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Research Article

Application of 3D Visualisation Video Technology for the Modern Business Management

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Nowadays, identifying problems is often more difficult and important than solving them in the complex business environment. Especially in modern enterprises, with more staff and complex working environment, it is more difficult to find the problems buried under the "iceberg." Thus the task of managers becomes how to find problems and create an environment conducive to management, so that problems naturally emerge. Based on the modern enterprise management as the research object, the information technology and 3D visualisation video technology in the application of modern enterprise management were carried out. Then it explains the concept and theory of 3D visualisation video technology, analyses the feasibility of applying visualisation video management in modern enterprises and, in particular, explores the existing problems of modern enterprise management, and comes up with methods and specific measures for implementing visualisation video management in large modern enterprises. It provides an innovative approach to the management of modern enterprises in China when facing new challenges and new turning points in the context of the financial crisis.

1. Introduction

The development of computer network technology and changes in the way information is transmitted have had a huge impact on the production, operation, and management models of modern enterprises [1, 2]. With the increasing competition in the market, the old mode of company operation (cost + profit = price) has been gradually replaced by a new mode of company operation (market-driven price – controllable costs for the producer = profit) [3]. This means that it is now difficult for companies to control the market price to achieve the desired profit. This challenging change has led companies to reduce costs, eliminate waste, and maximise profits by improving management [4]. In other words, all activities must be focused on how to achieve the same value for the customer at the lowest possible cost [5, 6].

But in order to eliminate these unnecessary wastes, increase efficiency and add value to customers. The chief problem is to identify these wastes. In today's complex business environment, identifying problems is often more difficult and more important than solving them [7, 8]. This is especially true in modern companies, where the number of staff and the complexity of the working environment make it more difficult to find the problems buried underneath the "iceberg" [9]. The task of the manager then becomes how to identify problems and how to create an environment, which is conducive to management and allows problems to come to the fore naturally.

As a result, the manager's task now becomes how to make anomalies visible automatically through effective management methods [10, 11]. But this is not easy to do, as there are often many complicated processes involved in the complex activities of a production site. The challenge for managers and academics alike is how to make problems automatically visible by using a number of methods [12].

This paper attempts to investigate the feasibility of using visualisation video in modern enterprises, by adopting the theories related to visualisation video technology to identify potential problems, find out solutions, and improve economic performance in modern enterprises.

2. Basic Theories Related to Visualisation Technology

The visual technique approach was first systematically introduced by Professor Yoshijiro Sawada of Kurume University in his book "Visual Management of Workshop Management." The method was first used at the Japanese company Toyota Motor Corporation) [13, 14]. After its introduction at Toyota, the company's efficiency was greatly improved, waste was significantly reduced, and products were delivered on time and with excellent quality. Many Japanese companies have since adopted the visual technology approach [15, 16]. For example, KODAK has set up a dedicated visualisation video team to promote visualisation video technology, which has yielded significant benefits. HONEYWELL has also achieved good results in the field of aviation maintenance using visual technology, which has made a great contribution to aviation safety. Many other major companies such as DELL, GE, and HP are also implementing visualisation video [17]. In view of the success of these large companies in visualisation video management, many small- and medium-sized enterprises are also trying to promote visualisation video management [18]. The image below shows a 3D scan of DELL's face visualisation technology, as illustrated as Figure 1.

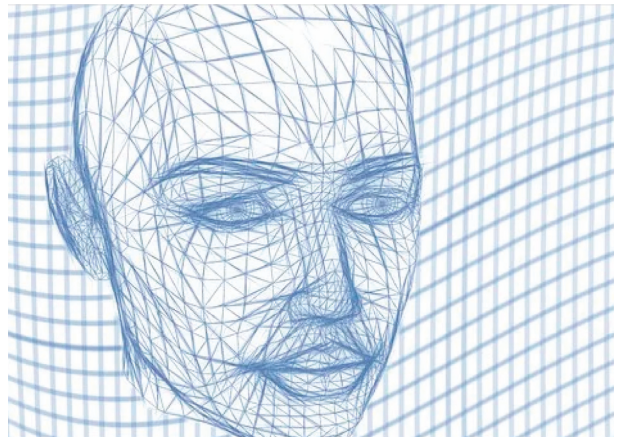

Figure 1: Technical 3D scan of DELL's face visualisation.

