theisen, H. & Vigil, S. 1993. Integrated Solid Waste Management. McGraw-Hill, New York.

Tzipi, E., Mira G.B., Mordechai, S. & Ofira, A. 2007. Measuring externalities of waste transfer stations in Israel using hedonic pricing. *Waste Management* 27(5): 614-625.

US EPA. 2000.Waste Transfer Stations: Involved Citizens Make the Difference. EPA530-K-01-003. Office of Solid Waste and Emergency Response,Washington.

US EPA. 2001.Waste Transfer Stations: A Manual for Decision Making. EPA530-K-01-005. Office of Solid Waste and Emergency Response,Washington.

Table 1. Task analysis in Transfer Station Advisor

Module	Function
Types of waste accepted	Module supervising the types of waste commonly handled at transfer stations and specific materials separately manage by transfer station.
Siting criteria	Module supervising the criteria for identifying a suitable site for waste transfer station depends on technical, environmental and community criteria.
Transfer station design	Module supervising the layout of the transfer station site's major features and vehicle and technology that use by a waste transfer station.
Benefit of transfer station	Module supervises the benefit of building a waste transfer station at our waste management.
Transfer station operations	Module supervising the operations issues and suggests operational practices intended to minimize the facility's impact on the community.
Problems	Module supervising the problem that may exist around waste transfer station and also the matter of solving the problem.

Table 2. Source of knowledge base

Author	Year	Title	Publisher
Agamuthu, P	2001	Solid Waste: Principles and Management.	Institute of Biological Sciences, University of Malaya, Malaysia.
Department of Environment and Conservation NSW	2006	Handbook for Design and Operation of Rural and Regional Transfer Stations	Department of Environment and Conservation NSW
Mockler, J. & Dologite, D.G.	1992	Knowledge-based system: an introduction to expert systems.	Mcmillan, New York.
Tchobanoglous, G., Theisen, H. & Vigil, S.	1993	Integrated Solid Waste Management.	McGraw-Hill, New York
USEPA,	2001	Waste Transfer Stations: A Manual for Decision-Making	EPA(530-D-01-005)
USEPA	2000	Involved Citizens Make the Difference	EPA(530-K-01-003)

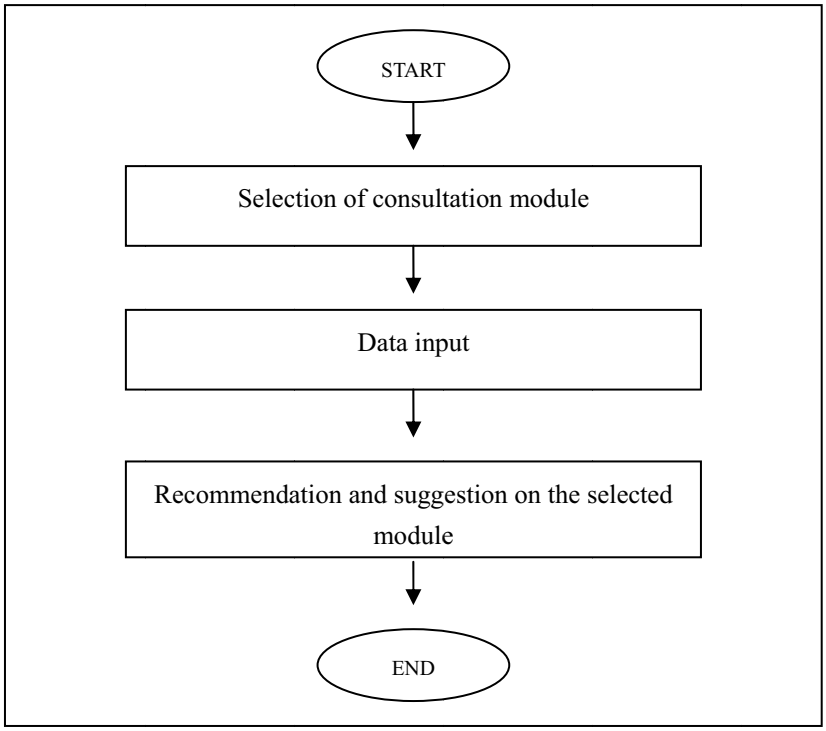

Figure 1. Architecture system of TSA

Figure 2. The main interface of TSA

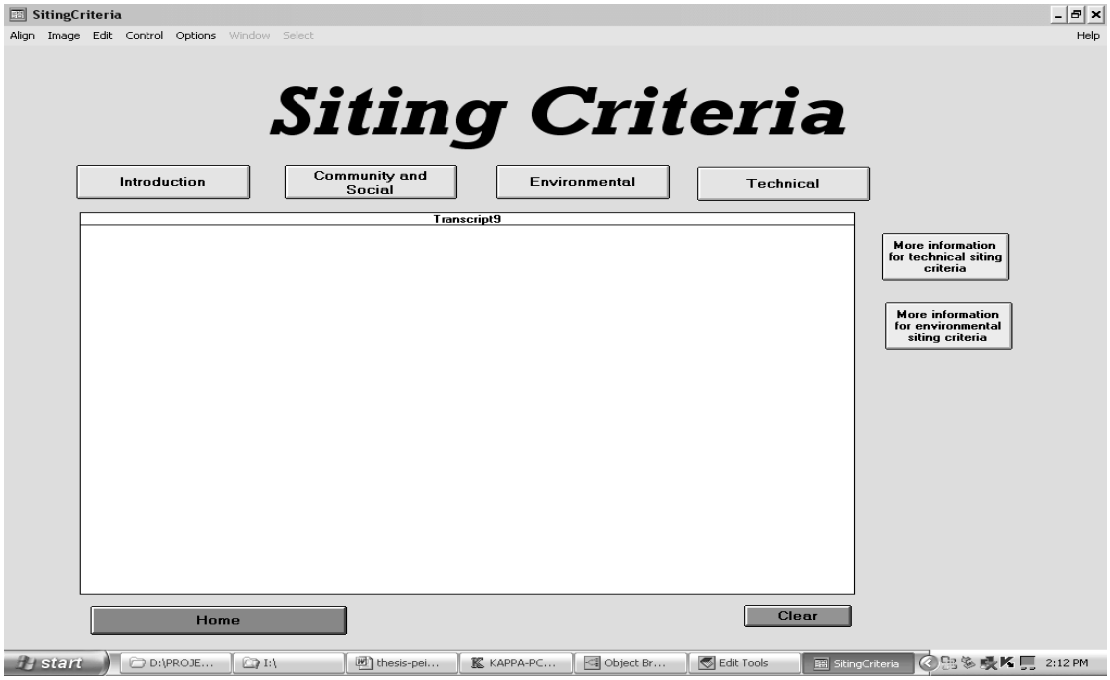

Figure 3. The main interface in siting criteria module

Figure 4. The technical siting criteria interface in TSA

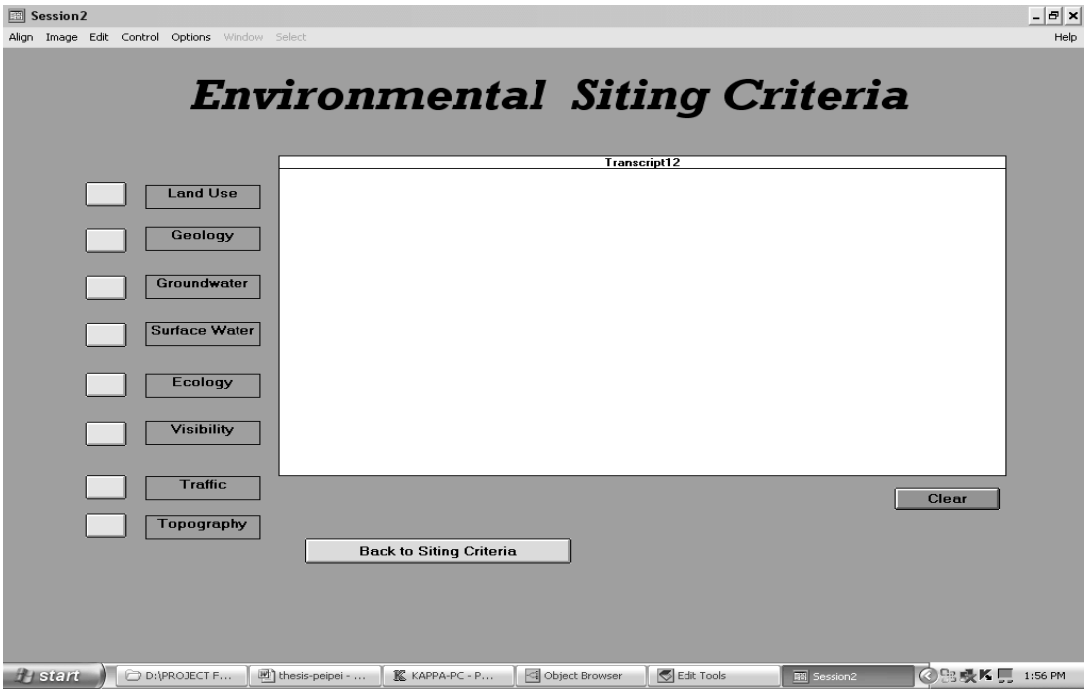

Figure 5. The environmental siting criteria interface of TSA

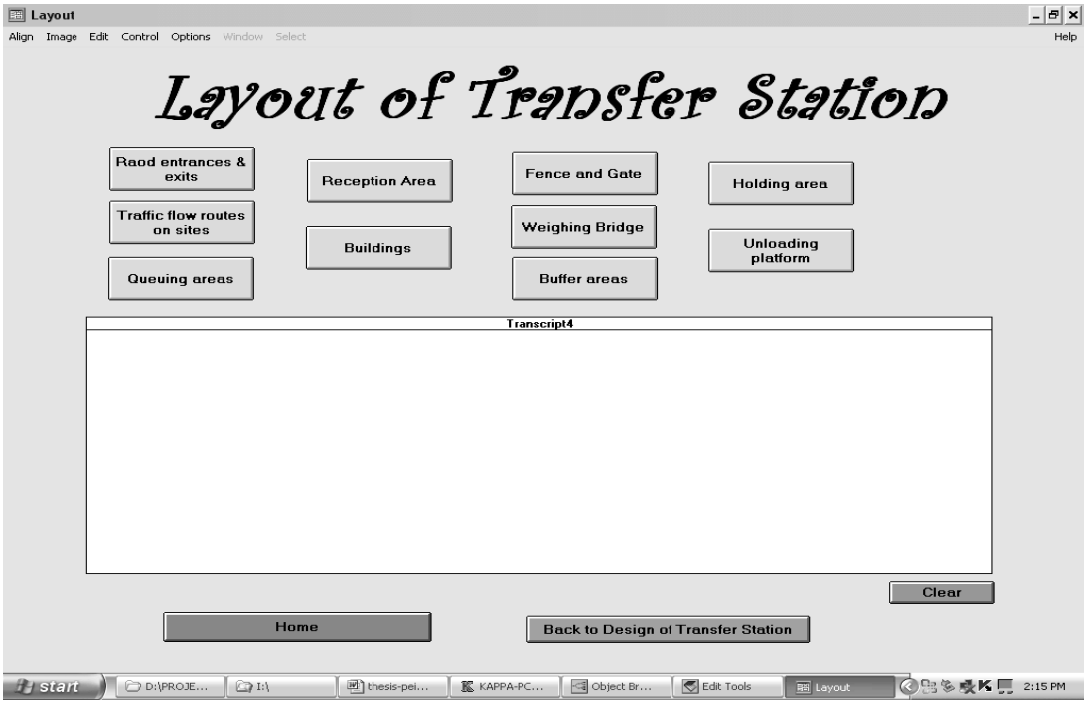

Figure 6. The layout of transfer station interface of TSA

```
RULE Emergency

    IF    Emergency: PF = TRUE;

      THEN    Backup power generations so at least some operations can continue
              when power failure.

RULE Emergency

    IF    Emergency: INJURIES = TRUE;
```

Figure 7. Examples of IF-THEN rules

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Conflict between Developing Economic and Protecting Environment

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Abstract

The economy growth is always the attention focal point to every country. The economy growth impact the protecting environment, on the contrary the protecting environment also impacts the economy growth. Whether the environment is a factor considering the economic growth? The core answering these questions is how to regard the relationship between economic growth and environment. Concerning on the situation of economic and environment whether has the intrinsic relation or has any type relation, this still has the dispute. In this essay I will analyze the conflict between the developing economic and protecting environment. Through the analysis cause where can get a balance between them.

Keywords: Environment, Economic growth, Poverty, Conflict, Contradiction, Environmental Kuznets curve

1. Introduction

Environment not only provides the substance foundation and activity space for human, but also is responsible for production castoff by human activity. Economic development not only enhances the integration national power and improves the people's life quality, but brings a number of serous environmental problems, such as air pollution, water pollution, soil degradation, desertification, and so on. Whether does economic growth affect the environment? On the contrary whether also does the protecting environment affect the growth economy? Whether is protecting economy and protecting environment a pair of contradiction or not? What creates the environment problems? Poverty is a main factor. Solving this problem is that developing economy. How to increase economy under the protecting environment? Analyzing their relationship is the focal point. Problem formulation: what is the conflict between developing economic and protecting environment?

2. The developing economic brings some environmental problems

Economy development is obvious at present. Many multinational enterprises have been invested following the all kinds of increased industries and agricultures. These such as machine, textile, chemical plant, foodstuff, and so on, not only are the record of the economic development, but also provide a great deal of working opportunities for the labor market, and reduce the burden of the country. That's the positive points, but it has the negative points like the traffic jam, pollution, chemical, etc, a series of serious problems.

In the traffic point, "The environment impact of transport has now become a global issue. Environmental impacts from transport in the developed world are now equaled or exceeded by those in developing countries. This is alarming given the relatively low level of car ownership and use in developing countries. Equally alarming is the advanced of modes of transport that are damaging to the environment and health, while less damaging modes are retreating. The impact of transport affects the global, regional, and local environment. It is at each of these levels that action needs to be focused in order to reduce and mitigate the impact on the environment." (1) The gases like $C0_2$, SO_2, NO_X from the transport directly impact the climate with rising temperature resulting the global warming. "Global warming has number of

effects and may result in change in climate, especially rainfall patterns which increase the likelihood of more intense tropical storms and will have significant consequences for agriculture production. Rising sea levels due to thermal expansion of the ocean and melting of glaciers will pose a threat to wetlands. Pacific islands and atolls as well as large areas of the world's densely populated coastal regions. Increasing levels of risk and costs associated with accelerating coastal erosion, flooding and increases in salinity of estuaries and aquifers can be expected."(2)

Economic development, through its indirect impact on social and cultural factors, lowers fertility rates. A concern for population growth must be a part of a broader concern for a more rapid rate of economic and social development. Increasing the population, the population density in the city are getting bigger and bigger, the pollution problems from burning coal, grey water and solid waster from household also become serious. At the same time, lessen of urban virescence area lowers the environmental purification capacity leading to the more intensive pressure to the environment. On the other hand, following the increasing economy, people from countryside who invade the cities and towns with certain dimensions not only baffle the urban development, but cause a series of environmental issues, such as air pollution and lack water resource.

3. Building capacity for environment policy

What is capacity for environmental protection? "A society's ability to identify and solve environmental problem, generally speaking, the capacity problem is not specific to the field of environmental policy. It can be found also in other policy fields. Lack of ecological, technological or administrative knowledge, lack of material or legal resources, the weakness of environmental organizations or institutions in relation to vested interests are well-known examples of such limitations. The main implication for the debate on sustainable development is that long term strategies must include concepts for improving the conditions of environmental capacity building." (3) In a country, the centre government is the authority to make the policy, regulation and the planning. Moreover the environmental protection agency is governed. When its economic strength and science and technology still remained at a low level, active public participation in environmental protection could be more effective at a lower cost. The public participation is like individuals, student groups, social groups, and semi-governmental organization. Particularly in the recent years, various public media has been increasing, such as television, internet, environment newspaper, many major newspapers, journal and magazines. Through adsorbing public opinions, spreading the public participation and increasing the performance of the law and regulation, government can revaluate and revise the policies in order to carry out the environmental impact assessment for the all kinds of pollution enterprises. To build the capacity for environmental protection, getting some difference voice from the non-governmental proponents is the very necessary. "There are three important groups of environmental protection, all of them able to influence polluters directly:

Environmental organizations

The media

Ecological innovative firms,

They are the factors in environmental improvements within industry."(4) Government environmental protection institutions can adopt the proponents of environmental policy from the non-governmental interest organizations to build the capacity of environmental protection. Public participation has gained the significant success, but intervention limitation reduces the public participation efficiency. How to efficiency organized the public participation groups is a challenge to solve the environmental problems. At the same time, the government should not only cooperate with them, but support the finance assistance and give the power to them.

4. Analysis the conflict between economic and environment

The effective implementation of market mechanism's precondition is a clear property right system, if only privatizing the property right to individual, the government could manage and implement the requirements of environmental protection and run in a sustainable way. Economic rationalism is a branch of market mechanism to achieve public ends. The market is a powerful tool to change individual and institutional behavior. If success, they can achieve environmental objective at less cost and with less opposition tan traditional regulatory approaches. Economic rationalism plays out in different ways in different societies, but it focuses on the conversion of environmental resources to private property. "Markets are systems based on commodity exchange, in which goods, service, and financial instruments are exchanged for each other. Markets work smoothly to the extent that participants in transactions can be confident that they do in fact have a right to sell or buy the goods in question ---in other works, they have property right, be it to a car, a can of beans, a company, a bond, or a piece of land. If we are to have markets in environmental goods, then we need private property rights in these goods too. According to economic rationalism, specification and enforcement of these rights is the main task of government when it comes to environmental matters. People tend to care more for what they hold privately than for what they hold in common with others; this is why there is more litter in public parks than in private gardens, or why public grazing land in the American west is more degraded than the private land."(5) For example in China the present economy is located with the innovation phase. The national enterprises

have transformed the private sector and joint-stock ones, the bigger bank also start developing the stock system, the environmental agency is beginning to innovate and catch the opportunity to form an effective and efficiency monitoring of market mechanism to control destruction and improve the environmental protection.

4.1. Poverty creates the ecological environment degradation

Poverty is one of the main causes of the environmental degradation. "inadequate technical know-how and managerial capabilities, common poverty resource management, and pricing and subsidy policies have been the major themes addressed and the solution suggested have been essentially techno-economics ones. Deeper socio-political changes or changes in cultural values are either ignored or paid lip-service."(6) In the figure 1 showing a more realistic representation of the poverty environmental degradation

Increasing economic is a main operational objective to solve the problem between poverty removal and protecting environment. Economic growth may occur simultaneously with either an improvement or deterioration in environmental quality. In order to analyze the deeper detail cause between developing economic and protecting environment, a relative case study from the countryside and urban in China will be provided in the following text.

4.2. A case study from the countryside and urban in China

On the one hand in the countryside, the poverty reclaims wasteland to cause soil erosion, herded to the sparse lawn causes the prairie degenerate; cut the tree to burn the firewood to destroy the forest resources. This perspective although makes reasonable and possibly is in reality some phenomena, but this is some superficial phenomena frequently. The soil erosion serious time, is our country implements "regards grain as the key link" the policy time. The north prairie degeneration in the very great degree is the result of the country summoned to open up wasteland and lawn to plant grain massively, in the annual rainfall insufficient 400 millimeter places, the land plowing very quickly causes the sand. But the our country forest resources two large-scale destructions was in 1958 builds up the steel and iron time greatly, another was 20th century at the end of 70's countryside management system moments change time. Therefore, these government policies in the formulation time has not carried on the sufficient environmental risk assessment, only then has created the serious ecological environmental problem. But in fact, farmer when daily life and practical training, protects the local recourses. The farmer often plants the trees nearby the around house, regards them for to protect the village forest, the scenic forest. The activities of the farmer participating in the over-cutting forest mainly are the policy with the national forestry and the power to concern. If the forestry policy is changeable, the forestry land right of management, the usufruct are unstable, "public resource tragedy" no matter can occur in wherever.

