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Aims and Scope

The aim of the journal of Operations Management and Information Technology is to provide academically robust papers, research, critical reviews and opinions on the organizational, social and management issues associated with significant information-based technologies. It is designed to be read by academics, scholars, advanced students, reflective practitioners, and those seeking an update on current experience and future prospects in relation to contemporary information and communications technology themes.

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Contents

Work Study to Reduce the Stressful Work by Redesigning of Material Handling Process

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ABSTRACT

The objective of the research is to reduce the human efforts to pick and place the compressor on main assembly line of refrigerator. There are different activities in this process. Initially, to place the compressor on refrigerator, worker has to pick the compressor from given bin of compressors placed on the ground. One bin contains the four compressors. At first the bin placed on the ground from the pallet and then compressor gets picked up from bin to place it on the refrigerator. It takes approximately 25 to 30 seconds. The weight of one compressor is nearly about 8 to 10 kg and daily there are nearly 800-1000 units of production of refrigerators. Therefore, to pick the 8-10 kg compressor and then place it to the refrigerator about 800-1000 times is very heavy work for worker which results to physical problems such as shoulder pain, back pain etc.

So to reduce the human efforts and reduce the physical problem of worker, assembly has been made which can pick the compressor and place it to the refrigerator comfortably. This reduces human effort, improves the material handling and also the productivity of the process.

Keywords: Production, material handling, assembly line, productivity, ergonomics

INTRODUCTION

Materials handling is comprises of different activities such as loading, moving and unloading of materials. Materials handling equipment represents the second-largest capital cost and labor the largest operating cost. There is a trade-off between the two in that labor costs can be reduced by using more materials handling equipment (Arnold et al, 2008).

Materials handling makes production flow possible, as it gives dynamism to static elements such as materials, products, equipments, layout and human resources (Stock & Lambert, 2001). Groover (2001) highlights that despite its importance, materials handling is a topic that frequently is treated superficially by the companies. In order to improve the performance of distribution operations and, in this specific case, the internal material handling process, it is important to consider both human and technical factors. In the Production Function Mechanism, the concepts are directly related to a production analysis. A process analysis consists of an observation of the production flows that turn raw materials into final products. The analysis of the operations comes later because it focuses on production subjects (operators and machines). When making this distinction, it is possible to perceive the relevance of materials

handling (Chakravorty, 2008).

To do material handling process safely and economically, different types of gadgets, tackles and equipment are used. Any human activity involving materials need materials handling. Materials handling as such are not a production process and hence do not add to the value of the product. It also costs money; therefore it should be eliminated or at least reduced as much as possible. However, the important point in favor of materials handling is that it helps production. The applied external forces on the body are transmitted to the support through the material of the body. Depending on the weight, volume and throughput of materials, mechanical handling of materials may become unavoidable. Operating point and operating range need to be get better system performance curve (Rattan, 2011; Modi and Seth, 2011). Whether products are to be repaired, remanufactured, or recycled, the economic interests of allthe parties involved must be understood and aligned for the activities to be performed (Chopra & Meindl, 2001).

LITERATURE REVIEW

According to Asef-Vaziri & Laporte (2005) an important proportion of manufacturing expenses can be attributed to material handling and the most critical material handling decisions in this area are the arrangement and design of material flow patterns. This idea is shared by Ioannou (2002), which argues that an important aspect of any production system is the design of a material handling system (MHS) which integrates the production operations.

It is well understood that material handling improvement may have positive effects over production. However, it is not only production, but the way the employees see the new situation. The secret of the fluid power's success and widespread use is its versatility and manageability (Esposit, 2008). When the perception is favourable, the benefits are possible; if not, behavioral issues can emerge. Evaluations are important when interventions into the work environment are implemented. By means of effective materials handling management, the company's operational performance may improve (Chopra & Meindl, 2001). The unit load principle stands as one of the most important and widely applied principles in material handling. In material handling, a unit load simply the mass that is to be moved or otherwise handled at one time. The unit load may consist of only one part, it may consist of a container loaded with multiple parts, or it may consist of a pallet loaded with multiple containers of parts.(Groover, 2001). Product reliability and product quality are closely related to each other (Bhandari, 2010).

According to Sujono & Lashkari (2006), material handling accounts for 30–75% of the total cost of a product along the production chain, and efficient material handling can be responsible for reducing the manufacturing system operations cost by 15–30%. According to Chan et al. (1999), a key factor in material handling system design process is the selection and configuration of equipment for material transportation.