2.1. The Concept and Content of Visualisation Video. Visual management is a systematic way of enabling all members of a work area to see, understand, and appreciate the situation in the area (both physical and virtual) through simple visualisation video and to make continuous improvements [19]. This is also called visual communication, where the work area is clear to the human eye. It guarantees self-explanation, self-regulation, and continuous improvement of the work area. Visual management can also be interpreted as the use of IT systems to enable managers to effectively grasp corporate information and to achieve transparency and visualisation video in management, so that the effects of management can permeate all aspects of the company's human resources, supply chain, and customer management. Using visual and colour information to organise on-site production activities is one way to increase productivity. Visual management uses visual signals as a basic tool and the basic principle of openness to make the requirements and intentions of the manager as visible as possible, thereby promoting self-management and self-control [20]. Visual management is therefore a form of management characterised by openness and visual display.

Visualisation video is already well established in business management and is used at four levels: in internal processes, in learning and growth, in customer management, and in finance. Focused on modern enterprises with numerous personnel and chaotic production environment, visual video management is introduced in the internal management process of modern enterprises, and on-site management through visual video can improve management efficiency. To show the efficiency advantages of visualisation video technology in modern business, it is compared with traditional technology. Figure 2 shows the comparison between the use of visualisation video technology and traditional technology in processing efficiency changes with the development of modern companies. As can be seen from the figure, with the continuous development of modern enterprises, the amount of information that needs to be processed increases dramatically, resulting in traditional technologies first increasing and then gradually decreasing, while visualisation video screen technology performs strongly in the context of large information.

2.2. Classification of Visualisation Video. Visualisation video can be divided into three categories according to its scope of application: scientific computing visualisation video, digital visualisation video, and information visualisation video. Figure 3 illustrates the relationship curves among scientific computing visualisation video, digital visualisation video, and information visualisation video in terms of processing data flow and 3D processing intensity. From the figure, it can be seen that there is a pattern of change in the peaks of the three in increasing order. Scientific computing visualisation video refers to the theory, method, and technology of using computer graphics and image processing technology to convert data and calculation results generated in the process of scientific computing into graphics or images and then display them on the screen and to process them interactively. Information visualisation video includes operations research and related subjects, focusing more on the visual video of abstract information. The main areas are visualisation video of hierarchical information structures, visualisation video of multidimensional data structures, visualisation video of network structures, operational status, browsing history, and network users [21, 22].

3. Enterprise Management Objects and the Advantages of Applying Visual Management

In a modern company, the focus of management is on managing exceptions. In modern enterprises, exceptions can be divided into two categories: firstly, what should be done is not done and what should not happen [23]; secondly,

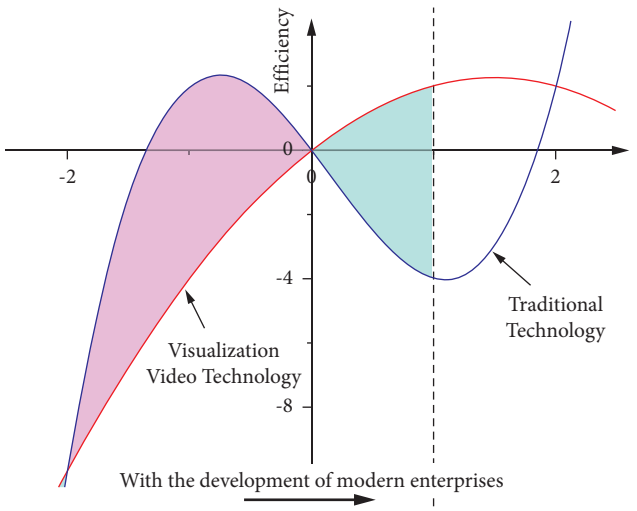

Figure 2: Comparison between the use of visualisation video technology and traditional technology.

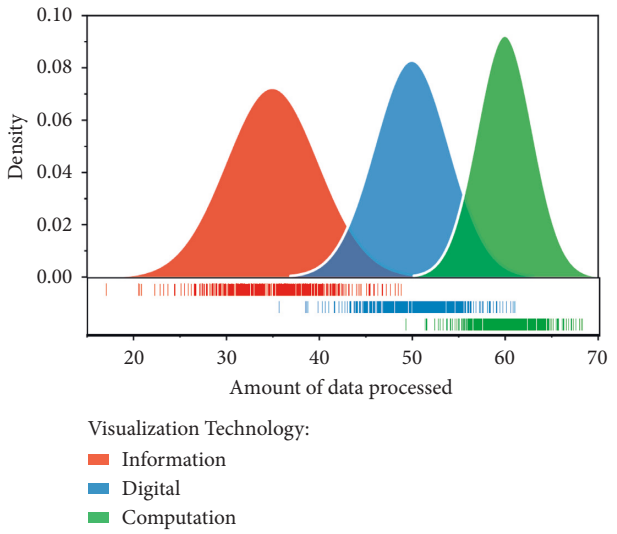

Figure 3: The relationship curves among scientific computing visualisation video, digital visualisation video, and information visualisation video in terms of processing data flow and 3D processing intensity.