On the other hand in the urban, cause environmental problems which the humanity pays attention, first occurs in the city. In an each one very small city space, is gathering the massive population is carrying on the massive productions and the life activity, massively discharges the pollutant is unable promptly to dissipate, the dilution, decomposes and disperses, causes the serious air pollution, the water pollution, the waste pollution and the virulent harmful dangerous material harm. The city since long ago in particular is far away impoverished. But along with urbanized advancement speeding up with the industrial structure adjustment, a city poverty crowd is forming. China condition is that the urban environmental pollution in quite is also serious, the city poverty problems already reappeared. But in policy stratification aspect, also does not have a system on the city to reduce poor arrangement. On the one hand, the city poor people more receive the environmental pollution harm. When the city drink water is polluted, the poor person does not have the money to by the mineral water; when the air pollution is serious, the poor person does not have the money to buy the air cleaner. When treatment environmental pollution, if does not have the advantageous policy arrangement, the poor person possibly bears the big share treatment expense. In a sense, the poor person more exposes during the environmental pollution, possibly more receives the virulent harmful waste harm, and thus is sick and the risk is bigger. When the poor person contracts slight illness, with the very high proportion perhaps the human choose does not go see a doctor, economizes is important consideration, because the present medical expense rate of rise is higher than the people to receive the level greatly the rate of rise, this further increased the poor person to contract the big sickness, when the risk once trouble big sickness, poor person's living standard rapidly will drop. Because sickness returns poorly, forms a poverty big reason.

4.3. Analyzing the conflict using Environment Kuznets Curve

The economy growth is always the attention focal point from every country. Whether can the economy growth restricted by environment? Whether can the environment improved impel the developing economy? Whether is the environment a factor when considering the economic growth? The core answering these questions is how to regard the relationship between economic growth and environment. Generally speaking one economy in the certain time with biggest productivity can be decided by the use economy resource at that time. Therefore the increased speed and potential of the economy are decided by its economical resource total quantity and development way. In the traditional economic development opinion industry growth (GDP) is regarded as only symbol, and realizing the national industrialization and industry civilization also is a symbol. In the realistic economic life this development opinion performs a goal for gross

national production and rapidly increasing. But in the traditional opinion a country with high GNP is a country with successful economy and prosperity. Pursued GNP growth became a goal and power for national economy. From the developed country or developing country one-side pursuing GNP brings a serious outcome: the environment worsens, resource shorten, people welfare level dropped and so on. Why is like these, because this type of economy is not based on the ecology foundation. On contrary in some countries sacrificing environment replaces development. The result is the ecosystem is broken, and finally development economy can't be persisted without perfect ecosystem. In present GNP index not only natural resource and environment quality didn't be reflected, but also the resource price and environment price for economic growth didn't be stated in a country. With more pollution and more resource consumption the increasing GNP is faster. It displayed the boom economy has the very big falseness in the traditional economic development opinion. In fact understanding the relationship between economic growth and development has mistakes. The development is broader than the growth. Development not only is the output increased, but also includes environment quality improvement.

According to the Environmental Kuznets Curve (The environmental Kuznets curve is a hypothesized relationship between various indicators of environmental degradation and income per capita. In the early stages of economic growth degradation and pollution increase, but beyond some level of income per capita (which will vary for different indicators) the trend reverses, so that at high-income levels economic growth leads to environmental improvement.) Showing in figure 2, in the early period of developing economic pollution increases and reaches a maximum level and eventually starts to decrease following the rising income.

The environmental Kuznets curve states along with the developing economy and increasing income and enhancing environment awareness the people will start a good quality environment. The enlargement of environment protection investment and environment quality makes up the early time to loss and keeps the dynamic balance of environment quality supply and demand. Finally the environment quality and economy will synchronization positive cycle with increasing capacity of investment and increasing sustainable development. For example in China near for 15 year the environment Kuznets curve matches for 15 fast economical development with the economy launching phase, industrialization and town industries. The requirement of resource is increased greatly and the pollution charge also is increased rapidly. All these indicated our country the economy development is being at the transformation stage because the coarse type of economy growth didn't changed at all. In the next period the environmental Kuznets curve must display the ∩ horizontal stage for quite long. Here also have a figure 3 to explain conflict between economy and environment.

From the below figure 3 showing, the economic affects pollution; on the other hand pollution also affects income. First, income directly influences the environmental quality because pollution is the environmental by product. In environmental quality increasing improvement demands always accompanies the growing income through some driving forces such as public and individual control measurement, technological progress, and structural changes in consumption, production, international trade and institutions, pollution reduced, and the relationship between income and environment would also be influenced by some exogenous variables such as traditional production factors, policies, population density and variables. Second the pollution activity on production is also multiple. (1) Pollution is the negative externality directly reducing output and productivity per capital and labor. (2) Since emission permit with greater levels may increase the availability of more human and per capital for production when enterprises reduce pollution emission, their production costs are raised and outputs are reduced.

The development economy and the protection environment, sometimes, are contradictory in particular in the short-term. But this kind of contradiction had the condition, in the majority situation, this kind of contradictory performance is, protected the environment request to reduce the development path choice space. In the reality, this kind of space nearly always exists, sometimes possibly needs us to develop. A typical example is, Sweden for protects in the 20th century 70's the environment when forbids the use leaded gas gradually, at first estimated this can increase the use gasoline cost. When, to forbid the leaded gas use completely, the new technology is created, not only can substitute the lead function, but also the new technology is cheaper. The final result is, polluted was eliminated, the cost also reduced, the mew technical choice has avoided the development and the environment contradiction. Moreover, manages the good eco-tourism, also can while obtain the economical development, protects the resources environment. The development economy and the protection environment are pair of contradictory, must get rid poverty, must endure the certain time the environmental pollution or the ecology degeneration; must protect the ecological environment, must endure poorly.

Removal poverty and protecting environment is not inevitably contradiction. In the reality they possibly exists the conflict, is always the people technology choice result, is some kind removal poverty way to cause the contradiction which perhaps some protection environment way creates, but the people may choose other ways originally to avoid the two the contradiction which will exist possibly in the near future. In the long-term view, eliminates poverty and protecting environment not only does not have the contradiction, but also nearly always mutually promotes positive cycle. When poverty is removal, people increase to the environment service demand, and people to be more positive

improve the environment on own initiative, at the same time also may have more investments to maintain the good environment. The good environment can provide for the people more new development opportunities. Today obtains more and more many approvals in humanist new conception, the good environment should become human's development essential condition, but no longer is the luxurious demand.

Looking from the economics, the environmental problem is the economic problem. The environmental pollution is caused by the production process with external diseconomy. Namely the enterprise of pollution didn't calculate harm about the pollutant impacting the environment in production cost. Solving the problem the enterprise should put the external diseconomy in the production cost and reflected to the product price. The government department forces the enterprise to carry out this action through the law and regulation and economical tool like environment tax revenue.

5. Conclusion

Whether is the developing economy and protecting environment a pair of contradiction? The answer depends on the economy development stage. In the developed country the developing economy and protecting environment is not a pair of contradiction because of environment improved along with the economic structure changed. But in the developing country it is a pair of contradiction because of environment worsens with a high speed economy increasing. The choice of the industrial structure is a factor affecting the environmental pollution. Generally speaking by agricultural and light industry pollution level low; the manufacturing industry proportion high country the pollution degree can be high inevitably. Technology also is an important indicator to affect the environment. The country of using low technical can consume more resources and more pollution.

In economic development low stage the economic activity is low. In the economy launching phase the manufacture is developed greatly. The result is the resource consumption surpasses the resource generation. The environment worsens in an economical development higher stage. When economic structure changes, the pollution industry stops producing or is sifted. The environmental condition starts to improve. Along with economic development people will pay more attention to the environmental protection. The environmental protection fund also will be increased. The protecting environment meant the fund invested because a lot of environmental protection equipments are very expensive. In the long term, the disbursement and effect of protecting environment is an important factor affecting environment Kuznets curve.

References

David I. Stern: International Society for Ecological Economic, Internet Encyclopaedia of Ecological Economics, the Environment Kuznets Curve, Department of Economic, Renesselaer Polytechnic Institute, Troy, NY 12180, USA June 2003

John S. Dryzek: The Political of the Earth-Environmental Discourses-Part III Solving Environmental Problems, Oxford University Press 1996, page 105. Main course: Policies, Planning and Regulation Related to the Environment, Global, Regional and Theoretical/Methodological Considerations, section 2 lecture 1, page 29

John Whitelegg: Critical Mass, Transport, Environment and Society in the Twenty-first Century, Pluto Oress, London, 1986, page 115. Main course: Policies, Planning and Regulation Related to the Environment, Global, Regional and Theoretical/Methodological Considerations, section 2, page 41

John Whitelegg: Critical Mass, Transport, Environment and Society in the Twenty-first Century, Pluto Oress, London, 1986, page 115. Main course: Policies, Planning and Regulation Related to the Environment, Global, Regional and Theoretical/Methodological Considerations, section 2, page 41

M. Jannicke: The Political System Capacity for Environmental Policy, Berlin 1992. Main course: Policies, Planning and Regulation Related to the Environment, Global, Regional and Theoretical/Methodological Considerations, section 2 lecture 3, page 92

M. Jannicke: The Political System Capacity for Environmental Policy, Berlin 1992. Main course: Policies, Planning and Regulation Related to the Environment, Global, Regional and Theoretical/Methodological Considerations, section 2 lecture 3, page 97

Sharach Chandran M.Lele: Sustainable Development: A Critical Review, World Development, Vol.19, No. 6, pp.60621, 1991, printed in Great Britain, Energy and Resource Group, University of California, Berkeley, page 613. Main course: Policies, Planning and Regulation Related to the Environment, Global, Regional and Theoretical/Methodological Considerations, section 1 lecture 1 page 33

Sharach Chandran M.Lele: Sustainable Development: A Critical Review, World Development, Vol.19, No. 6, pp.60621, 1991, printed in Great Britain, Energy and Resource Group, University of California, Berkeley, page 614. Main course section 1 lecture 1 page 34

Van Ewijk, C and S. Van Wijnbergen, "Can Abatement Overcome the Conflict between the Environment and Economic

Growth?" Vrije Universiteit Amsterdam, 1995

Madhusudan Bhattarai and Michael Hannig: Institutions and the Environmental Kuznets Curve for Deforestation: A Grosscountry Analysis for Latin America, Afria and Asia, Clemson University, South Carolina, USA

Policies, Planning and Regulation Related to the Environment, Global, Regional and Theoretical/Methodological Considerations, Department of Environment, Technology and Social Studies, main course lectures, Roskilde University, Denmark, 2005

Stern, D.T., M.S. Common, and E.B. Barbier: "Economic Growth and Environmental Kuznets Curve and Sustainability Development" world development. Responsible Growth for the New Millennium, Integrating Society, Ecology and the Economy, the World Bank, Washington, D.C. 1996

Jeroen C. J. M. vam den Bergh & Jan van der Straaten: Economy and Ecosystems in Change, Analytical and Historical Approaches. Department of Spatial Economics, Free University, Amsterdam; European Centre for Nature Conservation and Department of Leisure Studies, Tilburg University, Tiburg, the Netherlands,1997

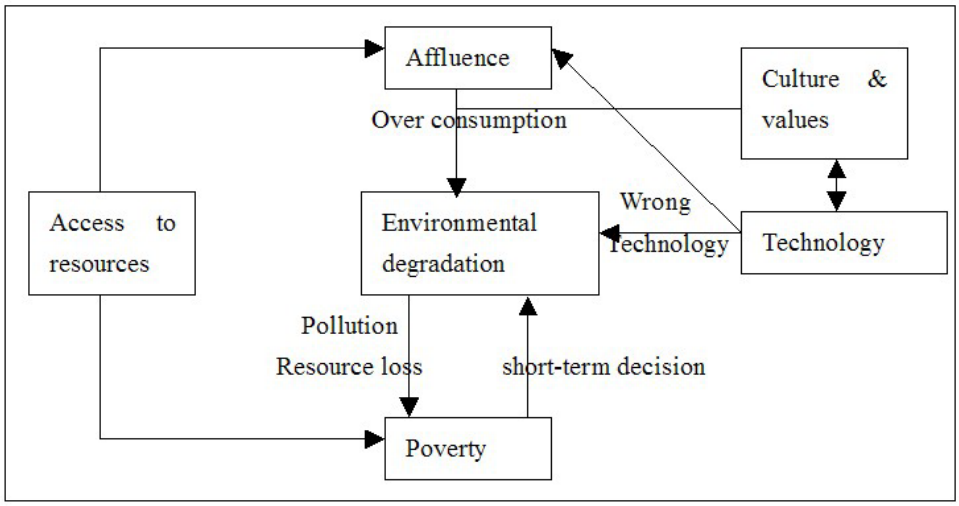

Figure 1. a realistic representation of the poverty and environmental degradation (source: Sharach Chandra M. Lele, 1991) (7)

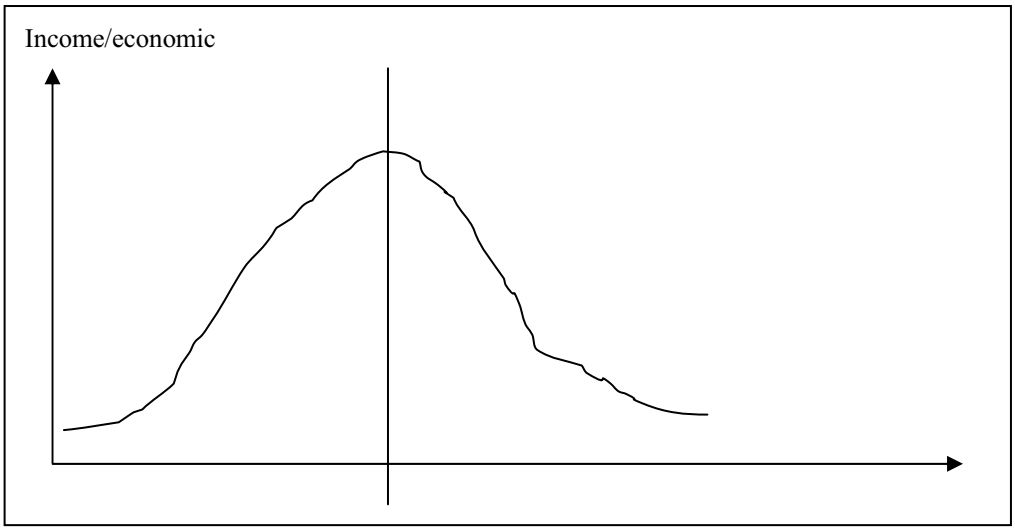

Figure 2. the Environmental Kuzents Curve (David I. Stern, June 2003) (8)

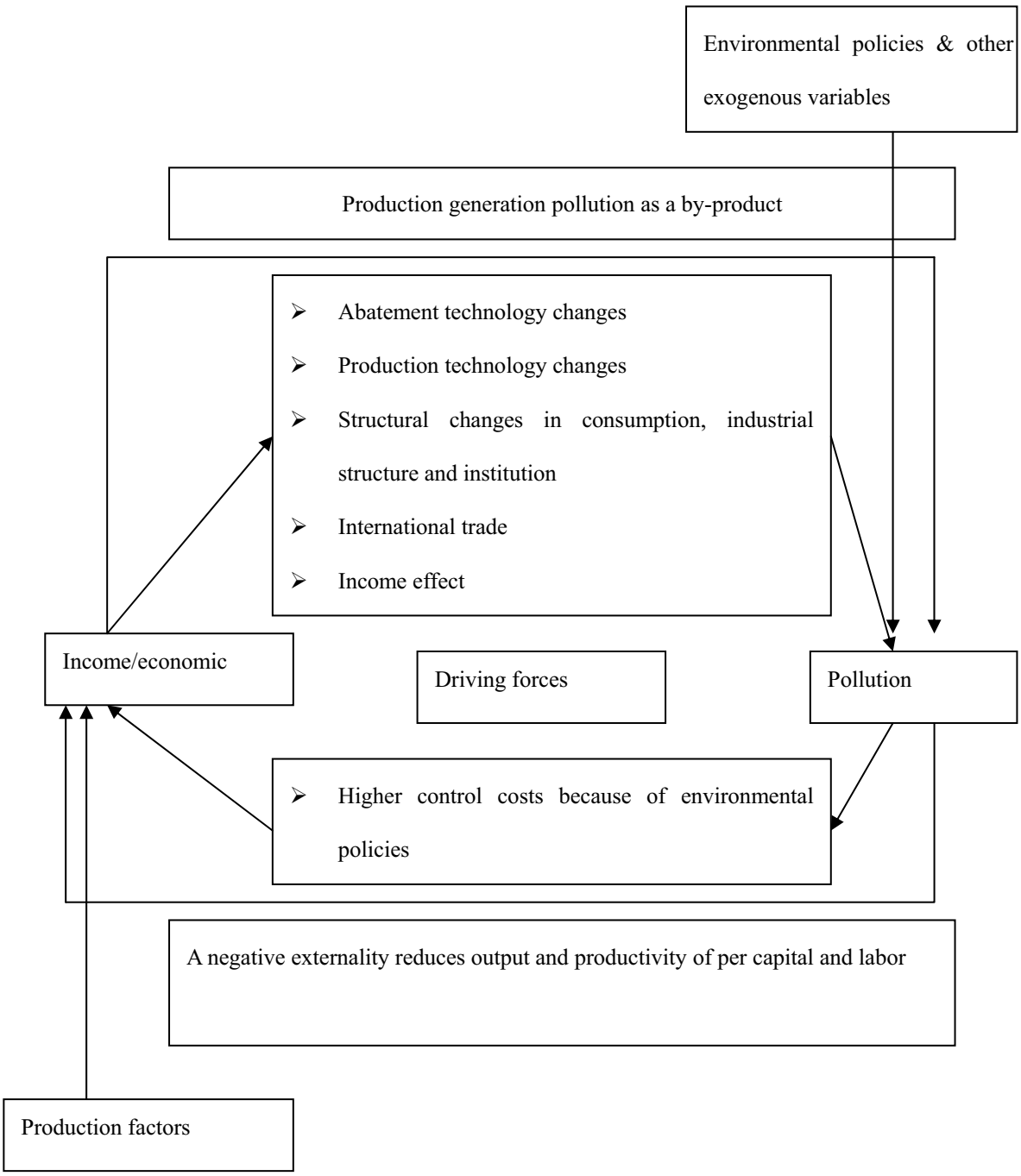

Figure 3. The relationship between income and the environment (source: Van Ewijk, C and S. Van Wijnbergen, 1995) (9)

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A Critical Review of the Methods Used to Estimate the Cost of An Adequate Education

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Abstract

Policy and decision makers find the task of determining the cost of education a difficult process. One of the reasons for this is the complexity of the process itself. Answering questions such as: *what entails an adequate education?* and *how much is needed to provide adequate education*? is complex. Thus, stakeholders in the education sector need a thorough understanding of the concepts and knowledge of the variables that determine an adequate education. In relation to this, this paper seeks to provide an overview of the concepts and critically reviews various methods that are currently utilized to determine the cost of adequate education. It also makes comparisons between the methods and discusses the pros and cons in an objective and integrated manner.

