

# A look into Low-carbon Office in Practice

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**Abstract:** Low-carbon office is the critical process for social transition, the inevitable trend in social sustainable development, which has several forms such as paper-free office, teleconferencing and office automation to work together. The purpose of this essay is to investigate the difficulties and measures of low-carbon office employed in enterprises and the effectiveness and negativity of paper-free office in order to exploit the potential for sustainability with comparison to the paper-based office. The research highlights the benefits of low-carbon office in terms of energy conservation and environment protection: reducing cost of resources and measuring standards of low carbonization interior office area, which decreases the expenditure of wasteful paper, meanwhile to ensure that people work in a healthy office environment.

**Keywords:** Paper-free office; Low-carbon Economy; Evaluation standards

## 1. Introduction

S Zhang (2015) suggests that the activities at work, for instance, printing paper in the normal office environment could make great consumption of power supply such as electricity, gas and water funded by the government and produce a great amount of CO<sub>2</sub> which has accounted for 28~30 percent of the world's total CO<sub>2</sub> emissions. This can aggravate Greenhouse Effect. Annually a tremendous amount of office waste paper (OWP) is discarded creating environmental pollution (Wanqing Lei et al., 2018). Therefore, how to make this paper from waste to wealth should become a meaningful and challenging work (Singh, Harprit., 2008). Chen (2014) offers tips to reduce paper that is to encourage employees to use laptops as a substitute with the help of technology. Hui (2014) found that waste paper materials such as office paper, newspaper and paper sludge present unique advantages for biological ethanol (a kind of alcohol) production.

Compared with developed countries which had promoted low-carbon office with the aid of Internet in the early 1980s, China is relatively late in the technology practice. In the process of implementation of paperless office, some companies in China are still passive to undertake non-pollution obligation, even escape from bearing it (Gu Chaolin et al., 2013). Therefore, the research studying the obstacles in promoting paperless office among firms which decreases greenhouse gas emissions, will undoubtedly have great significance and scientific value in social sustainability.

Although the introduction of internet technology to China is fairly late, the circumstances are urgent to upgrade. By discussing the practice in colleges and universities and green accounting in enterprises, a recent paper came to the conclusion that there will inevitably be problems such as information decryption in carrying out all-around low-carbon office (Chen Xiaochun et al., 2017).

To balance the efficiency and the level of lower carbon in the face of ignorance of environmental problems in enterprises and the lack of government supervision, it is said that the most underestimated elements is the need to continuously adapt and adjust the conversion from paper office to paper-free office contributing (Leena E. Thomas, 2010; Meng Qingjun et al., 2015).

As a good example of sustainability and innovation, sustainable consumption and production aim at reducing consumption, the quality of life while increasing the net welfare benefits of economic activities by reducing the cost of resource, environmental degradation and pollution in the entire life cycle (Bartold PM.,2017).

Carbon footprint covers all aspects of office business, and we will analyze carbon content by comparing it with standard value. As for carbon emissions, it is not only a simple production problem, but also a consumption problem, even at the root of consumption.

Statistics in Table 1 is from China Input Output Table in 2012 and China Energy Statistics Yearbook. The consumption tendency of 6 industrial sectors in China and the output intensity of the unit CO<sub>2</sub> output were calculated.

**Table 1. The Consumption Tendency of the 6 Industrial Sectors in China**

Sectors	Propensity to Consume	Paper consumption in Shanghai(t)	Unit produced co2 emission intensity
Wholesale retail and accommodation catering	0.581	769.5	0.065
Real estate and leasing services	0.649	859.6	0.102
Financial industry	0.604	798.9	0.102
Processing and manufacturing industry	1.378	1528.1	0.169

Transport, computer software services industry	0.520	528.7	0.651
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The Table 1 presents an increase of the CO<sub>2</sub> emission of the 6 industrial sectors with varied levels of consumption tendency respectively. From the table, it could be noted that the resulting CO<sub>2</sub> emissions intensity is relevant to departments.

According to the indirect mathematical conversion method of GDP, one kilowatt-hour of electricity is produced by burning 300g of coal which could generate 0.997kg of CO<sub>2</sub> the electricity. A ton of paper is produced by cutting down 20 trees, increasing 12.5 grams of CO<sub>2</sub> emissions (Zhang., 2013). Therefore, paperless office is another central point of this paper.

Despite visions of a paperless future, the total number of pages printed has until recently begun to decline from Figure 1. We've been informed that only 17% of the corporate organizations are in the process of paperless office, despite the growth in the number of paperless projects (56%). In order to explain the reasons why a large number of Chinese companies rely on paper office largely, Table 2 compares the process and performance in OA (office automation) between the U.S. and China.