although what should be done is done and what should happen happens, it does not occur according to the process or the prescribed way of working, even without processes to follow, and if a replacement of the staff, the scenario, or the customer occurs, problems will arise. For example, there are no work instructions for a particular process and workers operate according to their own experience, which results in the following: if a skilled worker operates the process, the product is guaranteed to be satisfactory; if that worker leaves and is replaced by a new worker, a large number of defective products will be produced [24, 25]. Both of these things lead to abnormal production waste. Therefore, as a manager, you need to be able to detect anomalies in the operation of the company, and when you find anomalies, find solutions and organise implementation, which can be expressed in the following equation:

$$E_{cs} = \frac{(A_P E_P + A_S E_S)}{A}, \quad E_{cs} = mE_P + (1-m)E_S. \tag{1}$$

In this equation, E_{cs} and E_s represent total and partial anomalies in the course of a company's operations, respectively; A_p and A_s represent total and partial abnormal production waste respectively; m represents degree of visualisation.

In the production industry, large companies can afford to spend a lot of money on a range of management software or carry out a range of consultancy activities to visualise their management. Modern companies, however, are mainly small- and medium-sized enterprises that do not have the financial resources and energy to create the conditions for costly, scientifically calculated visualisation video management [26]. In fact, visualisation video itself is an art that solves the problem of how to express the unique perspective of visualisation video to build modern enterprises. Management processes will help enterprises to identify and solve internal problems in a timely manner, reduce costs, inventory, and waste, improve performance, and increase customer and employee satisfaction through image information visualisation video management. Figure 4 illustrates the schematic diagram of image information visualisation video technology to improve customer and satisfaction.

The benefits of visualisation video for modern companies at the production management level can be seen in the following areas.

3.1. Visual Management can Improve Efficiency. Visual management is intuitive and conducive to improving efficiency. On-site managers organise and direct production, in essence releasing all kinds of information. The process of receiving information and then acting on it is the process by which operators carry out their production work in an orderly manner. The production system runs at high speed, which requires the information to be transmitted and processed quickly and accurately under the condition of machine production; otherwise it will cause huge direct economic losses. If information relating to each worker had to be communicated directly by the manager, there would be a relatively large number of managers on the production site of a modern company with hundreds or thousands of workers. Visualisation video offers a shortcut to this problem [27]. By far the most common sensory organs used by operators and other managers to receive information are the eyes, ears, and nerve endings, where visual sense is used most frequently. Visual signals, sent out by instruments, television, signals, signs, diagrams, etc., are easy to be read and recognised. Where possible, visual signals can be used to transmit information quickly and accurately, so that production can be organised effectively without the need for on-site management. This relationship can be expressed by the following mathematical equation:

$$\alpha = K - \frac{2}{3}G. \tag{2}$$

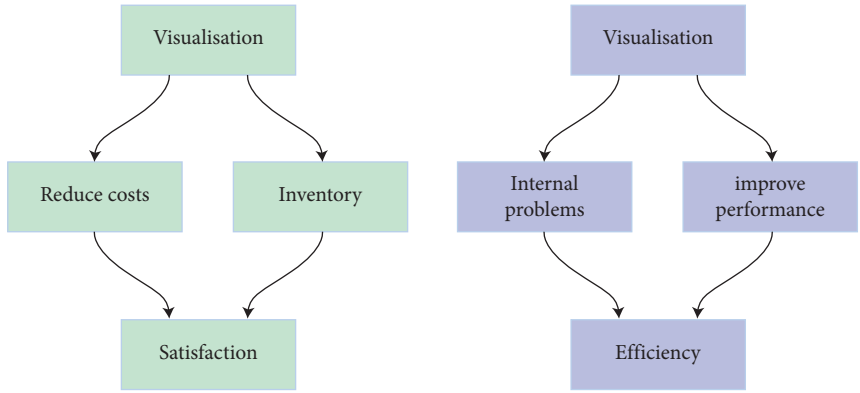

Figure 4: Schematic diagram of image information visualisation video technology to improve customer and employee satisfaction.