1. Introduction

While, a bigger budget allocation can facilitate improvement in many areas in the educational sector, research has shown that there is really no distinct co-relation between the budget size and positive outcome in terms of student performance. In relation to this argument, it has been argued that a more important variable that determines educational outcomes is how the financial resources are managed and utilized. In other words, it is not the size of the budget allocation that is pertinent but rather how finance is managed in order to bring about the desired results. This brings into focus the following two concepts: 1) *adequate (or adequacy)* used in the phrase *adequate education* and 2) *cost of adequate education* which, hence, raises the oft-asked question: *What is the least amount of money (considered adequate) that needs to be spent to achieve the desired level of educational outcome?* (Andrews, Duncombe & Yinger, 2002). In order to do this, one needs to thoroughly understand the concept of adequate in relation to one's own educational setting and the methods that can be used to calculate the cost of education.

In relation to the scenario above, this paper, thus, attempts to provide a critical review of some of the more popular methods that are currently used to compute the *cost of adequate education* worldwide. Before this is done, it is important to establish the definitions of the key concepts in this paper.

2. Definitions of the important concepts

2.1 Adequate

In Myersk and Silverstein's definition (2002), the term *adequate* refers to the number of teachers required to perform a certain task or tasks using a specific type of resource. This is basically an 'input-based" definition. Haveman (2004), in the contrary, defines the term from an *"output-based"* perspective: *adequacy* is said to have been achieved if certain test scores standards is achieved. From a broader perspective, such as a nation's desire to produce a knowledgeable workforce, adequacy is achieved when students achieve a set of specific skills as specified in the curriculum while studying in formal educational institutions. In most developing nations, the basic skills that a student is required to master are reading, writing, and mathematical skills. They should also have sufficient knowledge of the culture and heritage of their respective countries which will provide them with a sense of belonging and patriotism (see Reschovsky & Imazeki, 1999).

2.2 Cost of education

According to Reschovsky and Imazeki, (1999), the phrase *cost of education* refers to the minimum amount of funding that is needed to produce the desired outcome. Basically, estimating the cost of education depends on the various related components of education. However, Hall (204) claims that a typical estimation of the cost of education often does not include certain components such as the cost involved in getting parents' support or contributions of cash or kind from private foundation. This means that any typical estimation of the cost of education is lower than the actual cost incurred.

While acknowledging the logic and relevance of Hall's view (2004), this paper prefers to utilize Reschovsky and Imazeki's (1999) definition as it would be tedious and cumbersome to actually obtain the data in such a specific manner. So, in this paper, *cost of education* is viewed as the minimum value of resources needed to produce the desired level of student output or the minimum amount of expenditure or outlay needed to produce a certain level of student achievement.

3. Determining the Cost of adequate education

There are numerous methods that are currently employed by researchers, education consultants and other relevant stakeholders to compute the cost of education. Each method has its own strengths and weaknesses. In the following sub-sections, a critical review of the major methods that are being used is provided.

3.1 Professional Judgement Approach

As the name suggests, the cost of education is basically determined by the teachers since they are the people who are directly involved with the students. Hence, researchers such as Fowler (1998) and Augenblick and Myers (2003) argue that teachers, more than any other stakeholders, would have a greater knowledge and skills to determine the quality and quantity of the various resources deemed necessary to ensure an *adequate education*.

The basic view that is posited by this approach is that it is the teachers, who are ideally-positioned in the education system; hence they will be able to describe in detail the kind of delivery systems that should be made available in educational institutions. This includes areas such as the counseling and technological resources that should be provided to meet the demands of students.

Given such a responsibility, the teachers would, thus, have the final say on the kind of resources and support services necessary to provide students with an adequate education. After the resources and services are identified, they are priced according to the existing market value which is computed as the cost of education in that particular setting (Verstegen, 2003). This method is quite popular in the education fraternity as it reflects the views of the actual service providers i.e. the teachers and easily implemented compared to other methods (Myers and Silverstein, 2002). However, many academics and researchers generally do not favor this method.

According to Duncombe and Lukemeyer (2002), the method is flawed because the cost is calculated based on the preferences of one segment of the education system without consideration of the views and opinions of the other stakeholders. Even that one segment is only made up of just a representative group made up of a few individuals and not every teacher.

Another criticism against this method is that the recommendations made by teachers are usually based on their current needs without much emphasis on the anticipated needs in the future (see, Verstegen, 2003; Augenblick and Myers, 2003; Myers and Silverstein, 2002). Thus, the dynamic and ever-evolving nature of the education system and technological advances are oft ignored.

Studies have also shown that the teachers who are involved in calculating the cost of education rely entirely on their experience in making decision (Duncombe and Lukemeyer, 2002). In relation to this, the experience of the decision makers is multifaceted which often cause problems. For example, the experience of rural teachers may differ completely from those teaching in urban areas and decisions on the type of resources needed in schools will naturally differ. In addition, Verstegen (203) argues that the panel of decision-makers may rely on the element of guessing in their decision making process because their experience may be limited.

Researchers also believe that this method does not take into consideration the actual or projected achievement of students. For example, Peyser and Costrell's (2004) claim that there has been very little attempt to evaluate how the resources play a part in influencing student performance positively. In view of this, Verstgen (2003) argues that more research must be conducted to determine how the money spent on resources has a direct influence in terms of students' performance level.

Another pertinent criticism targeted towards this method is that it focuses more on the consumption of the resources rather than the actual expenditure incurred, thus, making the task of estimating the cost of an adequate education difficult (Odden, Archibald, Fermanich and Gross, 2002) Finally, it has been observed that teachers involved in the decision making process may overlook budget constraints and decide based on the notion that funds are unlimited, which is always not the case.

3.2 Cost Function Approach

This approach is considered better because cost function which allows decision makers to quantify the relationship between per-pupil spending for education, student performance, various student characteristics, and the economic and spatial characteristics of school districts are given due focus (Imazeki & Reschovsky, 2004). This means that the influence of variables such as the setting of the school i.e. rural or urban, etc are given priority in computing the cost (Taylor and Keller, 2002). Similarly, Fowler (1998) states that researchers applying this method can include the differences in the price of resources across various locations. For example the price of educational resource, such as computers may not the same in every part of a country.

In this method, decision makers also take into account the patterns of input substitution that occur in response to differences in relative prices and differences in the technology requirements associated with pupil needs. For example, students in urban areas are likely to be more exposed to sophisticated technological advances than students from rural areas and may thus require more sophisticated hardware such as a scanner and so on.

Apart from the above-mentioned advantages, this method is also considered more superior as it not only considers the cost of resources but also the students' achievement in relation to the expenditure incurred. For example, achievement in an exam can be used as the yardstick to determine the cost of the adequacy.

There are several variables that researchers consider in determining the adequate cost of education via this approach. They are:

(i). District expenditure

(ii). Educational outcomes

(iii).School Size

(iv).Input prices such as teachers, administrators, Auxiliary personnel and Computer equipment & Instructional equipment

(v). Environmental Factors such as range of students, and family and neighbourhood characteristics.

(vi).Capital

(vii).Geography or location of school

(viii).Efficiency of the school (Gronberg, Jansen, Taylor & Booker ,2004)

However, taking into consideration all the above variables alone does not ensure validity and reliability of the results, thus, it is equally important to determine the achievement standard and the acceptable (tolerable) level of inefficiency. This can be done if the cost index for each school is determined by dividing the predicted spending level for each district to the predicted spending level in a district with average characteristics.

3.3 Empirical Identification Approach

Another viable approach is the empirical identification approach, where the objectives are well laid and specified by the school or other stakeholders such as the district or state educational departments (Augenblick and Myers, 2003). In this method, schools that will serve as good models for research will be schools which have met the specified objectives. Usually, a minimum level of test achievements is used as the yardstick (Duncombe and Lukemeyer 2002). Basically, this approach utilizes a 3-step procedure as listed in the table below:

Step 1	A set of schools are selected which have met the state standards.
Step 2	The total expenditure of the school is utilized to calculate the cost
Step 3	A base cost figure using the basic expenditure figure is calculated

Source: Augenblick and Myers (2003)

This method has two main advantages. According to Harris (2004) and Verstegen (2003) this approach is objective as it enables non-school factors like family background to be included in determining the cost. Secondly, since this method is based on actual evidence, it therefore does not require further testing.

The main weakness, however, is that schools which have outcomes or achievement beyond the norm are omitted. Thus, Verstegen (2003) questions the validity of this approach because it does not include these 'outliers' school in the process of computing the cost. In addition, Peyser and Costrell (2004) have questioned the practicality of this approach as they believe that it would be time-consuming to include the data of every student in the education system. Another weakness of this method is that the exact breakdown on how the selected schools have spent their money is often left out; instead only the average basic expenditure is provided (Augenblick and Myers, 2003).

3.4 Whole School Design Method

In this approach, a few schools are selected randomly to participate in an educational program. At the end of the program, the outcome of the program is evaluated. The best performing school in the program is then selected to serve as a benchmark for the other schools to follow in the future.

The main criticism of this approach is that the schools selected are selected randomly and thus, may not be a proper representation of the particular setting. In addition, there is also a tendency to eliminate the highest and lowest spending schools from the analysis in this method as noted by Odden, (2003) who claims that schools from large districts and urban schools are often not selected to take part in the program, thus raising doubts on its validity.

4. Conclusion

Determining what is adequate for the students and its cost is an important process. Hence, it is not surprising that there are several ways to compute the cost of an adequate education. Each method has its strengths and drawbacks. Thus, it is vital that a concerted effort is taken to select the most practical method, in relation to the local conditions. If the situation permits, it would be ideal to estimate the cost in a more localized basis such as within particular districts as the cost of adequate education will definitely differ according to the location. Another possibility is to use more than one method to increase the validity and reliability of the findings. However, the question to be answered is: Are these suggestions practical in real-world situations?

Decision makers must also note that there is little evidence to directly link more funds to better student achievement and performance. The crucial factor is the effective and efficient management of these funds. This means that it is vital for all stakeholders to take the necessary steps to ensure proper management of funds to maximize the benefits.

References

Andrews, M., Duncombe, W., & Yinger, J. (2002). Revisiting economies of size in American education: are we any closer to a consensus? *Economics of Education Review, 21*, 245-262.

Augenblick, & Myers. (2003, January). Calculation of the cost of an adequate education in Colorado using the Professional Judgement and the Successful District Approach. Retrieved 26 August, 2006, from http://www.cosfp.org/pdfs/FULLREPO.PDF

Chambers, J. G., Parrish, T. B., Smith, J. R., & Guthrie, J. W. (2004). *The New York Adequacy Study: "Adequate" Education Cost in New York State: Project Preliminary Report*: American Institute For Research & Management Analysis and Planning Inc.

Downes, T. (2004, February). *What is Adequate? Operationalizing the Concept of Adequacy for New York.* Paper presented at the EFRC Symposium on School Finance and Organizational Structure in New York State, New York.

Duncombe, W., & Lukemeyer, A. (2002, March). *Estimating the cost of Educational Adequacy: A comparison of Approaches.* Paper presented at the Annual Conference of the American Education Finance Association.

Gronberg, T. J., Jansen, D. W., Taylor, L. L., & Booker, K. (2004). *School Outcomes and School Costs: The Cost Function Approach*. Texas. USA: Texas Joint Select Committee on Public School Finance, Austin.

Hall, T. (2004). Public Education as a Business: Real Costs and Accountability. *NASSP Bulletin, 88*(640), 84-86.

Harris, D. N. (2004, April). Funding Florida's Schools: Adequacy, Cost and the State Constitution. from http://www.asu.edu/educ/epsl/EPRU/documents/EPSL-0401-110-EPRU.pdf

Haveman, M. (2004). Determining the Cost of an Adequate Education in Minnesota: Implications for the Minnesota Education Finance System. Retrieved 19 February, 2007, from http://www.mntax.org/cpfr/education.pdf

Imazeki, J., & Reschovsky, A. (2004, June). Is No Child Left Behind an Un (or under) funded Federal Mandate? Evidence from Texas. Retrieved 28 November, 2006, from http://www.lafollette-wisc.edu/publications/otherpubllications/education/2004/Reschovsky-NCLB-Unfunded.pdf

Myers, J., & Silverstein, J. (2002, August). Calculation of the cost of a suitable education in Montana in 2001-2002 using the Professional Judgement Approach. 2007, from http://wwwmtsba.org/study/Final%20Report.pdf

Odden, A. (2003). Equity and Adequacy in School Finance Today. Retrieved 30 April, 2008, from http://www.edsourceonline.com/pdf/sfequityadequacy.pdf

Odden, A., Archibald, S., Fermanich, M., & Gross, B. (2003). Defining School-level Expenditure Structures that Reflect Educational Strategies. *The Journal of Education Finance, 28*(3), 323-356.

Peyser, J., & Costrell, R. (2004). Exploring the Cost Accountability [Electronic Version], 13. Retrieved 18 November 2007 from http://www.hks.harvard.edu/pepg/PDF/Papers/Peyser_Costrell.pdf.

Reschovsky, A., & Imazeki, J. (1999). *Does the School Finance System in Texas Provide Students with an Adequate Education?* Paper presented at the Conference Name|. Retrieved Access Date|. from URL|.

Taylor, L. L., & Keller, H. (2002). Competing Perspectives on the cost of Education. *Development in School Finance: 2001-02* Retrieved 25 March, 2008, from http://nces.ed.gov/edfin/pdf/comp_pers_2003403.pdf

Verstegen, D. A. (2003). Calculation of the cost of an adequate education in Kentucky. Retrieved 26 March, 2008, from http://www.schoolfunding.info/states/ky/KYAdequacyStudy.pdf

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The Research about Dynamic Relationship between Human and Geography

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Abstract

"Human and geographical" is a term short for the relationship between human and geographical environment. Sometimes, it's used to refer to the relationship between human and nature. It is an ever-lasting fundamental relationship, and it is the foundation of all other relations in human society. The process of human using and changing physical geography equals to the evolutive process of the relationship between human and geography. With the social development and the progress of productive forces, this relationship develops and progresses. It is of dynamic character. Nowadays more attention has been paid to the research about the dynamic relationship between human and geography. It marks the progress of society and human's awareness.

Keywords: Relationship between human and geography, Dynamic, Research

In the 46 billion year evolvement history of the earth, human came into the world just only 200 million years ago. Since human was born on the earth, there was a relationship between human and geography. It is an ever-lasting fundamental relationship that belongs to the field of the relationship between human and nature, and it is the foundation of all other relations. Human come from the geography environment. In order to exist and multiply human sculpture the geographical environment constantly. The process of human using and changing the physical geography equals to the evolutive process of the relationship between human and geography. With the development of its social development and the progress of productive forces, this relationship develops and progresses. It is of dynamic character. It's not only necessary for the time and the society, but also a sign of social progress and people consciousness's improvement.

1. The Origin of The Relationship between Human and Geography

1.1 The Relationship between Human and Geography is a Kind of Eternal Basic Relations.

"Human and geographical" is a term short for the relationships between human and geography environment. It specifically refers to the relation between human society and natural environment, which is, an open complex and enormous system is formed through the interaction between human activities and nature environment. From the origin of relation between human and geography, there is geography at first, and then the human follow. Human beings are the product of natural evolution. The geography can exist without human beings, but human beings can not exist without the earth, which means that the relations between human and geography is the relations that human beings depend on geography.

On the occasion of human being come into the world, the relations between human and geography come into existence as a kind of objective relations. It was established with material flow and energy flow as a link. It is an ever-lasting fundamental relationship, which belongs to the field of relationship between human and nature, and it is the foundation of all other relations. Such as the relations of production, blood ties, political relations, economic relations and a series of relations in the course of human society develop, which are all established on the basis of the relationship between human and geography.

1.2 The Relationship between Human and Geography in the Concept of Geography

The relationship between human and geography in the concept of geography is different from the general relationship between human and nature. The general relationship between human and nature is a kind of relations between human and the main element of nature, such as the relations between man and air, animals and plants, minerals, mountains, rivers, lakes, oceans and so on. People in the relationship between human and geography of the concept of geography refer to people of the community, people who are engaged in various productive activities or social activities in a certain mode of production, people who exchange material with nature consciously and purposeful and then compose

society, people who work in a certain geographical space. Geography in the relationship between human and geography of the concept of geography refers to the geographical environment that closely relates to human activities and combines the inorganic and organic nature of various factors in order. The geographical environment exists with geographical differences, whose faces have been changed by human's effect, which includes economic, cultural, social and geographical environment. Human beings are the product of geographical environment. In order to survive and multiply, humans take substances and energy from the environment continuously, and then give back to the environment on the form of waste. In fact, "the human and geography" is an interaction relation between the system of human and geography, with human society constantly enlarging, changing, using, adapting the geography environment, and with the geography environment affecting human activities' geographical character and difference.

2. The Development of Relationship between Human and Geography

2.1 The Relationships between Human and Geography are in an Eternal Developments and Changes.

The natural environment is in constant, eternal, regular development and changes. Human environment has much more mobility than the natural environment. Therefore, the relationship between human and geography is changing dynamically constantly. This dynamic relationship expresses with different socio-economic and environmental conditions, and the character of relations between human and geography are also in different stages of social development. Human are the main body in the relations between human and geography, and human are the master of geography in the adjusting and controlling system. Not only can they adjust the material and energy exchange between human and geography, but also jump out of the system to intervene and manager the relationship between human and geography purposely and consciously, by planting trees, establishing the protected section of nature, and making all kinds of laws to eliminate the negative impact of natural. Sustainable development is built on the appropriate management and intervention of the population, resources, environment, and economy's high degree of unity; so that human society's long-term development provides sustained economic benefits and environmental benefits. The harmony of the relationship between human and geography is a kind of progress in order, overcoming disorder and chaos. It is the core of sustainable development.

2.2 The Stage of the Evolutive Relationship between Human and Geography.

The first stage: human are natural slaves, including the ancient times and agricultural era. (1) Ancient times: from the human naissance (260 million years Quaternary Period) to 20000 years ago, that is the early primitive society. Mankind depends on natural food, living by hunting and gathering, it is no real sense of the production. Since the creation and using of fire, the productivity has a certain level of improvement, but it is still very low in the whole. Human mainly used the nature but did not transform the nature much. On account of human always been threaten by nature, but no ability to conquer the nature, so pay homage to the nature, and pray to God, the cultural totem was born. To survive and fight against nature is the main activity of humans at that time. The environmental problems are the famine caused by excessive and arbitrary picking and hunting. The main solution is migration. (2) The original period of agriculture and animal husbandry: from 20,000 years ago to 200 years ago, that is, New Stone Age primitive society. During the long arduous battle with nature, human learned how to grow plants and domesticated animals, and then entered the original era of agriculture and animal husbandry. Human began the real meaning of production. According to human own needs to produce food , there was the first revolutionary leap, and the production formed the first wave. Human began to transform nature consciously, and tools have a certain progress. "Slash and burn" is the earliest human agriculture technology. Human experienced twice social division of labor that greatly promoted the development of productive forces in this period. However, people's ability to conquer nature is still very limited. Human mainly depend on nature, blessing empyreal pray, worshipping natural as God. Human has been changed from worship totem to saints in concept. They thought that the god dominated the earth. The environmental problem is damaging the geography, including geography erosion and desertification. What deserve our serious consideration is the environmental problems caused by the first wave of production has extended to today, it is still a serious global environmental problems. The solution is relocating in ancient and planting trees in modern.