RESEARCH METHOD

Objective of research is to find out better method to lift the compressor of refrigerator. As a regular practise of lifting the compressor, a single compressor from bin lifted using manual mechanism. This creates stress in the spinal cord area of labour. New mechanism considers the mechanisms like chain mechanism, conveyor, electromagnetic lifting, ergonomic lifter, pneumatic lifter/vacuum technology etc. The main purpose is to identify current prevailing technologies to lift compressor and adding it to the process so that to develop ergonomically better way to lift the compressor.

Designing and implementing new compressor lifting system

During lifting of single compressor from bin, the orientation of each compressor inside bin is different. So it's difficult to lift the one compressor and also it increases the cycle time. Hence, it has been recommended to lift all the four compressors at a time from bin. For that, need to consider electromagnetic mechanism and pneumatic/vacuum technology for holding of compressors. Compressor is hermetically sealed, that means it is with motor. So during use of electromagnetic mechanism, there may be magnetic defect on motor of compressor. Hence, prefer use of pneumatic mechanism i.e. vacuum technology is confirmed for holding. And for lifting the whole assembly, the options are spring balancer, pneumatic air balancer or electrical motor. Spring balancer and pneumatic air lifter are rejected due to high jerk and high cost respectively. Hence, electric motor has an advantage and preferred.

Fig.1: Orientation of compressors in bin

As per the orientation of compressors inside bin, it is difficult to get grip of single compressor for lifting it from the bin hence it has been decided to lift the all four compressors at a time. Therefore for holding assembly of compressors rectangular frame been made which can support better grip. For holding vacuum pads, ventures are preferred. In case failure of vacuum pads or venture to avoid falling of compressors, lock should be provided. Holing assembly should be lifted by lifter motor which slides on rail way. This rail way can rotate freely on vertical 'I-section' column. The rail way is supported by the cantilever truss. This truss will be fixed on the 'I-section' column.

For easy rotation of the truss with track about column, it will fix on the vertical rods and these rods are fixed in the inner race of the bearings. Outer race of bearings will be fixed on the plates welded on the top

of 'I-section' of column

Fig.2: Arrangement of bins

Vacuum is used as gripping force. The lifting is a function of the degree of vacuum achieved and the size of the area on the part where the vacuum is applied. Vacuum grippers work on Bernoulli's principle where suction is created by using compressed air. The relative high vacuum is created by vacuum generator which is powered by an electric motor. Vacuum cups are used for lifting objects. They are made of synthetic rubber.

PNEUMATICS CONTROL: PICKING AND LIFTING THE LOAD

The vacuum generator generates a vacuum in vacuum reservoir and then in vacuum distributer the difference between negative pressure and ambient pressure draws the work piece to the suction plate when device is place on the work piece. This is generally called 'picking up' the work piece.

LOWERING AND RELEASING THE LOAD

Device has controller, which control the chain hoist after picking up the load using lifting device.To release the load, the vacuum in the distributor is eliminated through atmospheric venting. The vacuum reservoir remains filled for next lifting process.

ADVANTAGES OF VACUUM TECHNOLOGY:

It requires only one surface to grasp an object.

Applies a uniform pressure on surface of an object.

It relatively needs a lightweight gripper.

Suitable to a variety of different materials.

It has very low cost.

It can be used on curved or contoured surface as well as flat surface.

Flexibility of vacuum cup provides the assembly with a certain amount of compliance.