In this equation, α represents coefficient of on-site management; K and G represent intensity and frequency of visual signals, respectively.

Visual management is highly transparent and facilitates mutual supervision and motivation of the personnel on site. It is easy to see what to do, how to do it, how much to do it, when to do it, and where to do it, which is conducive to tacit cooperation and mutual supervision and makes it less easy to hide any breaches of labour discipline [28, 29]. For example, if workers are required to wear different uniforms and caps according to the characteristics of different workshops and types of work, it is easy to put those who leave their jobs without permission or chat on the job in full view of the public, so that they can exercise self-restraint and gradually develop good habits. For example, some countries (data from China, India, the United States, and Japan) have implemented a plaque system for enterprises, in which units are assessed and put up different coloured signs according to four grades: excellent, good, poor, and bad; individuals are assessed and wear different coloured armbands for those who are orderly and qualified. Figure 5 shows the rose chart comparing the popularity of visualisation video screen technology in the production and sales sectors in China, India, the United States, and Japan. As can be seen from the figure, sales departments in the four countries are greater than traditional production departments in the application of visualisation technology. In this way, visual management can play the role of encouraging the advanced and spurring the backward. In short, the production of modern enterprises requires both strict management and the development of people's habits and abilities of self-management and self-control. Above all, visualisation video screen technology provides an effective and concrete way of doing this. The mathematical expression can be given by the following equations:

$$S_1 = S_p + \Delta,$$
$$S_p = \int_0^L \frac{p_p(z)}{E_p} \mathrm{d}z, \tag{3}$$

where S_1 and S_p represent excellent and good plaque system, respectively; Δ represents the degree of self-restraint.

3.2. Visualisation Video Is Good for Staff Management: Visual Management Facilitates. Visual video is conducive to employee management. Visual management helps to produce good physiological and psychological effects. The physical and technical aspects of improving production conditions and environment are often ignored at the expense of the physical, psychological, and social characteristics of on-site personnel. For example, instruments and meters used to control machinery and production processes must be available, which is an essential material condition to strengthen on-site management.

3.3. Visualisation Video Facilitates Performance Management. Visualisation video allows managers to understand at a glance the overall sales, new market development, new product promotion, etc., so that they can take timely action to correct problems or increase market share, etc.

4. Approach to Visual Management Implementation

Modern enterprises generally lack production knowledge training for their employees, who are not aware of the need to streamline production and are unable to identify problems in a timely manner [30]. Visualisation video can be a very important method of production management, as it allows for the standardisation of visual displays. It includes mark line, mark plate, and sign colours.

4.1. Signage. Signage as a means of production control is intuitive and easy to use. The signage is an effective means of controlling production operations so that each production step and each process is carried out in strict accordance with the quantity standards and so that overproduction and overstocking are eliminated. The use of signage needs to be adapted to the working conditions of the site and be simple and practical. Signage includes some of the following elements.

(1) Kanban. If a process breaks down or stops for other reasons, the operator can see the signage and stop production when the previous process does not need to supply work-in-progress. Kanban is therefore a means of transmitting information that serves as a reminder.