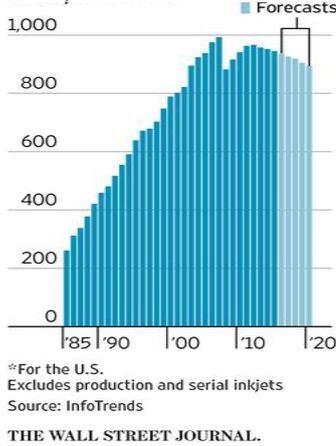


Figure 1. Printing Paper has seen a Tendency to Slide Down in Recent Years (Derived from the Wall Street journal)

Table 2. Two countries differ in process

Original time	U.S-1950s	China-1980s
Development	File type OA (i.e. paperless office) - process type OA- collaborative work OA- intelligent OA	
Current level	Artificial intelligence and face recognition,AR(Augmented Reality)	Information sharing and collaboration work

Meanwhile, with the development of energy conservation and emission reduction in Europe, EU member states

have vigorously promoted the paperless from the Kyoto treaty. Obviously, most countries are far ahead of us in the introduction of advanced technique .We still need to do the following work to understand the status quo better.

## 2. Materials and Methods

These investigations were carried out through project case studies and personal interviews. The project case studies attached importance to energy performance and carbon footprints of a green certified office. Personal interviews were conducted with a sample of six companies in three different industries in Shanghai.

### 2.1. CO<sub>2</sub> Indoor detection report

The following analysis compared the carbon content concentrations in a specific 20.3 m<sup>2</sup> office in Shanghai when using air conditioner in summer and using heating in winter. Moreover, we also monitored the content of carbon dioxide when the window is closed and fully open.

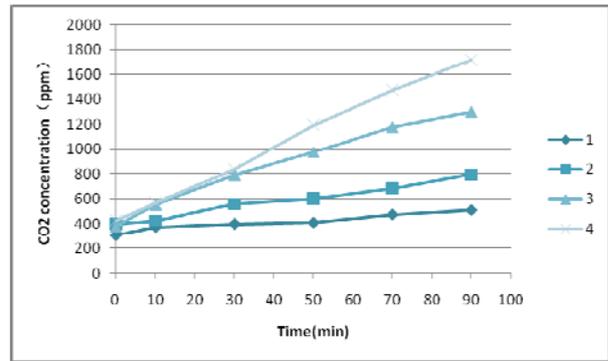


Figure 1. Different changes along with different number of people without ventilation

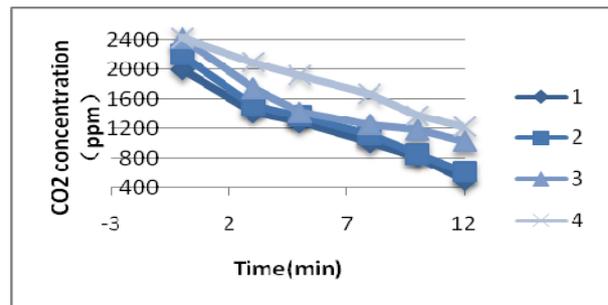


Figure 2. Recession curve with time for different number of people with entirely ventilation

From above the experimental data in Figure 2, when indoor without ventilation when indoor, the curve of CO<sub>2</sub> concentration starts relatively fast growth, and then gradually declines in Figure 3. In Figure 3, when opening the window, natural ventilation plays a decisive role in reducing carbon dioxide.

In practice, ventilation systems in some working place are closed in order to reduce firms' administration cost, leading to higher CO<sub>2</sub> concentration in these offices than the normal standard. Some previous studies show that when the CO<sub>2</sub> content is between 2.0% and 3.0%, health problems such as headache, tinnitus and slow response can show in one's body (Zhang Xiaodong ET al., 2013). Based on the above researches, we give the suggested standard values of indoor CO<sub>2</sub> air quality evaluation in Table 3, which is previously proposed by Zhang (2013): level 1 refers to the luxury and comfortable environment; level 2 means to the condition where the old and the children could adapt well; level 3 refers to the environment which is suitable to most people.

**Table 3. The Standard Recommended Values for Indoor Air Quality Assessment in China (24h) (Zhang, 2013)**

Classify	Level 1	Level 2	Level 3
Standard value (ppm)	600	1000	1600
Space Volume (mg/m <sup>3</sup> )	1080	1800	2880

**2.2. Office equipment consumption testing**

We also track carbon footprints in energy consumption. IT equipment, such as computers and printers, is undoubtedly the most energy-consuming facility in office. The following table shows the energy consumption of some common used equipment in office.