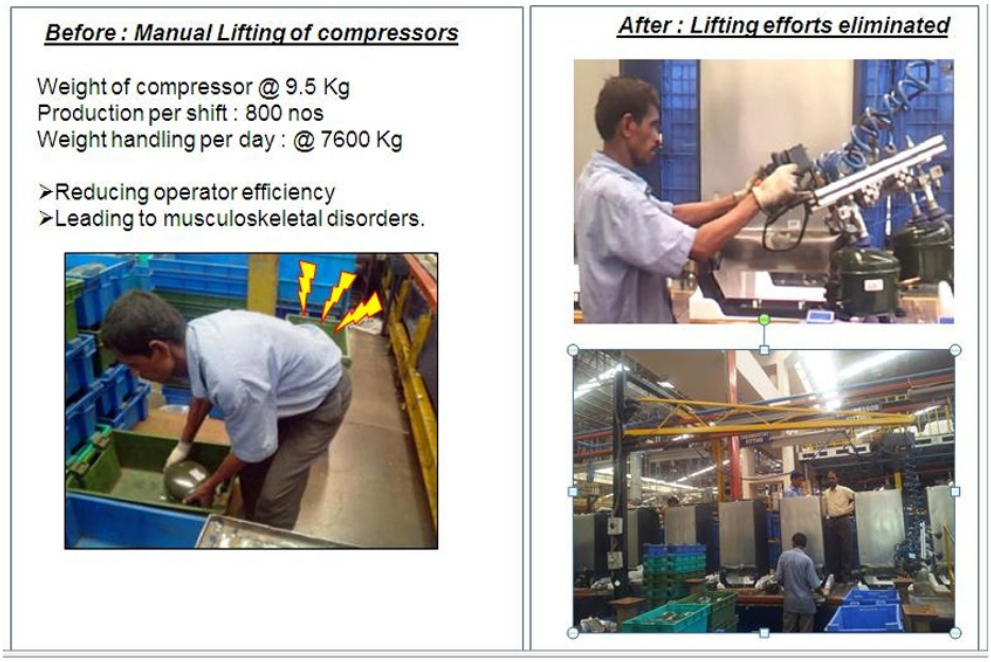

Fig.1: Difference in before and after work

When worker has to pick the compressors, he moves the lifting assembly towards bin containing 4 compressors using roller and track mechanism. After that he put the vacuum pads on the compressors and starts the vacuum selector switch and pressured air flows through the venture and suction is created. Vacuum pads grip the four compressors. Then worker press the up switch of the remote on handle, due to which motor lifts the load. After this worker moves the lifted load towards assembly line and press the down button on remote. This lowers the load. After lowering the load vacuum selector switch made to off by worker and compressors get released on the assembly line.

For any emergency in system one 'Emergency Stop 'button is also provided on the Remote on handle. If there is any crack on the air pipe or small lick in pipe then it will compensate it easily because System is designed for the 4.5 bar pressure and line pressure is about 5.5 to 6 bar, hence small pressure drop is permissible. There is no possibility of the fall down of compressor because if there is any cut on the vacuum pad, then respective pad or cup will not grip the compressor.

CONCLUSION

Human efforts are reduced using the new system of material handling. Now operator can lift four compressors instead of one, hence, it also increases operational efficiency. Due to semi-automatic mechanism possibility of falling compressors is avoided. The cycle time of operation also gets reduced. Initially there were requirement of two operators to completely assemble the compressor in refrigerator, but now one operator is sufficient for completing work.

FUTURE SCOPE

Pick and place mechanism is a semi-automatic robot may appear human being or simple electromechanically device. A robot mechanism will acts under direct control of human. This project involves design and development of model for reducing human efforts, to pick and place the compressor on main assembly, to pick and place the compressor on main assembly line.

Scope of human mechanism as follows:

Vacuum mechanism like robot may be used to perform task that are too dangerous or difficult to implement directly.

Nuclear west clean up: It may be used to automate relative task that can be performed.

Medical application: Mechanism includes Nano robotics using swarm robotics systems which consist of surgeries and operation can be done using knowledge of robot mechanism.

In future mechanism like vacuum, oiled, electric robot application will know about extend to field outside of manufacturing.

The possibilities include hazardous work environment, defense application, space exploration, and undersea preparation,

These are also opportunities for robot to be used in service industries, in restaurant, hospitals etc. similar activities.

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Dynamic Evolution Mechanism of the Location Value of the Ningbo–Zhoushan Port: A Competition Perspective

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ABSTRACT

This study discusses the dynamic evolution of Ningbo–Zhoushan Port's location value from the perspective of competition. Considering NingboZhoushan Port's construction of a free trade port (FTP) against the background of trade liberalization, this study summarizes the experience and laws of the dynamic evolution of the location value of well-known FTPs in China and abroad. It also investigates the dynamic evolution mechanism of NingboZhoushan Port's location value and how it leverages its location value in port competition. Finally, this study proposes five aspects to improve location value: driving subject and natural location value, port capacity location value, economic hinterland location value, science and technology location value, and policy location value.

Keywords: free trade port, dynamic evolution, location value, port competition, location advantage

China has established "comprehensive experimental zones" under its Belt and Road Initiative, including the establishment of free trade ports (FTPs) [1]. Moving beyond the functions of traditional transportation hubs, ports have become increasingly prominent in the global economy. Well-known ports such as the Port of Rotterdam, Singapore Port, Hong Kong Port, and Shanghai Port are all FTPs. In China, Dalian, Shenzhen, and Qingdao Ports have all become free trade zones. With regard to the Ningbo–Zhoushan Port, however, only Zhoushan Port has set up a free trade zone while Ningbo Port has not, thus missing out on an opportunity for FTP development.