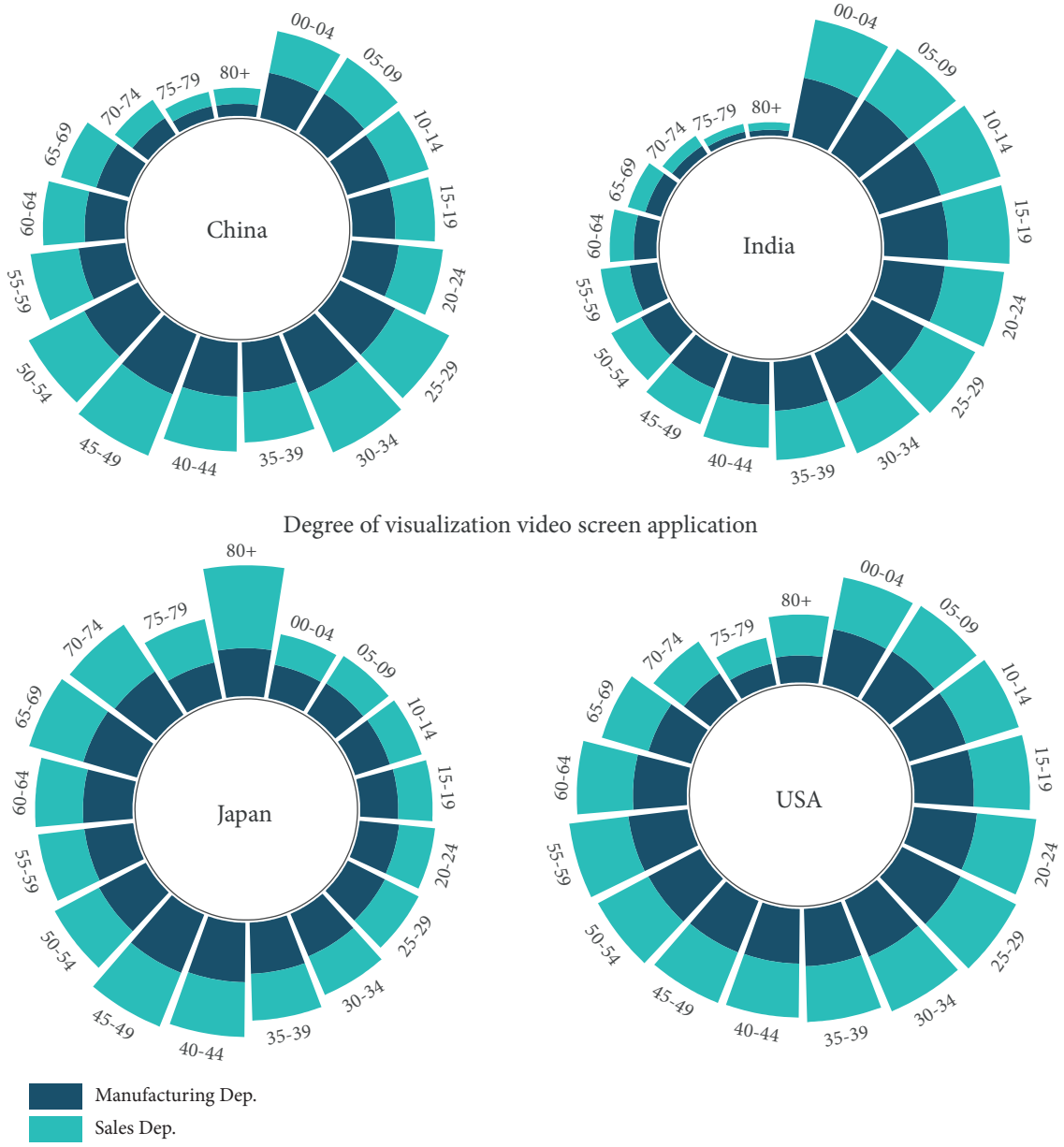

Figure 5: Rose chart comparing the popularity of visualisation video screen technology in the production and sales sectors in China, India, the United States, and Japan.

(2) Contact signs for each process. To minimise the loss of working hours and to improve the continuity of production, it is important to set up convenient and practical signals to communicate between the various production stages and types of work. For example, red lights can be installed on machinery and equipment, and workstation fault displays can be configured on assembly lines so that if a stoppage occurs, a signal can be sent out and a roving maintenance worker can see it and come to repair it in time.

(3) Standard signage. First, all kinds of work station apparatus, including boxes, boxes, trays, carts, etc., should be loaded according to the standard number of regulations, so that the operation, transport, and inspection personnel points are convenient and accurate. Secondly, the uniformity of the site personnel dress and the implementation of the tagging system site personnel dress can play a role not only in labour protection, in machine production conditions, but also in formalization and standardisation of one of the contents. Standard signage can not only reflect the excellent quality of the workforce, with access to identify different units, professions, and positions within the enterprise, but also bring about a certain psychological effect, such as a sense of belonging, a sense of honour, and a sense of responsibility. The signage system includes unit signage and