The second stage: human is the master of nature 200 years ago. On the basis of the continuous development and accumulated of human wisdom ,society have taken place the second revolutionary leaps in the 18th century, making the steam engine widely used for signs of the first technological revolution, rising the second wave of human production. With the rise of industrial civilization, the transition from agricultural society to industrial society provides a rapid development of the productive forces. The second technological revolution makes the wider use of electricity as the mark in the 19th century, increasing labor productivity substantially in a further way, and enhancing the ability of human using and changing natural. Mankind has entered a new industrial age, so that the production activities of the focus from the means of subsistence production to the production of means of production, from manual labor to machine production; from surface resources development to underground resources development, from the use of decentralized renewable energy (wood Grass) to focus on the use of non-renewable fossil fuel energy (coal), from agriculture and animal husbandry (reproductive life) to mining, processing (non-life production); from natural economic

to the commodity economy. This phase human achieve the numerous technological invention and creation, access to the ability of developing the tremendous natural, making an unprecedented increase of productivity, unprecedented growth in wealth, and a sharp change face of the earth. To dominate nature, conquer nature, and transform nature, human treat themselves as the master of nature. There is a “give me a fulcrum, I can prize the Earth" declaration on the industry.

Under the guidance of ideas "dominate the Earth, people are masters of the earth", all the activities of people around how to plunder the most natural resources and energy to produce the most wealth ,for the people to pursue the highest standards and the most whim of the consumer.

The rich material wealth improves the standard of living, resulting in population growth, then, the more the growth of population ,the more needs of production of farm-geography. The rise of the second production wave, people treat the nature as a conquer object, pool, and trash, which caused serious environmental pollution (industrial waste) and ecological damage and have taken place the world-famous eight major pollution incident. Particularly since the 1950s, not only did the industrial waste has large emissions, but also many new sources of pollution and pollutants were emerged, so that now it is difficult to find an unspoiled of "pure geography of Oasis." in the Earth. As a result of industrial pollution greatly exceeded the agricultural pollution, so environmental issues have become the global and the biggest problem which human face.

The third stage: the coordinated development of man and nature

Since 20 century mankind started the third technological revolution, making electronic computers, atomic energy and space technology as the representative of the third wave of the rise of production, so that the human society could go into the information age from the industrial age. Information has become the most important strategic resources, and productive forces have a rapid development. The relationship between human and the environment is more closely. New technology is conducive to deal with the industrial waste and other old environmental issues, but also brought new environment pollution , such as the space junk, nuclear radiation, the white pollution, noise pollution, automobile exhaust, light pollution, electromagnetic pollution and so on, which make the environment problem more complex, more and more serious. People began a serious reflection about the eight major pollution incident caused thousands of deaths in the first half of the 20th century, this is the first time human aware of their living space has been under serious threat, and aware of the urgency and importance to solve environmental problems.

In the 1970s, the Environmental Protection wave came and went, and people began to discuss the major environmental issues, making "environment and development" as the most prominent and most urgent, related to the future survival of the human world Issues after the "War and Peace" in the 20th century. June 3 to 14th in 1992, the delegations from 183 countries and regions, 107 heads of state, 70 representatives of international organizations met in Rio de Janeiro, Brazil, to attend "Environment and Development" the general assembly of the United Nations, and took the sustainable development put forward in 1987 into the "Agenda 21", and then it became the fundamental strategy of human resolving the environment and development issues.

Under the guidance of the sustainable development strategy, human is quietly breeding a global revolution of civilization that is the green revolution using their wisdom to rebuild a new home - eco-home. Therefore, human shouted another slogan "give me a seed, I can dye a Green Earth" in the green civilized era.

In the new century, 60 million people go into a hi-tech, information, environment of the times. Human beings will be developing with the fastest speed, but facing the most serious of the 10 major environmental problems (global warming, ozone depletion, acid rain, air Pollution, depletion and degradation of freshwater resources, solid waste disposal, biodiversity loss, and a sharp drop in forest area, soil degradation and desertification, lack of resources) of the threat. Therefore, only by choosing green and ecological that our common humanity and future generations can humans be in the earth’s embrace forever. We must treat the earth as our mother, cherishing her forever.

3. The Identity of Relationship between Human and Geography

3.1 The Basis of Relationship between Human and Geography

The Earth's surface was in a purely geographical natural state before human’s appearing. The natural world started to transform from the natural state to the nature and human interaction since human beings appear. In fact, the whole of mankind's history was the interactions history between human, nature and society. The relationship between human and geography is an ever-lasting basic relation, and it is the foundation of all other relations in human society.

3.2 The Importance of the Relationship between Human and Geography

The basis of relationship between human and geography decided its importance further. The coordination of the process between human and geography has always been the important subject which geography focuses on so far. And its main line has been always been around the core of human and geography symbiotic harmony to extend. Therefore, the study about the relationship between human and geography is of great significance whether in the early stages of the

development of human society, present or future.

3.3 The Close Relationship between Human and Geography

Human derived from geographical environment, and sculpture geographical environment constantly. It shaped an inseparable system of human and geography. Human and geography are impacting on each other in this system. Human's activity is subject to geographical environment, but human can dynamic transform and adapt to the geographical environment. Therefore, the natural environment to human society is not the role of control, but effects on human .The adaptation of human to nature geography is not ordinary but dynamic adaptation. Nature is an objective existence, the human have subjective consciousness, and the relationship between the two often changes with the change of the epics. But in any case changes will not affect the close relationship between human and geography until forever.

3.4 The Dynamic Relationship between Human and Geography

The relationship between human and geography was emerged with the emergence of human society, developing along with the development of human society. Therefore, the relationship between human and geography is of changing dynamics constantly. In different stages of social development, the human productivity is in different levels, the character of the relationship between human and geography is different too .The dynamic relationship between people and geography was mainly manifested in two aspects: First, the human side, the development of the relations between human and geography mostly depends on the development of human society. With the development of human society, enhancing the level of productivity, the ability of people using and transforming the natural is gradually strengthened. The intake of natural resources is growing, and the scope of developing resources is expanding continuously. Now it is very difficult to find a pure natural virgin geography on Earth. Second, the nature of the party, the development of the relationship between human and geography is based on the increasing reaction of the geographical environment on human. This reaction has not limited to the supply capacity of resources, but also from the living space, quality of life, energy consumption and environment pollution affect the development of human society. The problems such as resource issues, food issues, population issue, energy industry issue, even the world of conflict and peace issues, which were the performances of the relationship between human and geography was deepen.

3.5 The Contradictions of the Relationship between Human and Geography

The contradiction is the antithetical site of the relations between human and geography. Human is essentially different from the natural environment. Human essence is the sum total of social relations, with subjective attributes. The life and production of human is subjective, under the control of subjective sense. Human are of psychological, social and cultural composition of intelligence, so it is master of natural. The natural environment is objective, and does not rely on human to exist. It has an objective attribute and its own natural development laws, not transferred by human's will. The objective world's resources are limited, but the human desire is unlimited. In the relations between the people and geography, between the objective attributes and the subjective requirements, the antagonism between the limited resources and the unlimited desires, is the contradictions of relationship between people and geography.

3.6 The Unity between Human and Geography

Unity is one side of the relationship between people in the whole side. Human is a part of environment. Human is born in environment and impacting on the environment constantly.

People affect on the environment constantly, which is determined by the social attributes. The process of effect is the process of human using the power of intelligence and consciousness to mobilize the forces of nature for the benefit of mankind, and the process of human using technology to invent advanced tools to affect on nature environment by the labor. As the master of nature environment, human asked for material and energy to protect their own to survive and multiply from the four major atmospheres by the identity of producers. Human created the

Contemporary civilization and made the nature of the community attribute as the consumers human let emissions to the four major atmosphere, polluted the environment ,and made the degradation of the world environment. Human and geography formed to be an interrelated and interacted organic whole. As a part of the natural world, human is the biology human, no one can be divorced from nature to exist. The more important thing is the interaction but not only co-existence between human and geography. In addition, the environment is not just the external conditions of human social development. The most important thing is that it is the internal mechanism which people and the environment can develop systematically.

The quality of the environment related to human survival. So, on the one hand the natural decided human, on the other hand human decided the natural. Now these two are intertwined, which means the unity of the objective and subjective. That is, human activities and the laws of nature are unified. Human have to take the initiative to adapt to the object, making the actions in conformity with the objective law.

4. Outlook for Relations between People and Geography

Generally speaking natural evolution process is slow, but human society and economic development are rapid. Human activities impact on natural is fierce, which caused natural changes (evolution or degradation) often exceeds the afford ability of its own evolution, so that led to the rapid transformation of nature. The asymmetry relationship between human and geography indicates that human play a dual role in the relation between human and geography, who are not only the children of the geography, but also the masters of the geography and the initiator of the conflict of human and geography. Therefore, in any era, regardless of the ancient "Harmony" concept, the current theory of sustainable development, or the future "people coexist with geography", a scientific theory of the relation between human and geography has coordination of the two factors.

4.1 The Ancient "Harmony"

The so-called "Harmony" is the man and nature combined. It is the basic idea of the ancient Chinese traditional culture. As early as during the Western Zhou Dynasty "Harmony" has been produced, the earlier plain "Harmony" ideology was born after Confucianism, Taoism, and other families' common development. The well-known representatives of "harmony" are the philosophers such as Han Dynasty Dong Zhongshu, the Northern Song Dynasty Zhang Zai and so on. Therefore, "Harmony" can be said to be the master of ancient thought.

Chinese "Harmony" concept was restricted by the level of economic, scientific and technological development., which underlined the interrelated between human and nature. It is necessary to let human in the correctly position of "nature" and to fully understand the law of the "heaven". Therefore, "Harmony" in ancient China can be said that the "theory of sustainable development". Of course, it is only a simple ideas about the relationship between the people and geography, with certain elements of the passive acceptance and helpless. It requires human beings must first of all to conform to "heaven", before they can use the "Heaven." It put forward requests about an appropriate development, protection and conservation of natural resources in order to have sustainable development and use.

4.2 Today's Sustainable Development

From 1972's "Human Environment Conference" to the Rio de Janeiro in 1992, "Conference on Environment and Development", marking the awareness of human about the environment and development issues has a qualitative progress, which fully demonstrates human society has established the new ideas of sustainable development. Sustainable development: "human beings have the ability to make development sustainable, and can also guarantee so as to meet the current needs without endangering people's ability to meet their own needs. That is to say, we have to find a road which can make population, economy, society, environment and resource harmonized which can meet the needs of contemporary people and not endanger the needs of future generations.

Sustainable development includes three meanings: First, sustainable development encourages the growth of economic. However, we must change the way of using resources from extensive to intensive, changing the traditional model of economic growth to sustainable development patterns.

Second, sustainable development is based on protecting the natural, with the resources and the environment bearing capacity of coordination. We have to take attention to protect the environment when develop the economy, protecting the renewable resources' indissolubility and the non-renewable resources' limited. We have to try our best to keep the integrity of ecosystem, protect the diversity of organism, and prevent the extinction of biological resources. Third, sustainable development aims at improving the quality of life and adapts to the social progress. The economic growth way which just only simply pursuit the output will destroy the environment, so that the people's quality of life will decline. Clearly, sustainable development is including sustainable economy, sustainable ecology and sustainable society. The sustainable ecology is basis, the sustainable economy is guarantee, and the sustainable society is goal among these three content. The full meaning of sustainable development refers to the beneficial symbiosis and development between human and nature, which is the most scientific knowledge of the relation between human and geography.

Sustainable development has already reached a consensus. It reflects the suspicion and discards about the model of the traditional development, and the yearning of future development

4.3 The Symbiosis of Human and Geography in the Future

Science is a knowledge system which accumulated in the course of long-term labor.

Technology is the intermediary and bridge between human and the natural, and an important yardstick of the relation between human and geography. With the increased productivity, scientific and technological progress, the social material wealth and spiritual wealth is growing in the course of human society's development. Therefore, in the future of rapid economic development, highly developed technology, the relationship between human and geography should be based on the sustainable development. In order to make human and geography symbiosis, human have to create favorable conditions for own development, and human ought not to destroy the structure and function of geographical environment for the immediate interests. The symbiosis means the new alliance between human and nature, which is the

key to the success of sustainable development, especially to such a country likes China who is carrying the world's largest population with grim resources and the environment.

The key and essence of sustainable development are harmonizing and optimizing the relationship between human and geography. The coexistence and development of human and geography are not only the continuation of sustainable development idea, but also the result of the sustainable development.

The realization of human and geographical environment's symbiosis depends on the success of human intervening own actions on human's own initiative. The passive feedback mechanism of geographical environment is formed in a long-term evolution. The human affect on the nature is a very short time compared to the evolution of the geographical environment, but the effect is such profound and strong. Therefore, this demands that we have to prepare in advance on our own initiative, in order to welcome the stages of human and geography coexisting arrival early with ell-developed economy and the intelligence.

References

He Chengyuan,Wu Shaohong and Yang Qinye. *People in the scientific evolution.* [J] Soft Science 2004, 18(4): 1-3 .

Ju Naiqi and Ju Yajie.*The philosophical reflection on the relationship between man and nature* .[J] Journal of College of Arts and Baoji 2008, 28(1): 31-35.

Mao Hanying. *To people relations and regional sustainable development.* [M]Beijing: China Science and Technology Publishing House , 1995.48-60.

Ou Yanglin . *Human relations and progress in theoretical research.* [J] Journal of Chifeng College 2008, 24(2): 103-105.

Wu Chuanjun.*Geographical relations between the people and the theoretical study and control* [J] Journal of Yunnan Normal University 2008, 40(20: 1-3.

Xia Huanlong . *The relationship between man and nature in harmony evolution* .[J] Shanghai School of Business Journal 2006, 12(1): 8-9.

Zhu Dengchao. *To re-examine and establish the relationship between man and nature.* [J] Journal of Theory2007, 155(1): 47-48.

Zhu Guohong. *On the relationship between people and geography* .[J] population and the economy 1995, 88(1): 18-24.

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Utilization Potential of 30Year-old Oil Palm Trunks Laminated Veneer Lumbers for Non-structural Purposes

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Abstract

Oil palm trunks found in abundant and considered as an agriculture waste were investigated as a possible alternative to future wood in utilization for non-structural purposes. The trunks are of no economic important in their natural form. However, once converted into the form of laminated veneer lumber (LVL) their properties improved tremendously. This paper highlighted properties of the LVL made from oil palm trunks at four (4) different positions comprising two (2) portions height and two (2) cross-sectional zones. These LVL have shown to behave differently when tested for their physical, mechanical and glue delaminating properties. Testing on all the LVL specimens were done in accordance with the Japanese Agricultural Standard, JAS No. 237: 2003.

Keywords: Oil palm trunks, Laminated veneer lumber, Physical properties, Mechanical properties and Glue delaminating

1. Introduction

The future demand for timber by various wood-based industries in Asia and elsewhere are expected to exceed the existing supply. Efforts are being taken to overcome this problem in overcoming the anticipated shortage. Various alternative wood and non-wood forest products are being investigated by researchers in many parts of the world to find potential replacement to future timber. One of these is the oil palm trunks.

Oil palm is one of the main agriculture commodities in Malaysia. Currently, 4.17 million ha of land are being planted with this agriculture trees (Anis, *et al*., 2007) and over the years the area seemed to be on the increased. The economic live span of an oil palm tree is between 25 to 30 years. After this period the oil palm trees are no longer considered of an economic value. They need to be replaced with new trees. It is estimated that about 7,000,000 metric ton of an oil palm trunks were felled annually for replanting of the new trees. Most of these trunks are left to rot in the field as they are considered to be an agriculture waste.

The trunks possess densities ranging from 170 to 700 kg/m^3 depending on position along the height and cross-sectional zones (Khoo *et al*, 1991; Killmann and Lim, 1985). The oil palm trees at the age of 25 to 30 normally possess diameters from 45 to 65 cm, and can reached the height of 7 to 13 m (Khoo *et al*, 1991). In natural form they are considered to be of no economic important to the wood industry. However, once peeled for veneers and converted into the form of laminated veneer lumber (LVL) their properties improved tremendously. This paper highlighted properties of LVL from oil palm trunks. Properties such as the physical, mechanical and gluing were investigated.

2. Materials and Methods

The oil palm trunks used in this investigation were harvested from a plantation in Lahat Datu, Sabah. All together, ten (10) oil palm trunks of 30 year-old trees were harvested. Within a week after felling these trunks were transported to a plywood mill in Sandakan, Sabah, for peeled veneers production and later conversion into laminated veneer lumber (LVL). Twelve (12) LVL from oil palm trunks were produced with dimension of 610 x 2440 mm. Three (3) LVL were produced from the bottom portions of the trunks at peripheral area, bottom portions at inner cross-sectional zones, top portions at peripheral area and top portions at inner cross-sectional area respectively. Urea formaldehyde adhesive was used as the binding material to glue the veneers together. Eight (8) oil palm veneers were used to produce LVL of

dimension 240 cm length x 120 cm width x 25 mm thickness. The oil palm LVL were prepared based on method outlines by Hashim *et al*. (2004).

The LVL were labeled and later cut into various sizes to accommodate the physical, mechanical and glue delaminating tests. Prior to testing, all samples were conditioned in a condition chamber to attain moisture content (MC) of 12%. The samples were placed in the chamber which was set to 20±2°C and 65±5% relative humidity (RH) for 2 weeks. All testing were done in accordance with Japanese Agriculture Standard (JAS) No. 237: 2003. The physical tests focused mainly of the density, thickness swelling and the water absorption of the LVL. The strength tests for static bending parallel and perpendicular to the grain at flatwise, edgewise positions, and shear were conducted using Universal Testing Machine located at the School of Engineering and Information Technology, Universiti Malaysia Sabah. Ten replicates were used for each test. Rubberwood LVL of the same dimension were used a control specimens.

3. Results and Discussion

The results on the physical, mechanical and glue delaminating properties of LVL from oil palm trunks are tabulated in Tables 1, 2, 3, 4, 5, 6 and 7 respectively.

3.1 Physical properties

The density of the oil palm LVL varies according to their veneer positions along the height and cross-sectional zone of the oil palm trunks. The LVL at bottom portion and peripheral zone (AX) shows the highest value of 596.77 kg/m^3 followed by top portion and peripheral zone (BX) at 589.20 kg/m^3, bottom portion and peripheral zone (AY) at 492.62 kg/m^3 and top portion and inner zone (BY) at 441.67 kg/m^3. These values were lower between 14 to 36% than the density of the rubberwood that were used as control specimens. The values are higher than the mean density of the oil palm steam which is around 370 kg/m^3 (Lim and Khoo, 1986). However, according to density category the oil palm LVL of these densities fell under the light hardwood and strength group 5 and 6.

The thickness swelling and the water absorptions properties were also observed to behaved opposite to the density properties. These properties are greatly influenced by the value of density that each LVL possess as shown in Table 1. The thickness swelling at bottom portion and peripheral zone (AX) shows the lowest highest value of 2.99% followed by top portion and peripheral zone (BX) at 3.01%, bottom portion and peripheral zone (AY) at 4.35% and top portion and inner zone (BY) at 5.62%. The water absorption properties were found to be 63.03% at bottom portion and peripheral zone (AX), followed by top portion and peripheral zone (BX) at 66.53%, bottom portion and peripheral zone (AY) at 87.98% and top portion and inner zone (BY) at 94.33%.