To establish Ningbo–Zhoushan Port as an FTP, it is necessary to analyze the evolution mechanism of its location value advantage, clarify its function orientation, determine the direction and path of FTP construction, and focus on the port competition aspect.

1 Research reference

In location theory, location relates to placing and marking areas for specific purposes [2]. Location value refers to a region's comparative advantage over other regions, which can promote economic development and improve regional competitiveness [10]. Port location value is a comparative advantage [7] of a port compared to other ports. In the process of port development, its location value will evolve and develop as a result of various factors.

Research on port location value has mainly analyzed the geographical location conditions of port

formation, the factors affecting port location development, and port location evolution. Maritime distance, logistics transportation, labor resources, and construction costs determine the optimal location for port construction [17]. Morgan proposes that a port's economic hinterland determines port development [18]. Developing an "arbitrary port" model, Berd [8] divides port development into four stages—the traditional, port logistics, related development, and professional development stages—and puts forward the view of port–city separation [13]. Investigating the factors affecting the evolution of port location value, Dong et al. [12] find that port location changes depend on changes in natural, socioeconomic, scientific, and technological factors. On that basis, they propose the concept of port location potential [9] and develop a related theoretical framework and basic model. Bloom [4] further refines the concept of port location based on an analysis of the new location of the Port of Zhoushan. Location value reflects comparative advantages and resource advantages in the economic space of a port [3] [14]; on that basis, the factors affecting port location value can be established [5]. Applying the study of port location value to the theory of free trade area construction, Chen et al. [6] investigate the factors affecting the location value of a free trade area using a logit model. They find that location value advantages associated with the hinterland's economic level, infrastructure construction, government policy, and foreign investment positively affect FTP construction [11].

Existing research on port location value has proposed various methods and models, providing a good theoretical and methodological basis for subsequent work. Few studies, however, have considered the dynamic development of location value, and there is a lack of discussion of the law of location value. This study, therefore, investigates the dynamic evolution mechanism of the location value of Ningbo-Zhoushan Port in the context of port competition. It also analyzes the factors affecting changes in Ningbo–Zhoushan Port's location value and proposes a development direction for the construction of the Ningbo–Zhoushan FTP.

2 Dynamic evolution of the location value of free trade ports

The evolution of a port's location value can be divided into several stages based on physical location, changes in function, competitive advantage, economic development level, government policy, and other factors. According to the development characteristics of each stage, the general development law is investigated, and the dynamic evolution law and the main factors affecting FTP location value are summarized.

2.1 Dynamic evolution of the location value of foreign free trade ports

2.1.1 Port of Rotterdam, Netherlands

The Port of Rotterdam is located in South Holland, Netherlands, at the confluence of the Rhine and Nieuwe Maas Rivers. The eastern part connects the Rhine and the Danube with the Caspian Sea, and the

western part is on the North Sea. The economic hinterland includes half of Europe. The ports are not frozen and silted, wind and waves are small, and shipping conditions are excellent. The area of the Port of Rotterdam is about 126.06 square kilometers, with a total length of 89 kilometers and a water depth of 6.1–24 meters. It has 656 berths and has opened more than 500 routes to connect with more than 1,000 ports worldwide. The largest port in Europe, it is known as the "European Portal." In 2018, the cargo throughput of the Port of Rotterdam reached a record high of 469 million tons, and its container throughput ranked 11 among the world's 1.45 million standard containers. It is the most important import and export cargo transport hub in Europe, a global logistics center, and one of the world's largest container ports. Its development process can be recognized as evolution of its port function orientation and the changes in its location value.

2.1.2 Port of Singapore

The Port of Singapore is located on the southern coast of Singapore, close to the Strait of Malacca and the Strait of Singapore. The port area is 5.38 million square meters, with eight free trade parks and more than 30 industrial parks. It has one 400,000 ton and two 300,000 ton dry docks and has opened up more than 250 routes to connect 130 countries and regions. Its transit trade is developed, and it is one of the most wellknown transit ports, as well as one of Asia's largest ship repair bases.