**Table 4. The Energy Consumption of Some Common-used Office Equipment in Standby Mode**

Equipment	Energy consumption (w)		
	1min	5min	15min
Computer mainframe	2.85	2.89	2.91
Computer graph scope	0.60	0.58	0.60
Scanner	9.70	9.50	5.05
Printer	12.10	5.04	4.99
Copycat	10.64	9.98	10.06
Loudspeaker box	6.00	5.97	6.01
Water dispenser (heat preservation)	0.49	0.51	0.50

The test data showed that more than half of the devices failed to meet the "1W" requirement launched by the international energy agency (IEA) (Hu Hu, Han LiHong, etc., 2011), meanwhile it also illustrates that most of devices are the most energy-intensive when it starts.

**Table 5. Respondents' Background**

	Work for years (average)					(N=101)
	Just working(N=5)	3 ~ 5 years (N=22)	6 ~ 10 years(N=49)	11 ~ 15 years(N=14)	More than 16 years(N=11)	
Manufacturing	0.4	0.59	0.41	0.43	0.45	0.46
Financial investment	0	0.36	0.31	0.43	0.09	0.3
IT	0	0.68	0.33	0.29	0.09	0.36
Government	0.2	0.14	0.16	0.14	0.09	0.15
Others	0	0	0	0.07	0	0.01

**2.3. Questionnaire**

**2.3.1. Participants**

A questionnaire of ten questions was sent to a randomly selected sample of 500 persons in May, 2018, which was responded by 101(20.02%) persons. The participants have different work-time in different industries, which are Internet service industry (35.6%), finance (29.7%), manufacturing industry (45.5%), government (19.8%), etc. Personal interviews were conducted with a sample of six companies in three different industries in Shanghai. Participants were asked prepared questions about the knowledge, methods and attitudes towards paper-free office. Advice provided by experienced practitioners and new-comers form three different business was also collected.

**2.3.2. Procedure**

The questionnaire designed for anonymous responses included 9 questions. These questions can be divided into five parts with regard to their purposes:

Q1 and Q2 collected the backgrounds of participants in order to classify information. Staff's knowledge about paper-free office was conducted in Q3 and Q4. The purpose was to ascertain whether people put the concept of paperless office in practice. Q5 and Q6 recorded the amount of paper consumption and the recycling rate of waste paper in order to evaluate the feasibility of enterprise resource utilization under supervision. Q7 to Q8 were designed to investigate staff's attitude towards low-carbon office. Q7 attempted to find out the status quo of participating in the activities of paper-free office. The purpose of Q8 was to obtain information on the predicted behaviors and automatic changes of workers in the coming year. In the final question, we ask respondents directly why the resource waste in office activities is fairly serious.

**2.3.3 Results**

Table 6 reveals the background of the participants, and most of them have been employed for four to six years (46%).

According to the relevant factors in Q1 to Q3, although the working-hour is irrelevant to whether touched OA (automated office) or not, the job is distinctly related to

the way OA works, which the bar chart also provides some data regarding the most application in manufacturing and IT.

**Table 6. Peoples' Understanding of Paperless Office**

Option	Subtotal	Proportion
None paper	8	7.92%
Only Use network technology	60	59.41%
Maximized Resource utilization	32	31.68%
Never touched.	1	0.99%

Q3 to Q6 assess people's understanding of paperless office, and the result was exhibited in Table 6. Although only 31.68% of people accurately understand the correspondence of paperless office and resource utilization

besides more than half limited to network technology merely, the good news is that people willingly implement the concept of paperless office (82%) form Table 7.

**Table 7. Changes in Current and Future Attitude Towards Paper-free Office**

Options	Total(number of people)	Proportion
Strengthening resource recovery	57	56.44%
More convenient communication	56	55.45%
More convenience in personnel management	62	61.39%
Improvement of working efficiency and office environment	58	57.43%
System recurring problems	39	38.61%
Privacy exposure	17	16.83%
Some degree of reliance on paper.	22	21.78%
Others	0	0%
Options	Total	Proportion
Limit the amount of paper and the use of printer	64	63.37%
Shut off the standby equipment in time	72	71.29%
Reasonably design office, switch doors and windows timely	74	73.27%
Resource recycling	43	42.57%
Others	0	0%

Table 7 shows changes in people's current and future attitude towards paper-free office . More than eighty percent of people tend to communicate task more efficiently and care about health. At the same time, the hypothesis of government and enterprise managers' little supervision was further verified which accounted for 46 percent, and the awareness of environmental protection accounted for 78.2%.The graph depicts some interesting phenomenon where humans living in the high-tech era are more focused on efficiency than person privacy. People's predictions for the future of paperless office are very positive, and about 41% are kind of reluctant to care about the current situation.