In the delaminating test of the LVL, surprisingly the specimens from at bottom portion and peripheral zone (AX) and top portion and peripheral zone (BX) showed higher passing percentage compared to the rubberwood LVL (see Table 2). LVL made from oil palm trunks taken from bottom portion at peripheral zone, and top portion at peripheral zone passed delamination tests.

3.2 Strength Properties

In this part of the investigation, the bending and the shear tests were conducted on the LVL in determining their strength properties. Testings on static bending were carried out both in parallel and perpendicular to the grain in flatwise and edgewise positions. The rubberwood LVL were used as standard and control specimen for comparison. The results on LVL bending for the flatwise and edge position are shown as in Tables 3 and 4 respectively.

For static bending in parallel to the grain, the MOR values for the LVL ranged from 11.05 to 19.29 N/mm^2 and MOE from 405.83 to 712.84 N/mm^2 for LVL specimen AX, AY, BX and BY respectively for flatwise position. The values increases for the edgewise position where the MOR values for the LVL ranged from 13.04 to 24.63 N/mm^2 and MOE from 816.47 to 1501.11 N/mm^2 for LVL specimen AX, AY, BX and BY respectively

Tables 5 and 6 shows the results for static bending in perpendicular to the grain, the MOR values for the LVL ranged from 1.33 to 1.95 N/mm^2 and MOE from 106.68 to 117.39 N/mm^2 for LVL specimen AX, AY, BX and BY respectively for flatwise position. The values increases for the edgewise position where the MOR values for the LVL ranged from 1.43 to 2.09 N/mm^2 and MOE from 154.71 to 205.27 N/mm^2 for LVL specimen AX, AY, BX and BY respectively

Table 7 shows the shear values of the oil palm LVL and their comparison to the shear of the rubberwood LVL. The shear values of the LVL ranged from 0.76 to 1.71 N/mm^2. The overall value are lower than the shear of the rubberwood by 59 to 82%.

The overall results in the strength on the oil palm LVL tests for both the static bending either in parallel or perpendicular (flatwise and edgewise) and shear seem to be greatly influenced by the combined densities of the laminated veneers and the position of the veneers taken along the trunks height and cross-sectional zones. These values increase with the increases in density of the LVL. The highest values obtained in term of the physical, mechanical and glue delaminating tests however fell short of those found in the rubberwood LVL.

The oil palm LVL which possess densities and strengths mentioned earlier can be categorized as light hardwood and strength group C. Rubberwood also fall into light hardwood category and strength group C but they are in upper category list (*reference for strength group MTC*). The most suitable uses of the oil palm LVL is as material for LVL paneling and furniture where strength is not the critical element required. The strength of these LVL can however be improved further by increasing the density of the veneers through compression process (Edi *et al*., 2007). Injecting stabilizer or polymer into the veneers or oil palm LVL can also improve the strength but the processes involved are expensive.

4. Conclusions

1. The densities of the oil palm LVL ranged from 441.67 to 596.77 kg/m^3. These values lower between 14 to 36% compared to that of the rubberwood LVL.

2. The thickness swelling and the water absorption of the oil palm LVL were 79 to 89% and 52 to 68% higher than the rubberwood LVL respectively.

3. LVL made from oil palm trunks taken from bottom portion at peripheral zone, and top portion at peripheral zone passed delamination tests according to JAS: SE-11.

4. The bending parallel to the grain of the oil palm LVL has values lower between 65 to 80%, and 71 to 84% respectively for MOR and MOE at flatwise position to that of the rubberwwod. The specimen placed at edgewise has values 57 to 77% for MOR, and 50 to 73% for MOE respectively to that of rubberwood. They ranged from 11.05 to 19.29 N/mm^2 for MOR and 405.83 to 712.84 N/mm^2 for MOE at flatwise position, and 13.04 to 24.63 N/mm^2 for MOR, 816.47 to 1501.11 N/mm^2 for edgewise position.

5. The bending perpendicular to the grain of the oil palm LVL has values lower between 47 to 64%, and 61 to 65% respectively for MOR and MOE at flatwise position to that of the rubberwwod. The specimen placed at edgewise has values 51 to 67% for MOR, and 53 to 64% for MOE respectively to that of rubberwood. They ranged from 1.33 to 1.95 N/mm^2 for MOR and 106.68 to 117.39 N/mm^2 for MOE at flatwise position, and 1.43 to 2.09 N/mm^2 for MOR, 154.71 to 205.27 N/mm^2 for edgewise position.

6. The shear values of the oil palm LVL were lower between 59 to 82% to that of the rubberwood. They ranged between 0.76 to 1.71 N/mm^2.

References

Anonymous (2003). Japanese Agriculture Standard for Laminated Veneer Lumber, JAS: SE-11 (No. 237: 2003), Japan Plywood Inspection Corporation, Tokyo.

Anis, M., Kamarudin, H. & Hasamudin, W. H. (2007). Current status of oil palm biomass supply. Proceeding of 7th National Conference on Oil Palm Tree Utilisation (OPTUC). Kuala Lumpur 13-15 Nov. 2007.

Edi, S.B., Paridah, M.T., Hamami, S. & Fauzi, F. (2007). Properties enhancement of oil palm wood through modified compag method. Proceeding of 7th National Conference on Oil Palm Tree Utilisation (OPTUC). Kuala Lumpur 13-15 Nov. 2007.

Hashim, W. S., Puad, E., Zaihan, J., Dahlan, M. J. and Chuah, K. H. (2004). The manufacture of laminated veneer lumber from oil palm trunks. Proceedings of the Fourth Natioanal on Wood-Based Panel Products. 28-30 Sep. 2004. Kuala Lumpur. Pp. 83-88.

Khoo, K.C., Killmann, W., Lim, S.C. and Halimahton,M. (1991). Characteristics of the Oil Palm Stem. Oil Palm Stem Utilisation – Review of research, Research Pamplet No. 107, FRIM.

Killmann, W., and Lim, S.C. (1985). Anatomy and properties of Oil Palm Stem. Proceedings of the National Symposium of Oil Palm by-products for Agro-bases Industries, 1985, Kuala Lumpur.

Lim, S.C. and Khoo, K.C. (1986). Characteristics of Oil Palm trunks and its Potential Utilisation. The Malaysian Forester 49 (1): 3-22. Kuala Lumpur.

Table 1. Thickness swelling and Water absorption of LVL from oil palm trunks.

LVL samples	Density (kg/m^3)	Thickness swelling (%)	Water absorption (%)
AX	596.77 (-14%)	2.99 (+79%)	63.03 (+52%)
AY	492.62 (-29%)	4.35 (+86%)	87.98 (+66%)
BX	589.20 (-15%)	3.01 (+80%)	66.53 (+54%)
BY	441.67 (-36%)	5.62 (+89%)	94.33 (+68%)
RBW	696.54 (-00%)	0.60 (+00%)	30.28 (+00%)

(all value represent mean of 10 replicates; value in bracket indicate either % lower or higher than rubberwood)

Table 2. Delaminating tests of LVL from oil palm trunks.

LVL samples	Total samples tested	Samples passed test	Samples failed tests	% passed tests
AX	360	358	2	99.44
AY	360	320	40	88.88
BX	360	353	7	98.05
BY	360	312	48	86.67
RBW	360	342	18	95.00

(all value represent mean of 10 replicates)

Table 3. Bending parallel to the grain flatwise position

LVL samples (flatwise)	Density (kg/m^3)	MOR (N/mm^2)	MOE (N/mm^2)
AX	560.63 (-18%)	19.29 (-65%)	712.84 (-71%)
AY	486.97 (-29%)	15.13 (-73%)	480.06 (-81%)
BX	524.70 (-24%)	18.84 (-66%)	674.61 (-73%)
BY	419.02 (-39%)	11.05 (-80%)	405.83 (-84%)
RBW	689.15 (-00%)	56.57 (-00%)	2543.34 (-00%)

(all value represent mean of 10 replicates; value in bracket indicate % lower than rubberwood)

Table 4. Bending parallel to the grain edgewise position

LVL samples (edgewise)	Density (kg/m^3)	MOR (N/mm^2)	MOE (N/mm^2)
AX	559.11 (-19%)	24.63 (-57%)	1501.11 (-50%)
AY	475.29 (-31%)	21.02 (-63%)	1156.51 (-61%)
BX	530.08 (-23%)	21.97 (-62%)	1165.11 (-61%)
BY	409.33 (-41%)	13.04 (-77%)	816.47 (-73%)
RBW	682.23 (-00%)	57.94 (-00%)	2991.41 (-00%)

(all value represent mean of 10 replicates; value in bracket indicate % lower than rubberwood)

Table 5. Bending perpendicular to the grain flatwise position

LVL samples (flatwise)	Density (kg/m^3)	MOR (N/mm^2)	MOE (N/mm^2)
AX	582.15 (-17%)	1.95 (-47%)	117.39 (-61%)
AY	483.14 (-31%)	1.35 (-64%)	109.69 (-64%)
BX	509.35 (-27%)	1.53 (-59%)	114.18 (-62%)
BY	424.23 (-40%)	1.33 (-64%)	106.68 (-65%)
RBW	695.51 (-00%)	3.71 (-00%)	304.73 (-00%)

(all value represent mean of 10 replicates; value in bracket indicate % lower than rubberwood)

Table 6. Bending perpendicular to the grain edgewise position

LVL samples (edgewise)	Density (kg/m^3)	MOR (N/mm^2)	MOE (N/mm^2)
AX	565.72 (-19%)	2.09 (-51%)	205.27 (-53%)
AY	488.29 (-30%)	1.66 (-61%)	177.08 (-59%)
BX	513.14 (-27%)	1.74 (-59%)	180.58 (-58%)
BY	406.03 (-42%)	1.43 (-67%)	154.71 (-64%)
RBW	692.12 (-00%)	4.33 (-00%)	432.63 (-00%)

(all value represent mean of 10 replicates; value in bracket indicate % lower than rubberwood)

Table 7. Shear of the oil palm LVL

LVL samples	Density (kg/m^3)	Shear (N/mm^2)
AX	596.77 (-15%)	1.71 (-59%)
AY	492.62 (-30%)	1.23 (-71%)
BX	589.20 (-16%)	1.41 (-67%)
BY	441.67 (-37%)	0.76 (-82%)
RBW	696.54 (-00%)	4.27 (-00%)

(all value represent mean of 10 replicates; value in bracket indicate % lower than rubberwood)

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Analysis of TPS's Actualization Problem in China and the Countermeasure

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Abstract

As an effective production system, TPS (Toyota Production System) has been gone in for by numerous domestic and foreign factories recently. However, it is not effectively as in Japan actually, and many problems appear. This article analyses TPS's domestic operational status, and put forward a set of reasonable countermeasures and proposals. This analysis will promote the TPS applicability research and guide the domestic enterprises to push TPS entirely.

Keywords: TPS (Toyota Production System), Problem, Countermeasure and proposal

1. Introduction

TPS (Toyota Production System), what is concluded by Taiichi Ohno as "The necessary products, must be completed only in the necessary time, spending the lowest cost, as the necessary number", has promoted Toyota and even the whole Japanese manufacturing industry's development. In this increasingly competitive society, how to reduce waste, lower cost and maximize profits would be the most important point to the manufacturers. TPS, as a resultful system, turn to the focus, however, in China, for the implementation of TPS is still in the initial stage, and our domestic social and cultural environment is very different, TPS brought not much production as we expected. Under such environment, systematic analysis of domestic implementation of TPS become very necessary, therefore, this paper analyses TPS's domestic running status, and on this basis, brings forward reasonable countermeasures.

2. Brief Introduction of TPS

TPS came forth in 1947. Taiichi Ohno, as its founder, studied from the appropriate cooperation of people and machine, and gradually created popular TPS in 1974.

TPS, taking Just-In-Time, Total Quality Management, Team Working methods and Concurrent Engineering as platform, is a production mode, which enhances enterprises' competitiveness through the elimination of all waste and thereby the shorten of products' Production cycle. Its guiding ideology is" Maximize output via minimize input through optimization of the overall production process, improvement of technology, elimination of superfluous production, availability of making use of resources, reduction of cost and improvement of quality.". Besides, Taiichi Ohno pointed out that the two backbones of TPS are Just-In-Time and automation.

3. Analysis of the Problem that Came into Being in the Process of TPS's Implantation in China

Since TPS came out, manufacturing has acquired tremendous achievement. Many Chinese factory saw its magic power and began studying and actualizing but resulted a little. After all, TPS doesn't give birth to desired effect and our current domestic situation is in badness. The reason for this is various and can be divided into the following aspects:

3.1 National character

TPS's inbeing is challenge to high-point and unremitting reform. And Japan is a tiny country, lack of materials, in addition, often suffers from disasters, which makes Japanese people hold a sense of crisis and tragedy, so they can experience and observe meticulously and saving a lot. Whereas our national domain is more expansive, which makes

Chinese people can't understand economy forethoughtfully.

3.2 Social culture

For a long time, some factors in our social cultural make Chinese people create few of habits which go against TPS's implementation.

3.2.1 Paid by the job

Piece wage system once increased production efficiency, and promoted the development of enterprises, but in the side of mobilizing stuff's enthusiasm continuously, this system is adverse. And the piece-wage system essentially encourage employees to produce more, as well as production logistics' status of China is not very optimistic, so this will inevitably lead to an increase in inventory, and waste, which is go against TPS.

3.2.2 Crack-down

Chinese enterprises' pervasive "culture of punishment" is also a major obstacle to practice TPS. No error in work is impossible. In China, once the employee make mistakes, often be accused of not doing in accordance with the regulations and be punished. Very few companies will reflect on whether or not a reasonable business regulations, let alone start to improve this.

3.2.3 Lack of coherence and obligation

Chinese corporate culture and living environment make staff lack of cohesion and sense of responsibility, which is also difficult to implement TPS. Toyota's products' quality relies on self-inspection and checks each other, which, by contraries, will bring contradiction and alienation between the staff.

3.2.4 Lack of awareness of obeying

In Japan, staff will definitely obey orders of leadership, but it is not feasible in China. We are in defect of such awareness and our self-centered awareness is too strong, which makes it more difficult to accept TPS for the Chinese.

3.2.5 Agriculture thinking

We Chinese are used to keep food to prevent natural disasters. Enterprise also like keeping raw materials, semi-finished and finished products, if not, they will be fear. We all know that it run afoul of Just-In-Time, Therefore, in order to learn TPS, we must get out of this agricultural sense.

3.3 Only learning is useless

Many Chinese companies have learned or be learning TPS, but only learn not practice. The essence of TPS is "doing", and only the reform in practice is really reform.

3.4 Copy is of no effect

Currently, most of the enterprises learn TPS and copy it as a method, in fact TPS is only an ideological manner, and its specific method should be combined with company's specific instance.

3.5 Weak management foundation

The implementation of TPS need a higher level of management foundation, Such as: advanced operation methods, reasonable logistics system, scientific standards and intact equipment. However, most of domestic enterprises have developed for few years and own weak basic management.

3.6 The sense of equipment is more important than management

Chinese factories pay more attention on equipment level and technology ability. As long as implement TPS, they call for more and more equipment. But factually, implementation of TPS needs us to improve efficiency and get rid of waste.

3.7 Fine division of work

Chinese companies have detail work division internally. Firstly, our Chinese consider that duty must be clear. Secondly, we still think fine work division can result higher efficiency. And lastly, unstable employment policy cause those Chinese enterprises would not like to bring up employee chronically.

As a result, lack of flexibility lead staff can't support each other. Otherwise, TPS system needs staff not only has his party.

4. Countermeasure and Proposal

Through the above analysis, problems with TPS's implementation in China are obviously, and then corresponding proposals are as follows:

4.1 Improvement is basis

Aiming at the status quo (majority of enterprises have weak management foundation), this paper suggest that

implantation of TPS begin from continuous improvement. Begin from practicing 5S, improving operation methods and so on.

4.2 Employee training

As an enterprise, who employ employee, should self-reflect the reason for staff's resignation. As long as setting up good employment mechanism, and do long-term pre-job training or job training to staff, companies can practice glancing job division, which is the base of TPS.

4.3 Corporate culture with coherence

Only united organization can make staff improve production continuously, can also provide ancillary components to ensure timely production. Therefore, try best to form united organization is also necessary.

4.4 Action is always more useful than learning

Only training and learning is of no use. In current time, efficiency can't come from thinking. We must grasp the opportunity and do action.

4.5 Advanced equipment is not the focus

Advanced equipment is not the focus of TPS, enterprises must change thinking, and start from where they are, use where they own. Here we quote a very important improvement order: the first step: improve operations at not cost but wisdom; step 2: improve equipment; step 3: improve layout.

4.6 We should protect environment

Chinese economy is in a period of rapid development, but how to ensure our economic development while protecting environment is the task that every company face. We should not damage to our environment for the sake of temporary development.

5. Conclusion

China's implementation of TPS is still in the initial stage, so we need more learning and reform. Besides, it must be pointed out that if Chinese companies combine the TPS's successful example with their own characteristics, and find a mode for themselves, TPS will bring us more!

References

Guo, Zhenyu.(1998). "TPS and Industrial Engineering". Industrial Engineering and Management (December, 1998).

Pao, Maling. (2008). What is TPS? [Online] Available: http://www.pkvs.net/templates/1/article.asp?newsid=10961&u=paomaling (April, 2008).

Wang, Da. (2006). The most eye-catching ideas of Jack—Lean production. [Online] Available: http://www.fzfs315.com/news/news/2006919114542.html(September,2006).

Xiong, Shengxu(2002). "Analysis on TPS's Character and Rationality". Social Science of Hubei, 70-71.

Yang,Zhuang. (2007) "Why can't we implement TPS effectively?" International business administration, 62-65.

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Soil Nitrogen Phosphorus and Tea Leaf Growth in Organic and Conventional Farming of Selected Fields at Sabah Tea Plantation Slope

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Abstract

A comparative study of organic and conventional farming system at three different slope sections was conducted in Sabah Tea Plantation to determine the effect of management practices and slope section on soil nitrogen, phosphorus and pH as well as tea leaves size. Soils from two selected fields; B29 (conventional field) and NO3 (organic field) in Sabah Tea Plantation were analyzed using selected soil analysis method with UV spectrophotometer. Organic farming system resulted in significantly higher level of soil pH (4.14), leaf length (15.14 cm) and leaf width (7.33 cm) than conventional farming system soil pH (3.38), leaf length (13.19 cm) and leaf width (5.58 cm). However, conventional farming system produced higher levels of ammonium content (166.16 μg ml^{-1}) than organic farming system (22.56 μg ml^{1}). No significant difference in soil Phosphorus and nitrate content were observed between two farming systems. Results also showed no significant effects of slope sections on all parameters studied. This study has provided basic knowledge on soil Nnitrogen, phosphorus as well as tea growth of organic and conventional farming in Sabah Tea Plantation.