2.2 Dynamic evolution of the location value of domestic free trade ports

2.2.1 Port of Hong Kong

The Port of Hong Kong is close to the Pearl River Delta region, with all of mainland China as the economic hinterland. It faces Southeast Asia and the Asia-Pacific region from east to south. The deep-water channel conditions in the port are good, and its equipment is advanced. More than 20 routes have been opened. The port is internationally well-known for its facilities, cabin tonnage, cargo throughput, container throughput, and efficiency. Such excellent foundations are part of the important conditions for the development of Hong Kong's FTP. Hong Kong has a high degree of trade freedom, causing the port to be known as the most free port in the world. Moreover, Hong Kong is an important center of international finance, trade, shipping, and technological innovation, as well as one of the world's most competitive cities. The development time of the Port of Hong Kong has been shorter than that of other well-known ports. In terms of function, the Port of Hong Kong transformed from a single port to a processing trade port, and then to a comprehensive crossregional FTP. The high degree of trade freedom is its most prominent factor. Its location value forms a dynamic evolution pattern of "natural condition advantagenational policy advantage–economic hinterland advantage."

2.2.2 Port of Shanghai

The Port of Shanghai has four main port areas, a deep water channel, a water depth of 7–15 meters, a land area of 7.2 square kilometers, a water area of 3620.2 square kilometers, and a wharf line length of 87.6 kilometers with 1202 berths, 164 of which are over 10,000 tons. It has opened up more than 80 international routes and more than 500 ports in 215 countries. The port's throughput capacity has been the highest in the world.

Based on geographical location, port location, political factors, changes in port conditions, port logistics, and national policies, the Port of Shanghai developed from an ordinary foreign trade port to an international economic, financial, and logistic center. The dynamic evolution of its location value follows a pattern of "natural condition advantage–national policy influence–port capacity advantage–national policy advantage."

The above discussion of the location value evolution of well-known ports shows that in different development stages, owing to the influence of different factors, the function orientations of port continue to change, and their location value continues to develop and evolve.

2.3 Dynamic evolution of the location value of Ningbo–Zhoushan Port

Among well-known FTPs, regardless of the length of the development process or differences in location value, they have multifunctional orientations that focus on port resource endowment and can meet various needs. Therefore, to promote FTP development, it is necessary to focus on port capacity, location resource endowment, functional orientation, and multifunctional FTP development. Additionally, the development of FTP should focus on port trade development, logistics hub development, the prosperity of international financial trade, high-level science and technology, and sustainable development, in order to maximize the advantages of an FTP hub.

Based on the above, developing a traffic logistics hub and a comprehensive, efficient collection and distribution system are prerequisites for FTP establishment. Ningbo has developed its maritime transport, but the development of its air transport and land transport is unbalanced.

3 Location value evolution of Ningbo–Zhoushan Port

3.1 Longitudinal analysis

Ningbo–Zhoushan Port was divided into Ningbo Port and Zhoushan Port in 2006. Since the location conditions and development history of the two ports are very similar, this study analyzes the evolution of Ningbo–Zhoushan Port's location value. Specifically, its evolution is analyzed longitudinally, and the evolution law of location value is investigated.

3.2 Horizontal analysis

3.2.1 Factors affecting port location value

Based on the analysis thus far, location value is considered to affect the evolution of ports mainly in terms of natural conditions, port capacity, economic hinterland, government policy, and science and technology.

3.2.2 Horizontal comparative analysis

Port location and resources are the prerequisites for port development and utilization. According to the optimal distribution theory of regional economic layout [15], regional investment and factor distribution should prioritize investing in places with comparative advantages. The water depth of Ningbo–Zhoushan Port is 22 metres deep, and the deep-water coastline is more than 300 kilometers above 15 meters. The climate is warm throughout the year, without freezing or silting. There are rich nonmetallic mineral resources and oil and gas resources in the port area. Natural and marine tourism resources are also very rich. It connects the north-south water system, the Yangtze River water system, the Zhejiang inland river, and the Taihu Lake water system inward; outward, it connects with the Pacific Ocean. Ningbo–Zhoushan Port has comparative advantages in all aspects of its natural conditions, and its advantages of natural location are more prominent.