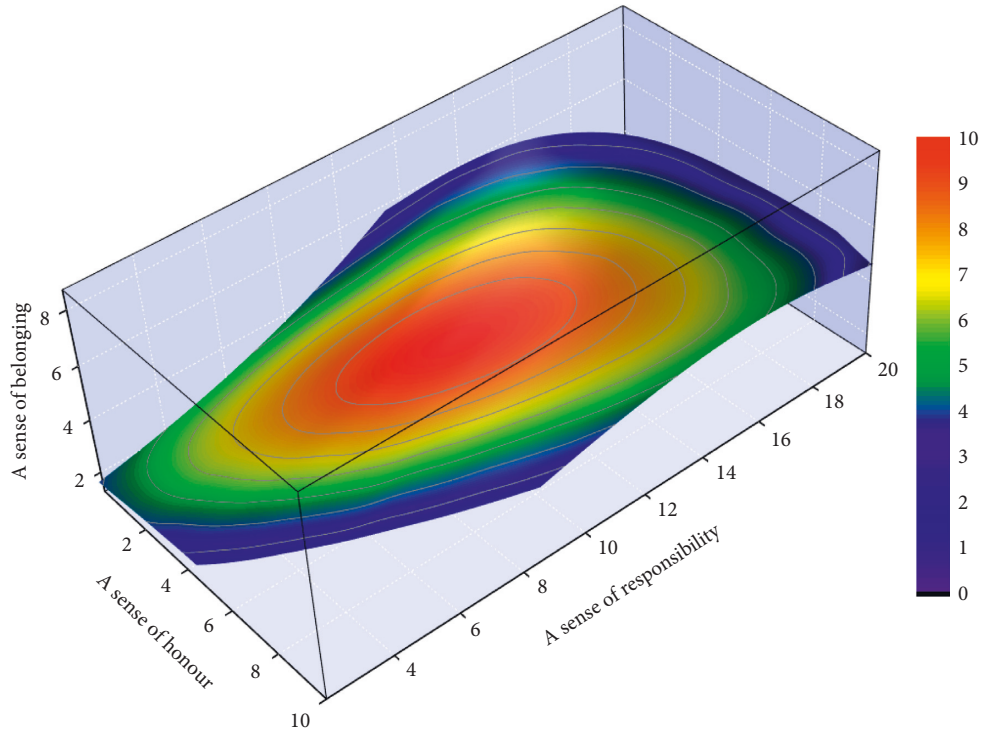

Figure 6: A visual three-dimensional representation of the sense of belonging, honour, and responsibility in modern enterprises.

individual signage. To visually describe the interrelationship among a sense of belonging, a sense of honour, and a sense of responsibility, Figure 6 shows a visual three-dimensional representation of the sense of belonging, honour, and responsibility in modern enterprises. The diagram indicates that there is a mutually reinforcing relationship between the three. The mathematical expression can be given by the following equations:

$$S = \frac{1}{M},$$

$$S = \frac{1}{M} + \frac{n}{\rho_w g L_p},$$

$$c = \frac{k}{S = 1/M + n/\rho_w g L_p}, \tag{4}$$

$$S = \frac{1}{M} + \frac{\alpha^2}{K + 4G/3},$$

where S represents plaque system; M and G represent coefficients of visual management, whose value depends on the degree of visualisation applied.

(4) Evaluation signage. In accordance with the internal inspection and evaluation system, the results of those assessment projects with a significant relationship with the achievement of the enterprise's strategic tasks and objectives are attached to the apartment in a visual and intuitive way, which can motivate the advanced units to go to the higher level and spur the backward units to catch up. Wearing signs for individuals, such as badges, badges, armbands, etc., serve a similar purpose with the dress code. In addition, it can also be combined with the appraisal to give people pressure and motivation to achieve the purpose of motivating people and promoting work.

4.2. Marker Lines. In addition to quantity control, there is also quality and cost control, which is also managed visually. For example, for quality control, at each quality control point (control), there should be a quality control chart, with clear critical lines drawn on the chart, so that quality fluctuations can be clearly displayed and abnormalities found and dealt with in a timely manner [31]. The workshop should make use of a board to publish the "Daily Statistics of Defective Products" and display the rejects of the day on a showcase for consultation and analysis by the relevant personnel to determine improvement measures to prevent recurrence.

4.3. Standard Colours. For colour standardisation management, colour is a visual signal commonly used in site management, and visualisation video management should be scientific, reasonable, and clever use of colour and achieving uniform standardisation management and not allowing arbitrary painting.

Danger signals are mostly red, while high-temperature workshops should be painted in light blue, blue-green, white, and other cool colours, resulting in a sense of refreshment and comfort; on the contrary, low-temperature workshops

Colour standardisation management			
	Phase 1	Phase 2	Phase 3
High temperature workshop	Light blue	Blue-green	White
Cryogenic workshop	Red	Orange	Yellow
Heat treatment equipment	Lead grey	Grey ink	Grey Purple

Figure 7: Illustration of the practical application of visualisation technology in the distribution of standard colours in different work scenarios.