Keywords: Nitrogen, Phosphorous, Conventional, Organic

1. Introduction

Tea has become increasingly popular nowadays due to its potential pharmacological properties such as antioxidative, antitumor and anticarcinogenic activities (Yamamoto et. al., 1997). Tea is consumed as part of daily diet to reduce the risk of cardiovascular disease and cancer, especially among men (Tsubono et. al., 2002). This has lead to the increase of about 6.2% of world tea production, from 3,146,000 metric tone in year 2003 to 3,342,000 metric tone in year 2004 (FAO 2007). Organic farming is replacing conventional farming gradually due to increasing demands for organic food and growing environmental concerns (Hansen et. al., 2001) Conventional farming often gives a lot of negative impacts such as soil erosion, nutrient runoff, loss of organic matter, impairment of environment quality, pollution of natural water by agricultural chemical and potential hazard to human and animal health from heavy use of pesticides (Diepeningan et. al., 2006) Studies reported that organic farming able to increase the level of total nitrogen, nitrate and available phosphorus in soil and preventing nutrients leaching (Hansen et. al., 2001) Slope effect on nutrients and soil fertility is closely related to soil erosion and run-off. Soil erosion often happens during rainfall at steep slopes and is a complex phenomenon resulting from soil detachment by raindrop impact and surface flow, and transport of particle by rain splash and surface flow (Anderson & Ingram 2001) Soil losses by erosion affect physical, chemical and biological

soil properties. Erosion also selectively decreases the nutrient and organic matter content (Lobo et. al., 2005). Steep slopes (>25º) together with acid soil and high rainfall is not considered to be a sustainable land use system, due to high nutrient losses mainly through erosion (Fagerström et. al., 2002). Very little research was done on tea crop in Malaysia, especially in Sabah regarding its soil nutrients under organic and conventional farming system and their potential effect on tea leaf growth. Moreover, the potential effect of slope section on soil nutrients content and tea leaf growth in tea plantation still not well understood. Thus, study was done to compare soil nitrogen and phosphorus content as well as tea leaf growth of two factors; first, different farming system (organic or conventional) and second, different slope sections at Sabah Tea Plantation.

2. Research merhods

2.1 Study site

Sabah Tea Plantation (STP) is located at Kampung Nalapak (5º 55' 58.53" North, 116 º 46' 22.44" East) of Ranau, Sabah with approximate 6,200 acres tea plantation area. The mean temperature of the study site ranges from 25 to 31 ºC and the annual rainfall is approximately 2,000 mm year^{-1}. Soil used in tea plantation mainly consists of sandy loam texture with pH range from 4.0 – 4.5. Two fields were selected for this study; Field B29 (conventional farmed field) and Field NO3 (organic farmed field), which share the same characteristics such as size of area, altitude, date of tea planting, time of fertilizer application and type of tea planted.

2.2 Samples

A total number of 18 soil samples (each soil samples constitute from five sub-soil samples) and 108 middle tea leaves were randomly sampled from the slope of two selected field in STP. The slope of each field was divided into three section; top, middle and low, using Random Complete Block Design (RCBD). Three soil replicates (sampled at depth of 0 – 15 cm) and 18 leaves were sampled from each section of slope. Soil samples were air-dried as soon as possible after sampled at temperature 30 – 35 ºC. Soil samples were ground and sieved through a two mm mesh before analysis take part (Dang 2004).

2.3 Physical measurement and chemical analyses

Tea leaves were measured manually for their length and width using ruler. Soil pH was determined using pH meter with soil-water ratio, 1:2.5 (Anderson & Ingram 1993). Soil available ammonium, nitrate and phosphorus were determined following the method as described by Page et. al., 1982, Cataldo et. al., 1975 and Mehlich-3 test with the use of Varian 50 Win UV Spectrophotometer. The concentration of nutrient in filtrate (µg ml^{-1}) was converted into kg ha^{-1} by multiplying with 2.0 x 10^6 (one hectare of soil at the depth of 15 cm is equivalent to 2.0 x 10^6 kg).

3. Results and discussion

3.1 Effects of farming systems

Figure 1 show that farming systems only significantly affecting soil ammonium ($p = 0.020$), soil pH ($p = 0.000$), leave length ($p = 0.001$) and leaf width ($p = 0.000$). Soil phosphorus ($p = 0.128$) and nitrate ($p = 0.065$) are not significantly affected by any farming systems. Organic farming system (OFS) resulted in higher soil pH (4.14), leaf length (15.1 cm) and leaf width (7.3 cm) while conventional farming system (CFS) resulted in higher soil ammonium content (166.2 µg ml^{-1}).

3.2 Effect of farming system on soil ammonium

Higher concentration of soil ammonium in CFS may due to excessive application of nitrogen fertilizers. Moreover, organic fertilizer nutrient availability to plants depend on many environmental factors such as soil aeration, soil moisture, soil pH, temperature as well as the C: N ratio of the organic materials before decomposition and mineralization can take place. In other words, organic fertilizers require more time before nutrients become available for plant use as compared to chemical fertilizers (Assouline & Ben-Hur 2006, Tisdale and Nelson 1975, Zech et. al., 1997). Higher content of ammonium in CFS soil may also due to the decrease in soil nitrogen absorption by tea plants due to plant toxicity. In tea plantations, excessive amounts of nitrogenous fertilizers are usually applied to ensure nitrogen is available for tea crop use (Oh et. al., 2006) Salisbury and Ross, 1992 reported that excessive supply of nitrogen in soil can leads to N toxicity in plant and nitrogen toxicity was an inhibitory to plant growth and development (Caicedo et. al., 2000).

3.3 Effect of farming system on tea leaf growth

Excessive amount of nitrogen were present in the soil, the positive response progressively declined and even became negative. This could be the reason for the lower tea leaf size in the CFS which had very high level of soil nitrogen. Willson and Clifford, 1992 reported, for unshaded tea, the increase in crop yield is directly proportional to the amount of nitrogen applied. Studies also showed OFS can produce higher yield of tea compared to CFS due to its ability to improve soil quality such as increase in nutrient, microbial biomass content and reduced soil acidity (Flieβbach et. al.,

2007, Marinari et. al., 2006). Acidic soil such as in the CFS is not a favorable condition for tea plant to maximize its yield production as acidification can result in plant root damage and reduce plant productivity (Kauppi et. al., 1986) Besides, recommended soil pH for tea cultivation is 5.0-5.6 (Willson & Clifford 1992) and the pH in CFS is far below this range, indicating the unsuitability of CFS acidity level for tea productivity at STP. Moreover, excessive amount of ammonium in soil was considered potentially inhibitory to plant growth and development due to plant toxicity (Caicedo et. al., 2000). Plant toxicity can retard the growth and development of tea leaf and might consequently resulted in lower leaves size.

3.4 Effect of farming system on soil pH

Studies showed that nitrogenous fertilizers used in tea cultivation (CFS) such as ammonia sulphate, ammonium nitrate, ammonium sulphate nitrate, urea, calcium ammonium nitrate and ammonium chloride, are acid producing (Ma et. al., 1990, Tee et. al., 1987) Long-term tea cultivation even caused serious soil acidification (77% of 70 tea fields having pH below 4.0) as a consequence of heavy nitrogen (N) application (Oh et. al., 2006). Study also shows the continuous use of ammonium sulphate without the addition of lime will reduce the soil pH to level that is unsuitable for economic production of crops (Tisdale & Nelson 1975) Vogt et. al., 2006 showed that substantial part of the potential acidity was represented by deposition of ammonium ($NH4^{+}$). These facts are consistent with the result obtained from this study, where CFS was produced higher level of soil acidity.

3.5 Effect of farming on soil nitrate

No significant different of soil nitrate content in any farming system may due to low content of nitrate in both fields as a result of leaching and denitrification. Nitrate is known to be very mobile in soil and moves largely with the soil water. Under conditions of excessive rain it will leach out from the upper horizons of the soil into deeper layers (Tisdale & Nelson 1975). Furthermore, through denitrification process, nitrate may be lost in the form of nitrous oxide at pH level 4.9 to 5.6 (Wilson & Clifford 1992) as a result of excessive nitrogen application (Oh et. al., 2006). Diepeningen et. al., 2006 also reported similar results in their study comparing the effects of organic and conventional management on chemical and biological parameters in agricultural soil. They suggest that soil type (clay or sandy soil) has a stronger effect on the soil characteristics rather than management type.

3.6 Effect of farming system on soil phosphorus

No significant differences in soil phosphorus content in both farming systems were observed. Ionic forms of phosphorus ($H_2PO_4^{-}$) readily react with oxides (hydroxide), iron and aluminium which are abundant in acid soil, to form insoluble compounds that is hard to be extracted from soil (Tisdale & Nelson 1975, Wilson & Clifford 1992). The incomplete extraction of phosphorus (P) from soil can some how lead to the inaccurate result. However, Diepeningen et. al., 2006 also reported the similar result in their study, suggesting that soil type (clay or sandy soil) has a stronger effect on the soil characteristics rather than management type.

3.7 Effect of slope sections

Table 1 show that none of the parameters studied show significant difference at different slope sections; ammonium ($p = 0.646$), nitrate ($p = 0.711$), phosphorus ($p = 0.686$), leaf length (0.202), leaf width ($p = 0.684$) and soil pH (0.174).

3.8 Effect of slope sections on all parameters

Results from this study showed no significant differences for all parameters for the different slope sections. The dense tea canopies in Sabah Tea Plantation reduce the impacts of raindrop that can cause soil detachment, surface flow and transport of particle by rain splash (Anderson & Ingram 1993). Minimum soil loss by erosion does not have a significant impact on soil properties (Lobo et. al., 2005) and this was consistent with the result obtained from this study, wherein no significant differences in all parameters for the different slope sections were observed. This can be explained by the presence of dense tea canopies.

4. Conclusion

In conclusion, types of farming systems do significantly affecting soil pH, ammonium and leave length and leaves width. OFS promotes better soil pH (4.14), leaf length (15.1 cm) and leaf width (7.3 cm) but lower ammonium content (22.6 µg ml-1). CFS produces higher ammonium content (166.2 µg ml-1), but lower soil pH (3.38) and leaf length (13.2 cm) and leaf width (5.6 cm). Phosphorus and nitrate were not affected by any of the farming system. Slope levels, on the other hand, show no influence on any parameters studied.This study has provided basic knowledge about soil N, P and pH as well as tea leaves growth of Sabah Tea Plantation (STP).

References

Anderson, J. M. & Ingram, J. S. I. (Eds.) (1993). *Tropical soil biology and fertility - A handbook of methods*. Second Edition. United Kingdom: CAB International.

Assouline, S. & Ben-Hur, M. (2006). Effects of rainfall intensity and slope gradient on the dynamics of interrill erosion during soil surface sealing. *Catena*, 66, 211-220.

Benitez, C., Bellido, E., Gonzalez, J. L. & Medina, M. (1998). Influence of pedological and climatic factors on nitrogen mineralization in soil treated with pig slurry compost. *Bioresource Technology*, 63 (2),147-151.

Caicedo, J. R., Steen, N. P., Arce, O. & Gijzen, H. J. (2000). Effect of total ammonia nitrogen concentration and pH on growth rate of duckweed (*Spirodela polyrrhiza*). *Water Research*, 34 (15),3829-3835.

Cataldo, D. A., Haroon, M., Schrader, L. E. & Youngs, V. L. (1975) Rapid colorimetric determination of nitrate in plant tissue by nitration of salicylic acid. In Anderson, J. M. & Ingram, J. S. I. (Eds.), *Tropical soil biology and fertility –A handbook of methods*. Second Edition. United Kingdom: CAB International.

Dang, M. V. (2004). Soil-plant nutrient balance of tea crops in the northern mountainous region, Vietnam. *Agriculture, Ecosystem and Environment*, 105,413-418.

Diepeningen, A. D., Vos, O. J. Korthals, G. W. & Bruggen, A. H. C. (2006). Effects of organic versus conventional management on chemical and biological parameters in agricultural soils. *Applied Soil Ecology*, 31 (2),120-135.

Fagerström, M. H. H., Nilsson, S. I., Noordwijk, M. V., Phien, T., Olsson, M., Hansson, A. & Svensson, C.(2002). Does *Tephrosia candida* as fallow species, hedgerow or mulch improve nutrient cycling and prevent nutrient losses by erosion and slopes in northern Viet Nam? *Agriculture, Ecosystem and Environment*, 90, 291-304.

FAO, (2007). FAO statistical yearbooks 2005/2006 (issue 1) [Online] Available: http://www.fao.org/statistics/yearbook/vol_1_1/index_en.asp (July, 8 2007)

Flieβbach, A., Oberholzer, H. R., Gunst, L. & Mäder, P. (2007). Soil organic matter and biological quality indicators after 21 years of organic and conventional farming. *Agriculture, Ecosystem and Environment*, 118 (4), 273-284.

Hansen, B., Alrøe, H. F. & Kristensen, E. S. (2001). Approaches to assess the environmental impacts of organic farming with particular regard to Denmark. *Journal of Agriculture, Ecosystem and Environment*, 83 (1-2), 11-26.

Kauppi, P., Kämäri, J., Posch, M. & Kauppi, L. (1986). Acidification of forest soils: Model development and application for analyzing impacts of acidic deposition in Europe. *Ecological Modelling*, 33 (4), 231-253.

Lobo, D., Lozano, Z. & Delgado, F. (2005). Water erosion risk assessment and impact on productivity of a Venezuelan soil. *Catena*, 64, 297-306.

Ma, W. C., Brussaard, L. & Ridder, J. A. (1990). Long-term effects of nitrogenous fertilizers on grassland earthworms (Oligochaeta: Lumbricidae): Their relation to soil acidification. *Agriculture Ecosystem and Environment*, 30 (2), 71-80.

Marinari, S., Mancinelli, R., Campiglia, E. & Grego, S. (2006). Chemical and biological indicators of soil quality in organic and conventional farming systems in Central Italy. *Ecological Indicator*, 6 (4), 701-711.

Mehlich, A. (1984). Mehlich 3 soil test extractant: A modification of the Mehlich 2 extractant. In Frank, K., Beegle, D. & Denning, J. (eds.), *Recommended Chemical Soil Test Procedures for The North Central Region*. United State of America: North Central Regional Research Publication.

Oh, K., Kato, T., Li, Z. P. & Li, F. Y. (2006). Environmental problems from tea cultivation in Japan and a control measure using calcium cyanamide. *Pedosphere*, 16 (6), 770-777.

Page, A. L., Miller, R. H. & Keeney, D. R. (1982). Ammonium by colorimetric method– Indophenol blue method. *Method of Soil Analysis Part II – Chemical and Microbiological Properties*. American Society of Agronomy, pp. 672 – 676.

Salisbury, F. B. & Ross, C. W. (1992). *Plant Physiology*. Fourth Edition. California: Wadsworth Publishing Company.

Tee, B. G., Dudas, J. M., Pawluk, S. & Harapiak, J. T. (1987). Physical, chemical and micromorphological effects of nitrogen fertilizers on Chernozemic soils. *Geoderma*, 40 (2), 177-192.

Tisdale, S. L. & Nelson, W. L. 1975. *Soil fertility and fertilizers*. Second Edition. New York: Macmillan Publishing Co.

Tsubono, Y., Takahashi, T., Iwase, Y., Iitoi, Y., Akabane, M. & Tsugane, S. (2002). Dietary differences with green tea intake among middle-aged Japanese men and women. *Journal of Preventive Medicine*, 26 (5), 704-710.

Vogt, R. D., Seip, H. M., Larssen, T., Zhao, D. W. & Xiang, R. (2006). Potential acidifying capacity of deposition: Experiences from regions with high NH_4^+ and dry deposition in China. *Science of the Total Environment*, 367 (1), 394-404.

Willson, K .C. & Clifford, M. N. (1992). *Tea – Cultivation to consumption*. First Edition. United Kingdom: Chapman and Hall.

Yamamoto, T., Juneja, L. R., Chu, D. C. & Kim, M. (1997). Second Edition. *Chemistry and Appliactions of Green Tea*. New York: CRC Press.

Zech, W., Senesi, N., Guggenberger, G., Kaiser, K., Lehmann, J., Miano, M. T., Miltner, A. & Schroth, G. (1997). Factors controlling humification and mineralization of soil organic matter in the tropics. *Geoderma*, 79, 117-161.

Table 1. Means values and standard deviation for six parameters studied under different farming systems and slope sections. Means with the same letter indicate no significance difference ($p < 0.05$).

Parameters	**OFS (mean ± standard deviation)**			**CFS (mean ± standard deviation)**		
	Top	**Middle**	**Low**	**Top**	**Middle**	**Low**
Ammonium (µg/ml)	27.37[a] ± 17.27	18.90 [a] ± 1.57	21.40 [a] ± 7.61	218.97 [b] ± 98.09	178.20 [b] ± 246.12	101.30 [b] ± 79.24
Nitrate (µg/ml)	11.73 [a] ± 2.61	9.38 [a] ± 7.02	7.57 [a] ± 2.78	22.10 [a] ± 3.49	14.43 [a] ± 15.86	22.00 [a] ± 17.96
Phosphorus	20.97 [a] ± 10.65	28.03 [a] ± 17.80	8.53 [a] ± 1.70	35.33 [a] ± 15.83	23.20 [a] ± 9.99	33.03 [a] ± 22.67
Soil pH	3.83 [a] ± 0.25	4.10 [a] ± 0.37	4.48 [a] ± 1.67	3.43 [b] ± 0.44	3.42 [b] ± 0.55	3.28 [b] ± 0.23
Leaf length (cm)	14.57 [a] ± 0.92	15.20 [a] ± 1.51	15.67 [a] ± 1.17	12.67 [b] ± 0.25	13.37 [b] ± 0.38	13.53 [b] ± 0.49
Leaf width (cm)	7.10 [a] ± 0.20	7.43 [a] ± 0.81	7.47 [a] ± 0.55	5.67 [b] ± 0.58	5.33 [b] ± 0.15	5.73 [b] ± 0.64

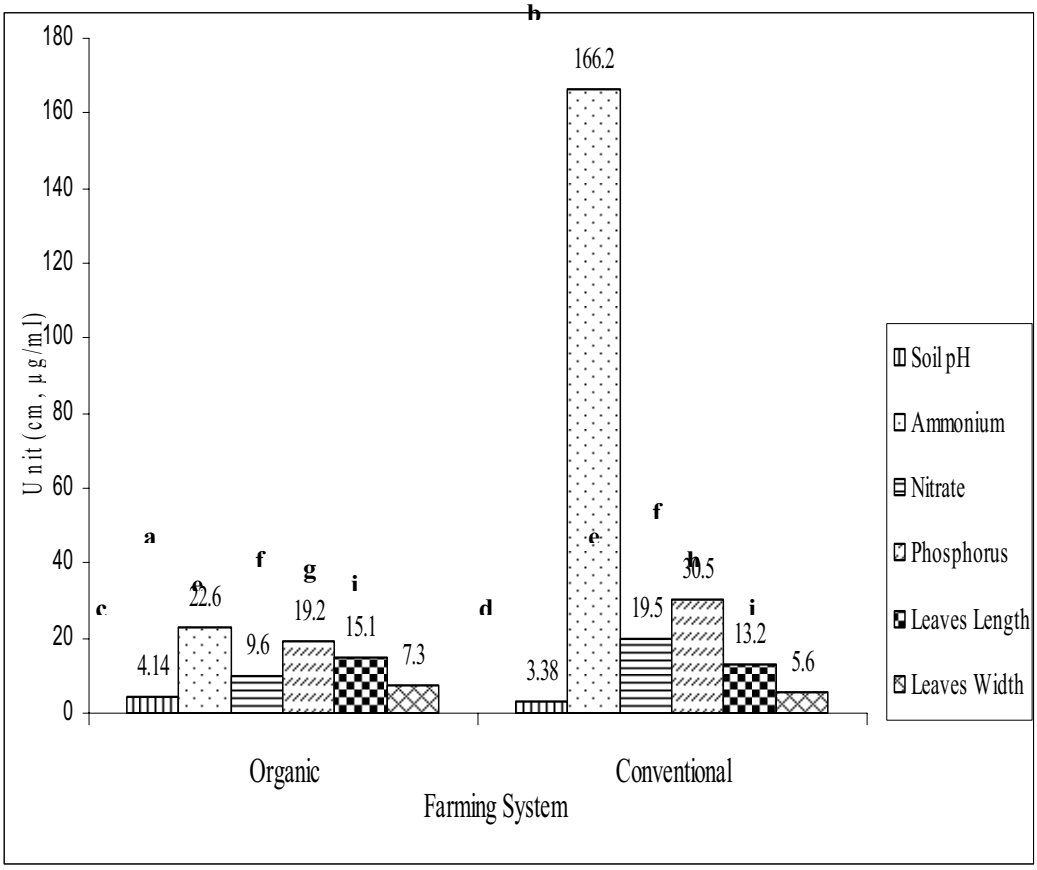

Figure 1. Mean values for six parameters studied under two different farming systems.