Port capacity is the foundation of port development. Regional economic theory suggests that optimizing the allocation and combination of existing production resources in a certain space can maximize output [16]. Port capacity is the main embodiment of port function, and its size is mainly affected by port infrastructure construction, throughput, logistics, and industrial systems. Ningbo–Zhoushan Port is divided into 19 port areas, with 19 straight wharves and 723 berths, of which 28 are more than 10,000 tons, and the yard area is 520.3 million square meters. It also has advanced loading and unloading equipment, such as remotecontrol intelligent bridge cranes and gantry cranes, and it has opened 246 routes. The port equipment is advanced, information management has been adopted, and its infrastructure is advanced. Meanwhile, the area of the Port of Shanghai is 3620.2 square kilometers, and the wharf line is 87.6 kilometers long, with 1202 berths, of which 160 are 10,000 tons or above. It is 1.776 million square kilometer yards and has 3256 various types of handling equipment; more than 80 routes have been opened to connect 215 countries and regions. Thus, the Port of Shanghai has the most prominent advantages in terms of port conditions and infrastructure. The Port of Singapore's conditions are slightly poor, but its infrastructure is advanced. Ningbo–Zhoushan Port has excellent port conditions, but its development is not complete, and its infrastructure construction is at a disadvantage.

4 Dynamic evolution mechanism of Ningbo–Zhoushan Port

As an important strategic resource of a country and an important way to optimize global resource allocation, port development directly reflects local and regional economic development, and it can even affect national economic development. Competition among ports in China is becoming increasingly

fierce. Competition in terms of resources, sources of goods, the hinterland economy, and port freight volume has entered the global level, and competition has intensified.

4.1 Drivers of the location value evolution of Ningbo–Zhoushan Port

Multiple subjects are involved in the evolution of port location value, such as governments, enterprises, science and technology R&D centers, and financial and trade institutions. These subjects may have close or loose relationships. In the context of port competition, they exchange resources, technology, information, and among other things. The combined effect of these relationships promotes optimal port development, thereby promoting the evolution of port location value and competitiveness. Given the different resource endowments, characteristics, effects, and functions of each subject, they will have unique positioning and have different effects on the whole port location value system. Therefore, to study the evolution of location value, it is necessary to understand the relationships between subjects.

Enterprises will be the main players in the development of port location value. Enterprises will participate in economic activities and promote trade development and the hinterland's economic development, thus further promoting port development and port location value. In the whole process of port development, enterprises can determine a reasonable position from customer needs, guide the development of natural location, and provide financial support for port infrastructure. Financial institutions generally do not directly participate in port activities, but enterprises can provide information, platforms, and financial support for other subjects to promote the evolution of port location value.

4.2 Dynamic evolution mechanism of Ningbo–Zhoushan Port's location value

Natural location differences and resource endowments are the basis for promoting port development. Ningbo's government has assumed the role of resource development leader. It has introduced many resource development support policies and has developed the rich regional resources, nonmetallic mineral resources, oil and gas resources, and coastal tourism resources in the port area. It has also guided the development of the Chunxiao oil and gas field, East Sea continental shelf oil and gas resource development zone, and Zhoushan coastal tourism development zone. Financial institutions, represented by banks, insurance, and intermediaries, do not directly participate in the development of location resources, but they provide some financial support and resource development innovation platforms for port resource development. Scientific research institutions provide &D technologies for resource development, improve the utilization of port resources, and maximize the value of natural location resource advantages.

5 Suggestions

Port resource development and port capacity building are the conditions and foundation for FTP development. It is necessary to develop the superior geographical locations and natural resources of ports to provide a resource basis for development. First, it is urgent to develop the long coastline and

deep-water coastline resources of Ningbo–Zhoushan Port, strengthen the construction of deep-water ports in Beilun Port and Zhoushan Port, increase the number of large port terminals, and improve the tonnage of port ships. Second, the investment of capital, technology, and personnel input should be increased. Zhenhai refining, as well as chemical energy enterprises, should be supported to develop oil and gas resources. Efforts should be made to develop nonmineral resources in the port area, especially the Chunxiao oil and gas field, whose natural gas reserves are more than 70 billion cubic meters. Effective development can meet the needs of the port and further promote energy industry development. Improving port capacity is also an important measure for enhancing port competitiveness. The Ningbo railway and the high-speed and maritime systems should be combined to strengthen the transport network through coordinated development.

Hinterland economic development is crucial for promoting FTP construction. Building the Ningbo FTP requires optimizing the industrial structure, promoting the transformation and upgrading of the port industry, strengthening port radiation, and promoting the development of the port economy. Relatedly, it is necessary to transform and upgrade traditional labor-intensive garment-textile industries into knowledge- and technology-intensive industries and improve their industrial added value. By promoting the transformation and upgrading of the port industry, we can improve the level of hinterland economic development, enhance location value advantages, and further promote the construction of the Ningbo–Zhoushan FTP.