**2.3.4. The Return Visits**

Return visits to people in three different industries, who make valuable suggestions for the plan that we will implement and reflect the drawbacks of electronic equipment which includes dependence on paper and isolation of human interaction.

An accountant who has worked in his field for over 20 years says that traditional accounting practices is strict but tedious paper- based work. Paperless office

improves the office efficiency while bringing old accountants with technology challenges.

Even though paperless office is with high feasibility and considerable efficiency, why do most enterprises still prefer paper-based working style? When discussing this question, one interviewee who works in the transportation industry said that paper can work better than computer screens in terms of collecting and passing information in transportation draft. To a large degree, another employee in the financial industry sales department agreed with those two, saying that computers' screen created a gap between communication and behavior.

Based on the survey, we presented a series of solutions (Table 9) in paperless working practice, which have been conducted by an office as experiment. Office Supplies consumption before and after adopting our proposals is compared. In Table 8, paper consumption in the office dropped sharply during the experimental period, which did support that our proposal is effective and usable.

**Table 8. Printed Paper Consumption**

Date	A3(piece)	A4(piece)	Total(piece)
8th March	28	244	272

16th March	78	167	245
26th March	46	178	224
13th April	46	124	170
22nd April	56	68	124

The chart below (Table 9) shows how low-carbon company's work through paper usage, space layout, files shared and equipment setting. It may also suggest that the content of CO<sub>2</sub> of office can decrease, if the company set up a stricter system of rewards and punishments to restrict the paper consumption.

Table 9. Low-carbon Companies case

Strictly control the office paper, must use the front and back. Adjust the page setting, do not leave too much blank in one page as far as possible!	According to the construction standard of office building, the office areas is 9 m <sup>2</sup> per person.
The company's files are fully shared in the internal network.	Idle equipment are set up to automatically low-energy mode; Turn off the power supply when the office equipment free for more than an hour; Elevators shall properly be set in terms of stopping floors and waiting time.

### 3. Discussion

The significance of the implementation of going paperless draws increasing concern from the community. The purpose of this study is to evaluate the effectiveness of Low-carbon office deployed information systems in Shanghai (40.7%) and to research on the current situation of paperless office with giving reasonable advice. The investigations of the study are as follows.

First, although 81.9% of old equipment exceeds the "1W" energy saving requirement, some companies exist to use outdated equipment or even purchase inexpensive devices that pose threat to human health in order to save companies' costs. Second, 68.32% of people in the survey have understanding bias towards the perception of paperless office. Only 31.68% of people accurately understand the correspondence of maximized resource utilization in paperless office. Third, the supervision system is not efficient. Employees are very environmentally conscious but in still rarely practice (86.9%). It would be better if the company set up a stricter system of rewards and punishments to restrict the paper and energy consumption. Finally, the effective practice of low-carbon office is due to the cooperation of managers and workers. Based on The Report on Paper Utilization of Chinese Enterprises, the statistics also revealed another contradic-

tory trend that more than 55 percent of respondents believe that their company is still dependent on paper work largely, or even entirely. It is inevitable to use paper during work, but how to maximize the usage of paper put us in the face of that.

This survey also reflects that the requirements of new-style changes to people far exceed people's imagination, leading to an increase in the speed of survival of the fittest in the industry. What's more, the 13th Five-Year Plan (China will lower 40% or 45% carbon emissions per unit GDP than 2005 by 2020) does not seem to function in Shanghai as well. Therefore, we must constantly adjust the concept of people and optimization of technique in the process of introduction referring to developed countries.

Overall, findings from this essay are of fairly practical significance to administrators who may be considering how to coordinate the lower carbon mode and profitability. First, administrators should stick to facts and monitor office carbon emissions, with more focus on the advantages and future economic benefits of paperless office. Second, government intervention is needed in China where a sustainable ecological system has not yet been formed. It may also suggested that ecological economy will be improved in our country, if administrators set up a stricter corresponding system of rewards and punishments to ensure the market fair and establish the supervision by public criticism for enterprises.

The sample of this study has certain limitations : The respondents are mainly from promising companies; Data varied with times, hence the results of the study should be treated with caution. It is hope that this research would help scholars in some more in-depth exploration.

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