Bars with the same letter indicate no significant differences ($p < 0.05$).

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Drying Kinetics of Saw Dust in Tray Dryer

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Abstract

Drying kinetics of palm wood saw in tray drying covering wide range in operating conditions have been investigated in the present study. The drying rate increased with an increase in the temperature and flow rate of the heating medium increased, and decreased with an increase in the bed height. A model has been developed based on Fick's law of diffusion to explain the drying kinetics.

Keywords: Drying kinetics, Palm wood sawdust, Tray dryer, Kinetic model

1. Introduction

Malaysia contributes more than 50% of the world palm oil production. Palm tree based plywood's are increasingly used due to its environmental friendliness. Nearly 100,000 hectares of replanting is carried out every year. Several saw mills ranging from small scale to large scale engaged in plywood production resulting generation of large amount of saw dust. The saw dust generated during plywood processing finds extensive applications in compressed powder boards, fuel pellets, mosquito coils, incense sticks, activated carbon etc. The mosquito coils prepared based on sawdust are reported to have less toxic compared to the coils prepared using coconut shells, resulting larger potential for utilization of saw dust for mosquito coil production (Akpinar et al., 2003; Crank, 1975) . Further the large scale saw mills can utilize the saw dust for cogeneration facility utilizing Integrated Gasification Combined Cycle (IGCC) technology. The high moisture content of saw dust deteriorates the quality of sawdust resulting restricted application. This forces the researchers to design a suitable drying unit to handle the saw dust for longer storage and cost reduction in transportation.

Drying is fundamentally a simultaneous heat and mass transfer operation and used for various thermal energy applications. Several drying methods have been proposed in the literature for high quality products. Among the drying techniques, tray drying is one of the most frequently used methods in chemical process industries. A proper drier design requires knowledge on the characteristics of the material to be dried and the drying kinetics. Extensive work has been reported in literature on tray drying, with respect to kinetics, mechanism and modeling (Larson at al., 2001; Marcello and Osvaldir, 2007; Srinivasakannan et al., 1995). The present study attempts to study the drying kinetics of drying of palm sawdust covering wide range in operating conditions.

2. Experimental

The sawdust collected from near by palm tree industry was 2 mm in size with 93% moisture. The samples moisture content were estimated by standard weight difference method and reported on dry basis (kg of moisture/kg of dry sawdust). The initial moisture content of the samples was estimated for each experimental run. Figure 1 shows the schematic representation of drying set-up. It consists of a fan, heating system, a drying chamber with tray and a weighing balance. The weighing balance had an accuracy of ± 0.01g. The drying chamber has the dimensions of 3m X 0.3mX 0.3m with a facility to load and unloading. The material depth in the tray can be varied with material loading. Experiments were conducted by varying material loading, temperature of heating medium and moisture content.

3. Results and Discussion

The drying medium was allowed at a desired flow rate and temperature. The temperature of the drying medium was recorded at both inlet and outlet of the drying chamber. Once the flow rate and temperature of the drying medium reached steady state, a known quantity of known moisture content of saw dust was taken in the holder and fed into the chamber. Experiments were carried out covering wide range in operating conditions: flow rate and temperature of the drying medium and material holdup and the experimental results are discussed below:

The Figure 2 shows the variation of moisture content with drying time. It can be ascertained from the figure that the rate of drying increases with increase in the temperature of the drying medium. This phenomenon is well known and it is generally attributed to the increase in diffusivity of moisture at higher temperatures. The flux between heating medium and the solid material increased with increase in the temperature of the heating medium, due to increased thermal and mass driving force resulting in increased drying rate.

The influence of the flow rate of drying medium on drying rate is shown in Figure 3. It can be seen from the figure that the drying rate increases with an increase in the flow rate of the drying medium. This can be explained that an increase in the flow rate of the drying medium reduces the external resistance for mass transfer and hence an increased drying rate. The external mass transfer resistance is significant during the early stages of drying and becomes less significant at the later stages of drying where the internal resistance for moisture transfer plays an important role. This is evident from the Figure 3 that the high slope of the drying curve during early stages of drying where the moisture content is high. This observation qualitatively matches with reported observation (Srivastava et al., 2002)

The Figure 4 shows the influence bed loading on the drying rate. The Figure 4 is plotted for two different bed heights of $3x10^{-3}$ and $5x10^{-3}$m respectively. It can be ascertained from the Figure 4 that an increase in solid loading decreases the drying rate. This can be explained that an increase in the solid loading increases the bed height which eventually increases the distance for the moisture movement to reach the surface of the bed resulting in reduction in the drying rate. Since the moisture diffusion in tray dryer is unidirectional, the moisture should diffuse through the bed void to reach the top of the bed for drying which results in a significant reduction in the drying rate with the bed height. Further it can be ascertained from the Figures 2 to 4 that the saw dust material used in the present investigation exhibits complete falling rate period with insignificant constant rate period. Since the material exhibits only falling rate period, the moisture movement can be modeled using Fick's Diffusion to estimate the effective diffusion coefficient. The drying chamber is considered as rectangular slab of thickness 2L having unidirectional flow of moisture with uniform initial moisture content as,

$$\frac{\delta X}{\delta t} = D \frac{\delta^2 X}{\delta r^2} \qquad (1)$$

the following boundary conditions can be used to solve the equation (1),

at t = 0 $0 < r < L$ $X = X_o$

at t > 0 r = 0 $\delta X/\delta r = 0$

at t > 0 r = L $X = X_e$

The analytical solution of the above equation can be obtained from (Weili et al., 2003) as

$$\frac{X - X_e}{X_0 - X_e} = \frac{8}{\pi^2} \sum_{n=1}^{\infty} \frac{1}{(2n+1)^2} \exp\left[\frac{-(2n+1)^2 \pi^2 Dt}{4L^2}\right] \qquad (2)$$

The diffusion coefficient is estimated by minimizing the standard deviation between the experimental data and the prediction using equation (2) as given below,

$$SSE = \sqrt{\frac{\sum_{i=1}^{n} \left(X_{i,pre} - X_{i,\exp}\right)^2}{N}} \qquad (3)$$

The Table 1 shows the variation of diffusion coefficient with operating parameters. The dependence of diffusion coefficient with temperature of the heating medium is well known from the mass transfer concept. It can be noticed that than an increase in the flow rate of heating medium increases the diffusion coefficient. It can be explained that though the present model accounts only the internal resistance for mass transfer, an increase in the drying rate due to reduction in the external mass transfer during early stage of drying is reflected on the diffusion coefficient (Yutthana et al., 2004). Further it can be noticed that diffusion coefficient is not influenced significantly by the bed depth (L).

4. Conclusion

Experiments were carried out in a tray drier to study the drying kinetics of wood sawdust covering wide range in the operating conditions. A model has been proposed based on Fick's law diffusion and the diffusion coefficients were

estimated under various operating conditions. The present experimental study has given better insight to the drying kinetics in tray drier. The following conclusions can be made from the present investigation:

1. The drying rate increases with an increase in the flow rate and temperature of the heating medium
2. The rate of drying decreased with an increase in the solid loading
3. The diffusivity coefficient increased with an increase in the flow rate and temperature of the heating medium
4. There is no significant effect of bed loading on diffusion coefficient

5. Nomenclature

D	:	Effective diffusion coefficient, m^2min^{-1}
L	:	Thickness of the slab, m
N	:	Number of summation term in equation (3)
r	:	Diffusion path, m
t	:	Time, min
SSE		Sum of squares of error
T_g	:	Temperature of heating medium, $^{\circ}C$
U_g	:	Flow rate of the heating medium, ms^{-1}
X	:	Moisture content of solids at any time `t` , kg of moisture/kg of dry solids
X_o	:	Initial moisture content of solids, kg of moisture/kg of dry solids
X_e	:	Equilibrium moisture content of solids, kg of moisture/kg of dry solids

6. References

Akpinar, E.K., Midilli, A. and Bicer, Y. Single layer drying behavior of potato slices in convective cyclone dryer and mathematical modeling, *Energy Conversion and Management,* 2003, 44, 1689-1705.

Crank, J., The mathematics of diffusion, Oxford, Clarendon Press*,* 1975.

Larson, E.D., Williams, R.H. and Leal, M.R.L.V. A review of biomass integrated gasification/gas turbine combined cycle technology and its application to sugar industries with an analysis for Cuba, *Energy for sustainable development*, 2001, 5(1).

Marcello, N., and Osvaldir, P. T., Drying of beans in a pulsed fluid bed dryer: Drying kinetics, fluid-dynamic study and comparisons with conventional fluidization *Journal of Food Engineering*, *80, 1*, *2007*, *Pages 249-256*

Srinivasakannan, C., Thomas, P.P. and Varma, Y.B.G., Drying of solids in fluidized beds. *Ind. Eng. Chem. Res.*, 1995, 34, 3068-3077.

Srivastava, V. K., and John, J., Deep bed grain drying modeling *Energy Conversion and Management*, *43 13 2002*, *1689-1708*

Weili, L., Junfeng, Z., Jamal, H. Hashim, Juliana, J., Zailina, H., and Bernard D. Gol. Mosquito Coil Emissions and Health Implications, *Environmental Health Perspective,* 2003, 111(2), 1454-1460.

Yutthana, T, Somkiat, P., Warunee, V., and Somchart, S., Simulation and grain quality for in-store drying of paddy *Journal of Food Engineering*, *Volume 64, 2004*, *Pages 405-415*

Table 1. Evaluated Effective Diffusivity Coefficient

Temp °C	**U (ms^{-1})**	**L (m)**	**D X 10^{10} m^2s^{-1}**	**SSE**
40	0.3	0.03	5.0	0.116
50	0.3	0.03	6.0	0.125
60	0.3	0.03	10	0.110
50	0.5	0.03	9.1	0.125
50	0.3	0.05	6.8	0.082

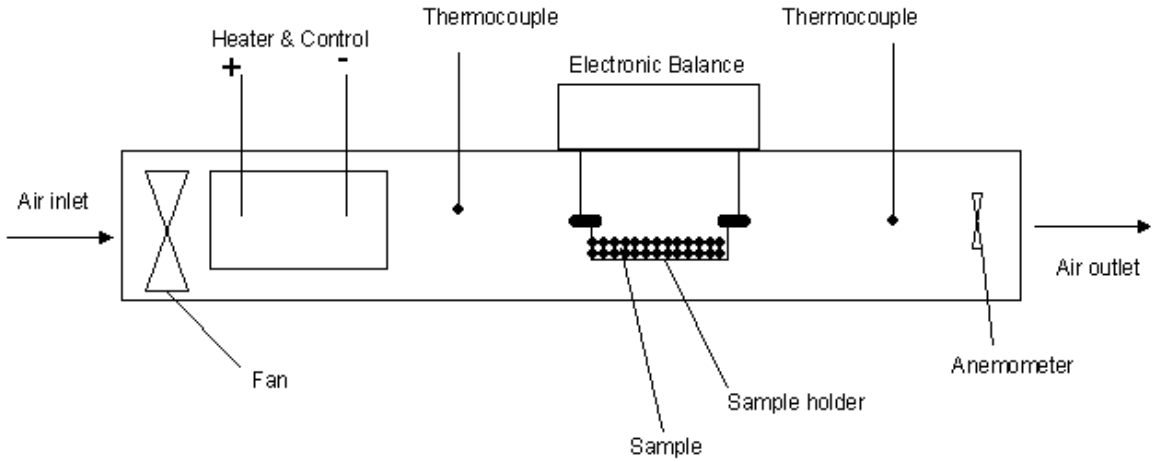

Figure 1. Schematic representation of the experimental set-up.

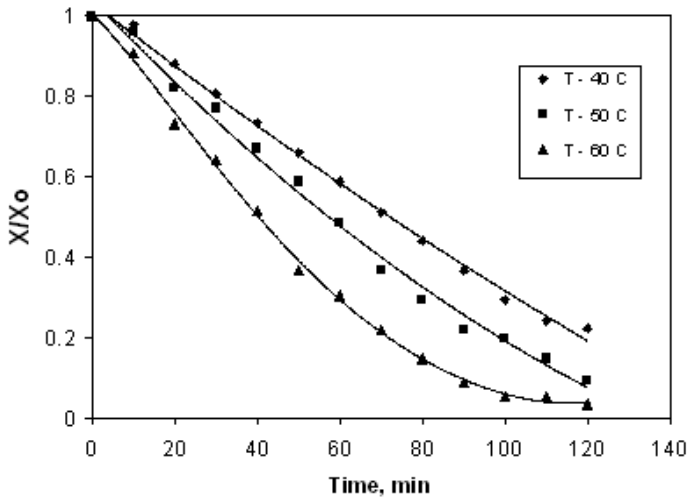

Figure 2. The variation of moisture content with drying time. U_g: 0.3 ms^{-1}; X_o: 0.93; L: 0.003m

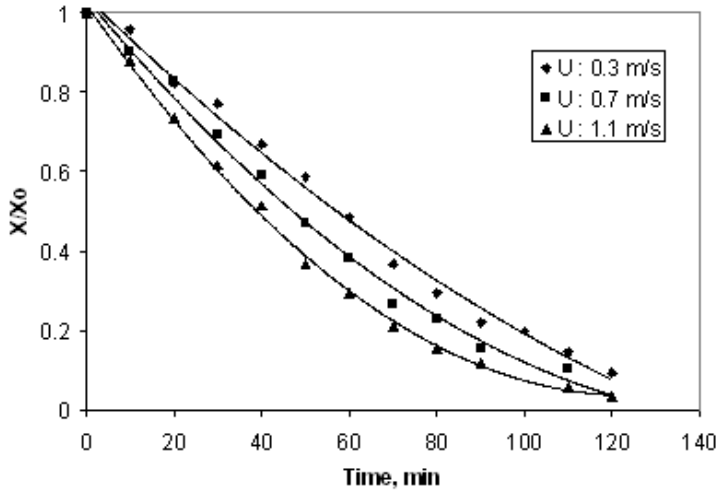

Figure 3. The effect of flow rate of the drying medium on drying rate. T_g: 50°C; X_o: 0.93; L: 0.003m

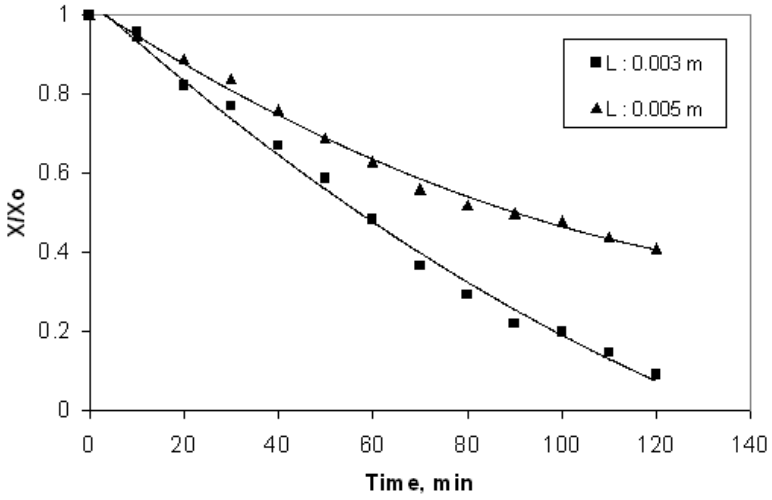

Figure 4. The effect of solid loading on drying rate. T_g: 50°C;, U_g:: 0.3 m/s, X_o:0.93

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Study on the Reverse Osmosis Rejected Water Treatment Process Based on Vacuum Membrane Distillation

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Abstract

In this article, we utilize new high flux PVDF hollow fiber hydrophobic membrane to implement vacuum membrane distillation (VMD) treatment experiment to the rejected water produced in petrifaction enterprise after reverse osmosis (RO) treatment, and we study producing water flux, the change of producing water and rejected water quality with the concentration treatment process and the influence of chemical flocculation on the rejected water treatment effect in the process of VMD. The results indicated that under the conditions of 75℃ and -0.096Mpa, the initial flux of VMD process would achieve 33L/m^{2}h, and the process of VMD combined with chemical flocculation, and when RO rejected water was concentrated to 10 times, the process of VMD was kept above 16L/m^{2}h, and the conductivity of producing water was stabilized in 4~7μS/cm, and the desalination rate was kept above 99.99%.

Keywords: Vacuum membrane distillation, Polyvinylidene fluoride, PVDF hollow fiber hydrophobic membrane, Reverse osmosis rejected water, Wastewater treatment

At present, RO technology has been applied in the wastewater treatment for sea water desalination, urban wastewater treatment, chemical industry, electric power, metallurgy and other industries. But the actual producing water rate in the RO process is only about 50%, so it still face serious discharge problem of rejected water (Zhao, 2005, p.58-59). It is very meaningful to develop high-effective rejected water treatment process to compensate the deficiencies of RO and realize water saving and wastewater reducing (Reddy, 2007, p.240-253 & Wang, 2003, p.49-52). VMD is a sort of new membrane separation process combining membrane technology with traditional distillation technology, and it has many advantages such as low operation temperature, simple equipment and large flux, and it is studied abroad in bitter and salt water desalination, water liquor concentration and volatile organic matter separation (Wu, 2003, p.67-79). The rejection rate of VMD process to inorganic salt, molecule and un-volatile matters could achieve 100%, and it could realize the treatment of high concentration liquor, so VMD technology may be the beneficial supplement or substitute technology for existing RO technology. However, most researches about VMD process centralize in sea water and bitter and salt water desalination, and researches using VMD technology to treat RO rejected water are few.

Aiming at the rejected salt water after RO treatment in petrifaction enterprise wastewater, we adopt hydrophobic polyvinylidene fluoride (PVDF) hollow fiber membrane to develop the experiment of VMD rejected water treatment. We study the influence of rejected water concentration multiple to the treatment effect of VMD in the process of VMD, and the changes of CODcr, conductivity and hardness for rejected water and producing water.

1. Experiment

1.1 Main experiment materials and instruments

PVDF hollow fiber hydrophobic micro-porous membrane, it is made by us, the interior diameter is 0.8mm, the depth of wall is 0.15mm, the average porous diameter is 0.160μm, and the porosity is 85%.

Hollow fiber membrane component, it is made by us, the effective length is 90mm and the effective membrane area is about 0.0226m^2.

RO rejected water of petrifaction enterprise wastewater, the conductivity value is about 6200μS/cm, CODcr is about 100mg/L, the hardness (CaO) is about 1000mg/L, and it is offered by Beijing Research Institute of Chemical Industry.

Electric balance, it is made by Tianjin Tianma Instruments Factory.

DDS-11A Conductivity Meter, it is made by Shanghai Rex Instrument Factory.