China's government should improve laws related to FTPs and provide a legal framework supporting the construction of the Ningbo–Zhoushan FTP. Then, based on national law, according to the location value and characteristics of Ningbo–Zhoushan Port, the Ningbo government can refine and improve policies and regulations according to local conditions, so that the construction of the Ningbo–Zhoushan FTP can be governed by law. Technological innovation capability is the catalyst of port development and FTP construction. It is necessary to increase investment in capital, technology, and talent; promote the development of science and technology; introduce scientific and technological factors into FTP management and operation; build the Ningbo Electronic Data Switching Center; promote the construction of intelligent FTPs based on information and automation; and promote paperless processes.

Sustainable development is the inevitable trend in FTP development. The construction of the Ningbo–Zhoushan FTP must adhere to the principles of sustainable development. In port construction, strict pollution detection standards should be followed. Environmental monitoring and pollution detection equipment must be updated, and the environmental protection of port equipment should be increased to meet the requirements of sustainable development. For coal, iron ore, and other seriously

polluted goods transported by the port, it is necessary to strengthen transportation management and supervision, strictly control transportation links, and reduce effects on the environment in transportation and processing. Strengthening the education of people and enterprises with regard to environmental protection, improving their awareness of sustainable development, adhering to simultaneous economic development and environmental protection, improving the sustainability of port development, and enhancing the development potential of ports are all also important.

6 Conclusion

Port location value has become a focus of port development research in recent years. The intensification of port competition has directed attention to the dynamic evolution mechanism of port location value. This study refers to the experience of well-known international ports to study the dynamic evolution mechanism of port location value. Moreover, it analyzes the location value of four driving subjects: government, enterprises, financial institutions, and scientific research institutions. In addition, it considers five aspects: natural location value, port capacity location value, economic hinterland location value, science and technology location value, and policy location value. This study summarizes the dynamic evolution mechanism of port location value, which can promote port development via the interaction of driving subjects and location value. This can shift port location value from being unitary to diversified, and change a weak location value to an advantageous value. This study can provide a theoretical reference for the construction of the Ningbo–Zhoushan FTP. At present, the dynamic evolution mechanism of the location value of the Ningbo–Zhoushan FTP is still in the stage of theoretical exploration. It will be necessary to continuously combine the construction of the Ningbo–Zhoushan FTP with empirical research to improve its dynamic evolution mechanism.

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Exploitation and Utilization of the Location Value of Free Trade Ports: Investigation of Meishan Port

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ABSTRACT

This study considers how to develop and utilize the location value of Meishan Port in China to leverage its competitive advantage as a free trade port (FTP). Based on the port area's location characteristics, further development and utilization are proposed based on specific, feasible measures. Against the background of China's 14th Five-Year Plan for development, proposals are made for revitalizing Zhejiang's marine economy and formulating strategies for Meishan's development as an FTP. The construction of this port and the planning of regional industrial development can provide ways to build an internationally comprehensive free trade port.

Keywords: free trade port; Meishan Port; location value; development path

Ningbo Meishan bonded port (Meishan Port) was established with the approval of the State Council on February 24, 2008, becoming the fifth bonded port area in China after Yangshan, Tianjin Dongjiang, Dalian Dayaowan, and Hainan Yangpu. In 2017, in the context of China's Belt and Road Initiative, a comprehensive pilot zone was established in Ningbo. The area has a strong foundation in port logistics as well as in financial innovation, marine science and technology, tourism, education, and cultural industries. Free trade ports (FTPs) fulfill the traditional port functions of loading and unloading, transshipment, and other activities. FTPs integrate trade, logistics, finance, science, education, and tourism; these are consistent with the original industrial base of Meishan. Although Meishan has developed rapidly in recent years, all of its industries are still in their infancy. This study, therefore, investigates how to develop and utilize Meishan Port's location value, improve regional industries, and establish the port as an FTP complex of international trade, international supply chains, financial innovation, high technology, and travel.

1 Literature Review

Various studies have investigated the location development of FTPs. Estuary-shaped FTPs are built based on developed waterway conditions and the broad economic hinterland [1]. Yang comparatively analyzes the Port of Hong Kong, Port of Singapore, and Port of Shanghai and finds that all three occupy transportation node positions, have superior transportation conditions, and rely on their powerful economic hinterlands [2]. Wang et al. study the development of the Port of Hong Kong and summarize

the characteristics of different development stages [3]. Analyzing the Port of Rotterdam, Taiwan Port, and Port of Singapore, Zhai et al. find that those ports all have unique means of operation and management, in addition to relying on abundant natural location conditions [4]. Tian finds that customs tax incentives and financial and investment efficiency are high by analyzing the development of major global FTPs [5]. Most innovations in well-known FTPs are relatively free in terms of economic policy [6].