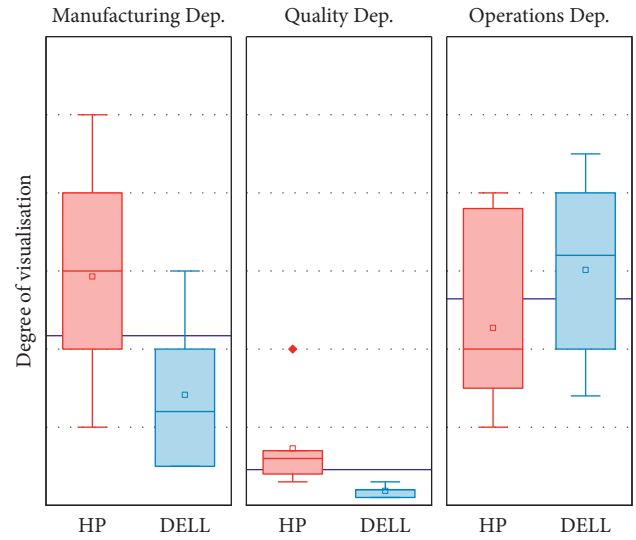

Figure 8: Groups box chart of degree of visualisation technology in different sectors in DELL and HP.

are suitable for red, orange, yellow, and other warm colours, bringing about warm feeling. Heat treatment equipment mostly adopts cold colours, such as lead grey, which can play a role in reducing the "psychological temperature." Since employees of furniture factories see warm wood colours all day long, wood processing equipment should be painted light green, relieving the irritation of the operator caused by the warm colour surroundings. The mathematical derivation for the relationship between the colour and sensation is given in equations (5)–(7). And Figure 7 shows illustration of the practical application of visualisation technology in the distribution of standard colours in different work scenarios.

$$p = \frac{P}{A}, \tag{5}$$

$$p_s = \mu_s p, \tag{6}$$

$$p_s = \frac{p}{1 + m(n-1)}, \tag{7}$$

where p and p_s represent psychological temperature; μ_s represents heat coefficient; m and n represent high- and low-temperature value.

5. Application Examples of Visualisation Management

A typical representative of modern enterprises, a modern company, was selected for this paper. During the survey, it was found that the enterprise suffered from rising costs. In recent years, with the impact of international oil price fluctuations, chemical fibre raw material prices rose, cotton prices rose faster, and since the second half of 2009, the average price of third-grade cotton market rose by more than 20%. Foreign trade market development difficulties increased pressure. The financial crisis has affected orders from overseas markets, with orders received by the company falling by as much as 70% year-on-year compared to the period before the financial crisis, leaving less and less room for profit. The backend yarn and fabric products only rose by about 5 percent [32]. In addition to the impact of adverse external factors, the company also suffers from low production efficiency, frequent delays in product delivery, and a large number of reworking due to quality problems. During a visit to the company, it was found that the production workshops were cluttered with machines and there were no obvious work zones; the responsibilities of the production process staff were unclear and problems were not detected and reported in a timely manner. The products were not placed in a standard way and the commissioner to sort out, check, and accept was required. Here are two examples of companies that illustrate the importance of the level of visualisation, illustrated as Figure 8. The figure shows groups box chart of degree of visualisation technology in different sectors in DELL and HP. As can be seen from the graph, HP has a greater degree of adoption of visualisation video screen technology than HP. The study therefore focuses on how to reduce production waste in the company, identify problems in all stages of production, and improve the value of production in four areas: visual area management, product management, equipment management, and production process management.

5.1. Visual Area Management

(1) Overall layout. Based on the TPS production model of lean production and the production process of the modern company, the layout of the entire factory is planned. The machines in each line should be closely linked and compactly arranged to reduce wasted space and to integrate the overall platform, moving