1.2 Experiment equipments and running

The experiment system flow of VMD is seen in Figure 1, and it is mainly composed by heat side loop, vacuum side loop and hydrophobic hollow fiber membrane component. The heat side loop mainly includes constant temperature water bathing, magnetic pump and thermometer. The vacuum side loop mainly includes condensation pipe, water cycle vacuum pump and producing water receiver. The RO rejected water on the heat side produces the transfer of heat and quality in the hollow fiber membrane porous, and the steams permeating the membrane porous condensate in the condensation system and are colleted by the producing water receiver.

2. Results and discussions

2.1 Influence of RO rejected water concentration multiple on the VMD treatment performance and the qualities of rejected water and producing water before chemical hardness ridding

From Figures, with the increase of concentration multiple, the membrane flux decreases very quickly, and CODcr, hardness and conductivity of rejected water obviously ascend, and the conductivity of producing water stabilizes in 4~7μs/cm, the CODcr of producing water is in 40mg/L~70mg/L, and the hardness of producing water is 0. The concentration multiple ascends from 1 to 2.5, and the membrane flux decreases from 33L/(m^2·h) to 2.8L/(m^2·h), and the CODcr of rejected water ascends from 104mg/L to 246mg/L, and the harness of rejected water ascends from 1011mg/L to 1305mg/L, and the conductivity of rejected water ascends from 6200μS/cm to 13000μS/cm. In addition, in the process of concentration, many scales occur in the material flume. The reasons that the flux of VMD decreases quickly with the concentration multiple of RO rejected water include two aspects. First, with the increase of concentration multiple, the concentration of RO rejected water gradually increases, which induces the steam pressure decreases. Second, according to the water quality composing of RO rejected water, we can judge that the separated matters include $CaSO_4$, $CaCO_3$, $MgSO_4$ and difficultly soluble salts, which would easily induce the jam of membrane porous, but $CaCO_3$ and $MgSO_4$ have strong conglutination force, so $CaCO_3$, $MgSO_4$ and other separated matters and NaCl crystals may stick on the surface of heat side and form the surface folium to reduce the mass transfer and heat transfer coefficients on the heat side and further quickly reduce the membrane flux of VMD (Qu, 2007, p.14-17). The change of flux with the concentration multiple is the result that both parties function together.

2.2 Influence of total RO rejected water concentration multiple on the VMD treatment performance and the qualities of rejected water and producing water after chemical hardness ridding

Add chemical reagent in the rejected water with 2.5 times concentration, get rid of part of Calcium and Magnesium ions and other contaminations, and filter the deposits by the ultrafitration membrane. Adjust the PH of ultrafiltration liquid to 9.5, and continue the experiment of VMD experiment, and the results are seen in Figure 6 to Figure 9.

From Figures, with the increase of total concentration multiple, the membrane flux decreases, but the decrease extent is small, and the CODcr, hardness and conductivity of rejected water obviously ascend, and the conductivity of producing water stabilizes in 4~7μs/cm, the CODcr of producing water is in 35mg/L~45mg/L, and the hardness of producing water is 0. The concentration multiple ascends from 2.5 to 10, and the membrane flux decreases from 22.2L/(m^2·h) to 17.7L/(m^2·h), and the CODcr of rejected water ascends from 247mg/L to 788mg/L, and the harness of rejected water ascends from 470mg/L to 1560mg/L, and the conductivity of rejected water ascends from 13000μS/cm to 46000μS/cm. In the process of concentration, there are no scale occur in the material flume.

After getting ride of hardness by the chemical flocculation method, the flux attenuation of VMD is obviously less than the attenuation before hardness ridding, and after 10 times concentration, when the conductivity of rejected water achieves 46000μS/cm, the flux of producing water keeps above 17L/(m^2h), and the conductivity, hardness, CODcr and other indexes of producing water all stabilized on the lower level, which primarily proves that the process of VMD is technically feasible for the concentration treatment of RO rejected water.

3. Conclusions

From above experiment results, we utilize homemade high flux PVDF hollow fiber hydrophobic micro-porous membrane and new VMD membrane component to disposal RO rejected water of petrifaction enterprise under the conditions that the vacuum degree is 0.096MPa, the temperature of original water is 75℃, and flow velocity of original water is 0.17m/s, and when the rejected water is concentrated to 10 times, the conductivity of producing water in VMD still keeps in 7μS/cm, and the desalination keeps above 99.99%, and the flux of producing water keeps in about 17L/(m^2·h), and CODcr, hardness and conductivity of rejected water ascend obviously, which primarily indicates that the effect that the new VMD process utilizing PVDF hydrophobic micro-porous membrane and chemical flocculation and ultrafitration process disposal RO rejected water of petrifaction enterprise is distinct.

References

K. W. Lawson & D. R. Lloyd. (1997). Membrane Distillation. *Journal of Membrane Science.* No.124. p.1-25.

Qudan. (2007). Influence of Calcium Precipitates on Membrane Distillation with Hollow Fiber. *Technology of Water Treatment.* No.10(33). p.14-17.

Reddy K.V & Ghaffour N. (2007). Overview of the cost of desalinated water and costing methodologies. *Desalination.* No.205. p.240-253.

Wangyue, Su, Baowei & Xu, Shichang. (2003). Recent Development of SWRO Desalination Process. *Membrane Science and Technology.* No.24(2). p.49-52.

Wu, Yonglie. (2003). Advance of Membrane Distillation Technology and the Application. *Membrane Science and Technology.* No.3(4). p.67-79.

Zhao, Shigang & Shi, Weiping. (2005). Discussion on Reclaiming and Utilization of Reverse Osmosis Rejected Water. *Industrial Water & Wastewater.* No.36(3). p.58-59.

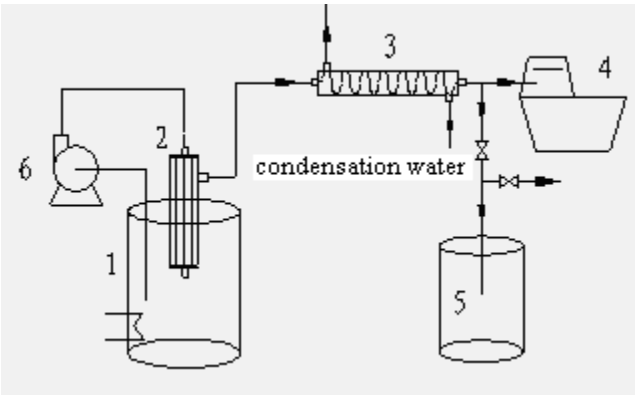

Figure 1. Sketch Map of VMD Experiment Equipment (1. raw material flume in the water bathing of constant temperature, 2. hollow fiber membrane component, 3. condensation pipe, 4. cycle water vacuum pump, 5. producing water flume, 6. original water pump)

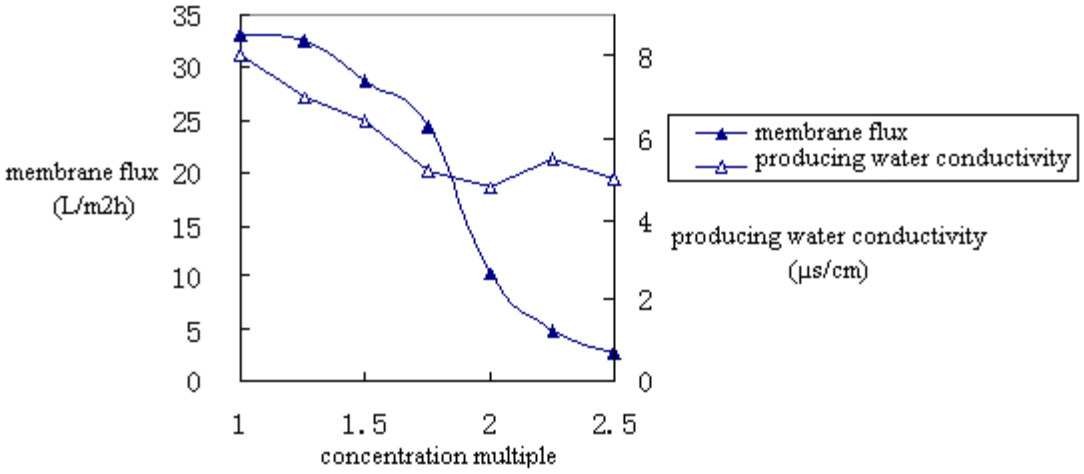

Figure 2. Influence of RO Rejected Water Concentration Multiple on the Treatment Performance of VMD Process

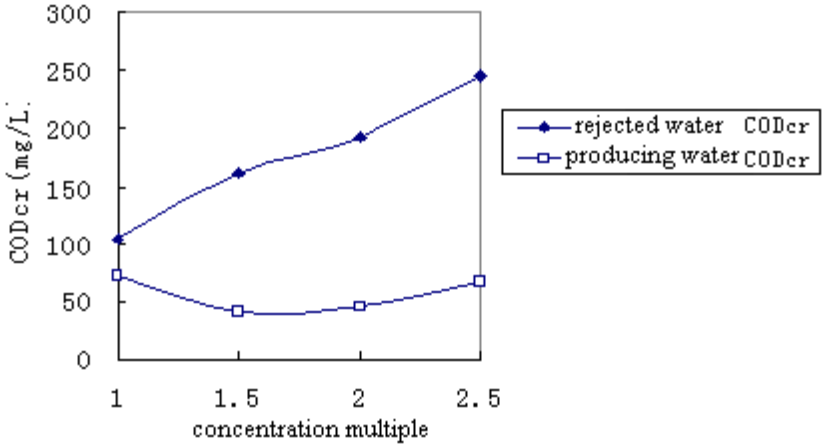

Figure 3. Influence of RO Rejected Water Concentration Multiple on CODcr of Rejected Water and Producing Water

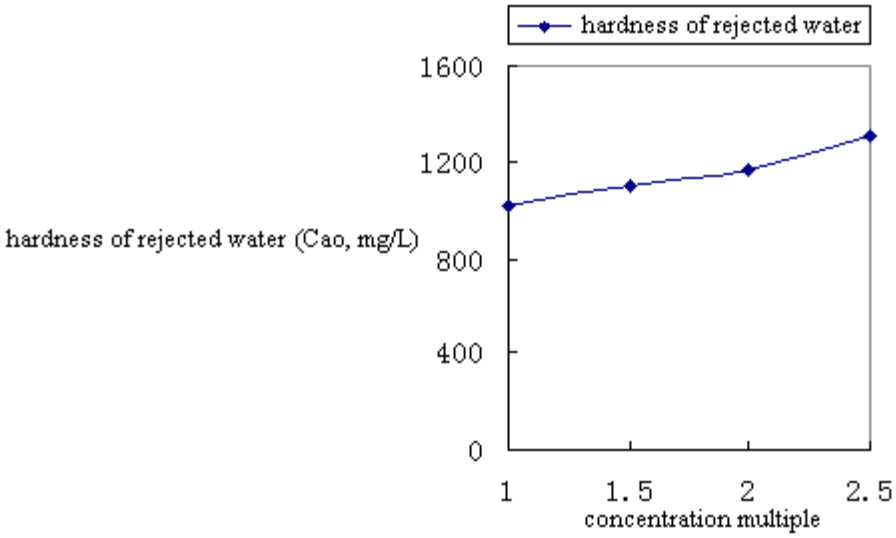

Figure 4. Influence of RO Rejected Water Concentration Multiple on the Hardness of Rejected Water

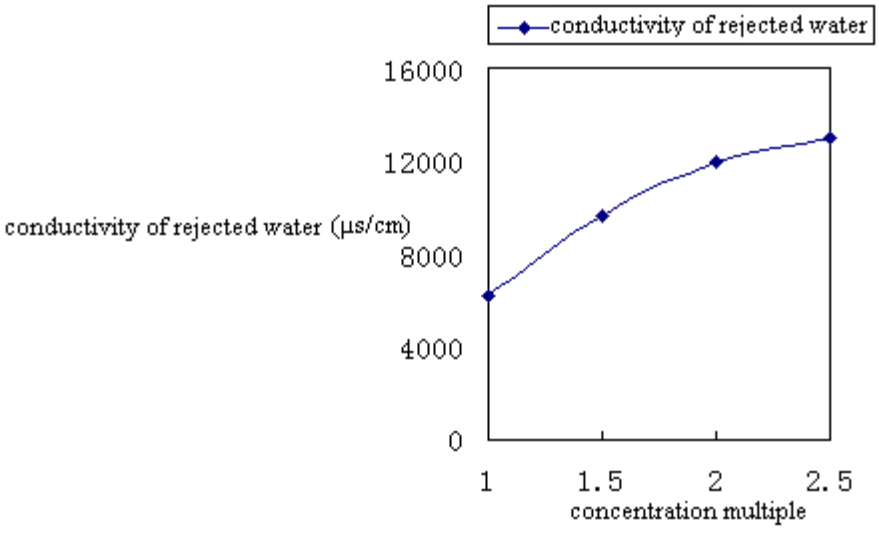

Figure 5. Influence of RO Rejected Water Concentration Multiple on the Conductivity of Rejected Water

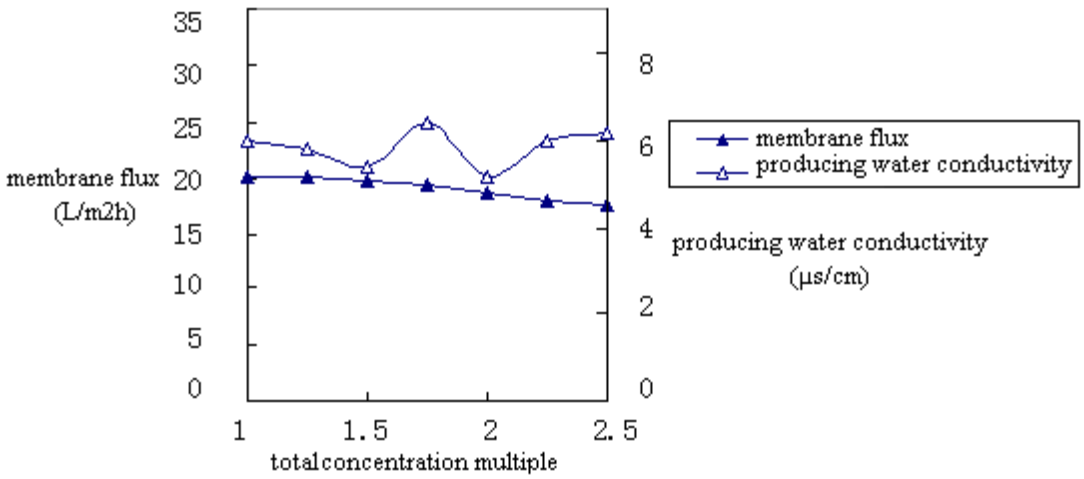

Figure 6. Influence of Total RO Rejected Water Concentration Multiple on the Treatment Performance of VMD Process

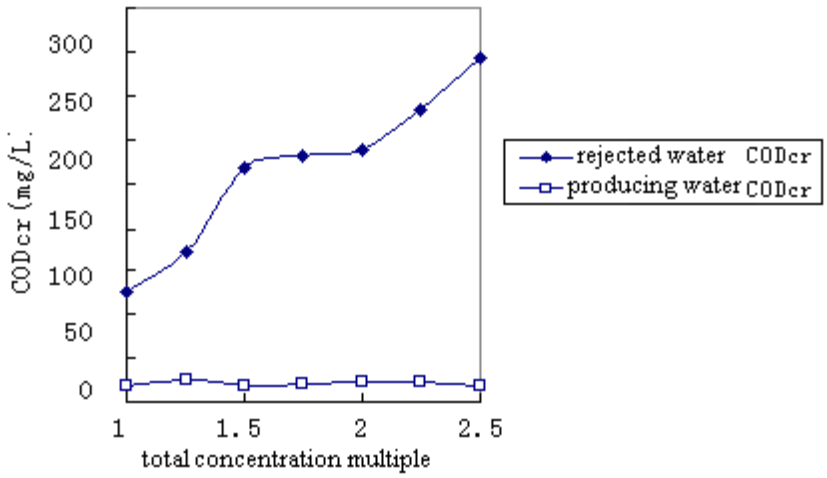

Figure 7. Influence of Total RO Rejected Water Concentration Multiple on CODcr of Rejected Water and Producing Water

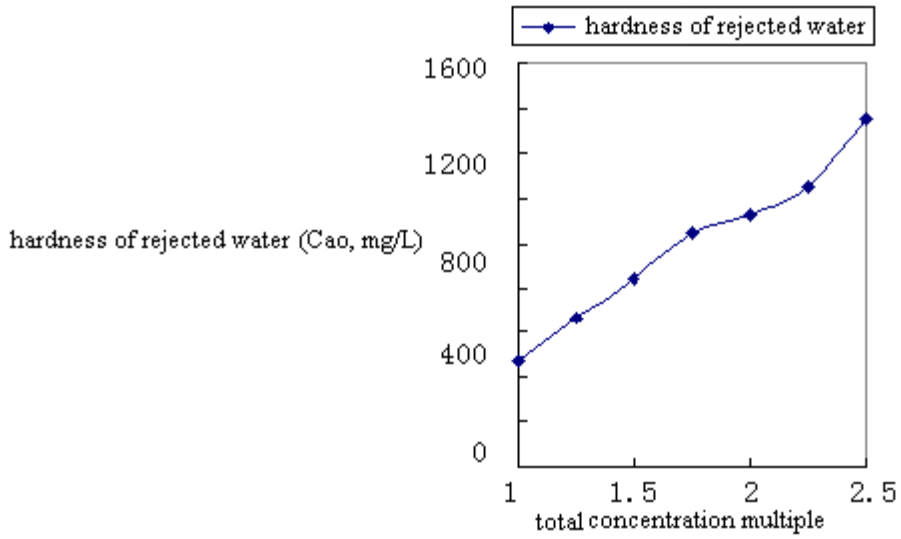

Figure 8. Influence of Total RO Rejected Water Concentration Multiple on the Hardness of Rejected Water

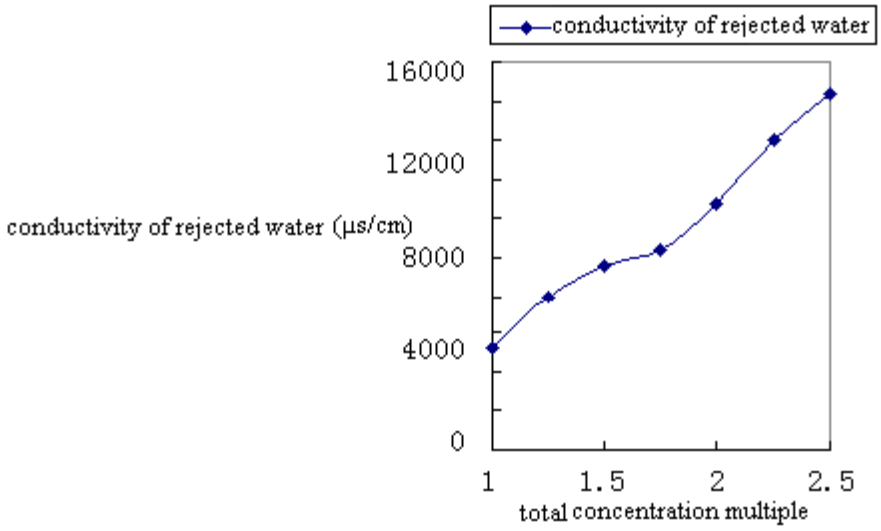

Figure 9. Influence of Total RO Rejected Water Concentration Multiple on the Conductivity of Rejected Water

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