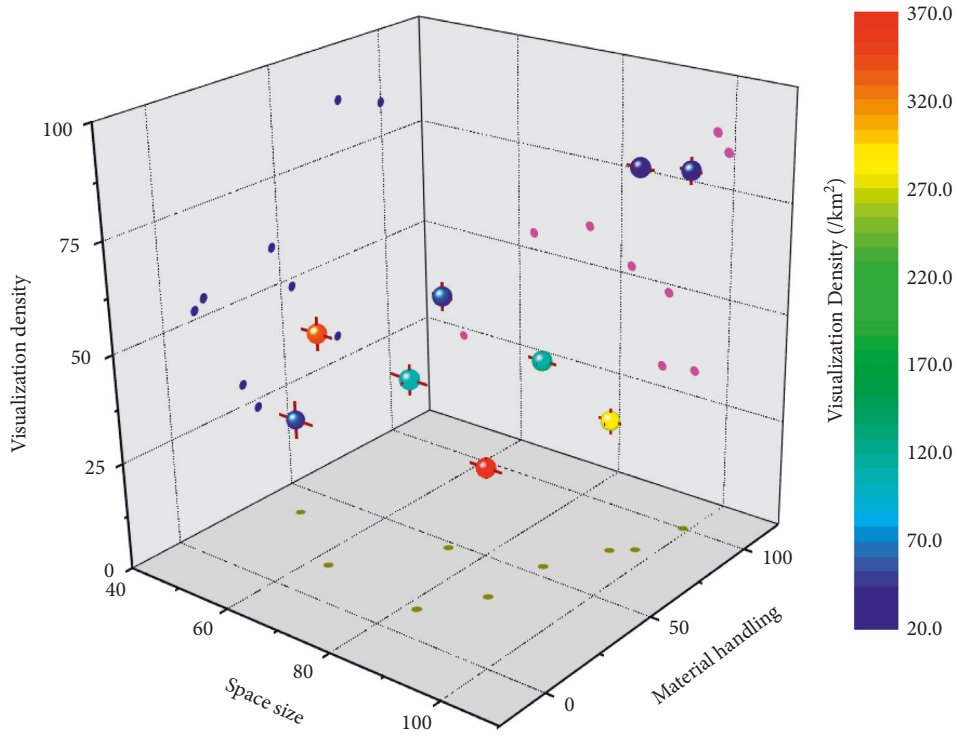

Figure 9: Three-dimensional scatter plot of interrelationship among space size, material handling, and visualisation density.

away from the previous independent and scattered state. This will result in continuous and compact processes, less space, less material handling, visualisation density, etc. In order to clarify the interrelationship among space size, material handling, and visualisation density, Figure 9 illustrates three-dimensional scatter plot of interrelationship among space size, material handling, and visualisation density. From the figure, it can be seen that the three show a positive correlation.

(2) Workshop layout. Similarly, for each workshop, it is also necessary to design a compact and easy-to-communicate humanised layout of the production process based on the theory of lean production in the TPS production model combined with the workshop production operation process.

(3) Posting. After the planning is complete, the workshop layout should be posted in each workshop, so that staff, management, new members, and customers can clearly understand it during the workshop production, so that every employee understands the layout of the process and can quickly find their own tools and items, reduce the time to find tools and items, reduce the time for training, let everyone participate in the process, and put forward ideas for improvement to make the area planning more rational.

(4) Colour coding. The marking of the areas is then done in two ways: firstly, the areas are marked with a specific text, such as a sign. The other requires visual colour management of the areas, with the following specifications.

5.2. Visual Product Management. There are two types of product identification: one is attribute identification and the other is status identification. Attribute labelling uses clear labels to indicate the type, date of manufacture, production batch, specification, quantity, and attribution of the product. This enables staff to know at a glance what the product is, so that they can easily do the right thing at once when shipping, collecting materials, etc., and also facilitates future traceability, etc. [33, 34]. In this modern company, red marks indicate defective products, yellow marks indicate products to be judged or detained, and green marks indicate qualified products. This enables any employee to know at a glance (unnecessary being a professional inspector) which product is qualified and which one is not. If an employee in the next process sees a red indicator attached to the product, he will not take it to the next process for further processing [35, 36]. This prevents further waste caused by defective products continuing to be produced. In the case of finished goods, the dispatcher can tell at a glance which products are non-conforming, thus preventing incorrect products from being delivered to the customer. This prevents the delivery of incorrect products to the customer.

5.3. Visual Equipment Management. The various states of the equipment are identified by the tagging of the equipment. A red tag means that the equipment is new or has undergone a special change and that it has not undergone "Q-TEST" or "F-test" since it was bought or after the change. The equipment cannot be used to officially mass-produce products. Even if the product is produced, it cannot be shipped, and if it is to be shipped, it must go through a strict

approval process; the yellow sign represents equipment for training practice, the product produced by this equipment cannot be shipped either, and the shipment must go through a full inspection: the green sign represents qualified equipment for normal use; the product produced by this equipment can be shipped according to the normal process; the "under repair" sign identifies that the equipment is under maintenance; the equipment is prohibited to be operated by employees, in order to avoid staff misuse resulting in casualties or economic losses.

6. Conclusion

This study focuses on the visualisation video and innovation management of modern enterprises in China, providing a theoretical basis and practical guidance for the implementation of visualisation video management, which is of great significance for the application of low-cost visualisation video management in modern enterprises. However, many aspects of this paper are worthy of further study, such as the specific visualisation video measures and methods for each production step and the evaluation of the effects of visualisation video implementation from a qualitative perspective.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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