Port development needs to leverage geographical advantages for positioning, integrate resources to attract demand, and establish an overall trading platform based on logistics, information flow, cash flow, and business flow [7]. Analyzing the degree of openness to the world of Hainan's FTP, Sun et al. finds that its development depends on highly developed local tourism conditions. [8]. Hainan should therefore aim to become an international FTP, focused on the five aspects of ecology, tourism, openness, science/technology, and livability [9][10]. Zhoushan's FTP has improved the openness of its financial service industry, thus extending the port logistics industrial chain [11].

Wang investigates factors related to port competitiveness, focusing on the heterogeneity of port resources, including the relationship between ports and the hinterland economy, the common development of combined ports, the improvement of port functions and logistics, and regional networks. In that regard, it is necessary to develop the overall operational capacity of ports in combination with the local situation, which is influenced by the demand and production environment of the port, the competition and development environment, the support environment, governmentrelated factors, and the opportunity environment [12]. Li suggests that China can further develop FTPs by enhancing trade openness, adopting the same standards as all high-level FTPs, strengthening institutional innovation, and enhancing financial and legal guarantee systems [13]. Chen et al., meanwhile, propose that FTP development should rely on realistic foundations, such as local economic and industrial development levels, original industrial foundations, and market development conditions [14]. Wang et al. suggest that a superior geographical location is the foundation for the establishment of FTPs [15] that participate in the global supply chain [16]. In summary, these studies indicate that the basis for FTP development is strategic national support and policy guarantees. Further, the ports themselves should have accurate functional positioning and be built based on existing port conditions, with a focus on improving the industrial structure and taking advantage of location value.

Investigating Ningbo Port, Xie concludes that intelligent port logistics technology is the key aspect that needs to be developed [17]. Huang et al. proposes an overall concept for FTP construction [18] while Xu et al. analyze the strengths of ports at all levels, including geographical location, the port–city relationship between, the foreign trade environment, and the level and efficiency of port infrastructure

[19]. Mou investigates the development of Zhejiang's financial system, identifies problems in the financial development of the free trade zone, and proposes innovations in financial supervision, transaction guarantees, and organizational systems [20]. Analyzing the Swiss financial center, Gong finds that the reason for its success is people-oriented and that it should replace traditional finance with blockchain to adapt to economic development [21]. Xu, meanwhile, analyzes the marine ecological culture industry and proposes development strategies [22]. Yang analyzes the industrial characteristics of Hainan as a site of international tourism and emphasizes that the think tank system should play its full role in development [23]. Gao suggests that the development of cultural and creative industries should rely on cultural accumulation and originality. Moreover, cultural and creative industries should be supported by creative economic and cultural policies [24].

Alexandre et al. designs a model of 13 free ports as typologies and explains their evolution and future development prospects [25]. Manuel et al. explore entrepreneurial competitive advantage and discuss the importance of public infrastructure, considering how regions with resource endowments develop based on regional advantages [26].

In conclusion, in developing as an FTP, Meishan Port should optimize its trade logistics industry, marine financial services industry, marine equipment industry, coastal tourism, and science and education industry. Since the development model of Meishan is similar to that of Hainan, lessons can be draw from FTP development in Hainan.

2 Development and utilization of FTP location value

2.1 Development and utilization of the location value of well-known FTPs

2.1.1 Hong Kong FTP

Hong Kong is a global center of finance, shipping, trade, and science and technology innovation. Hong Kong relies on the port of Victoria Harbour. Today, the Kwai Chung Container Terminal has become one of the most efficient container ports and the main processing center for container logistics in the world. The development of Hong Kong's FTP can be divided into four stages. In the beginning, it focused on entrepot trade; later, it focused on processing trade. Then, it developed into a comprehensive port and is now a comprehensive transregional port [3], as shown in Table 1.

Table 1. Development of the Port of Hong Kong

Years	Type of port (FTP)	Development approaches	Results
1841–1949	Entrepot trade	The British period, characterized by free trade policy and excellent location conditions; a gateway for the dumping of goods	Sustained economic growth through entrepot trade
1950–1978	Processing trade	Hong Kong developed its industry, relying on industrial technology, foreign capital from Southeast Asian countries and the mainland; high free trade, low tax rate, cheap labor resources	Obtained rapid development based on the processing trade
1979–1990	Synthesized	With the development of Asia-Pacific economic integration and China's reform and opening up, labor-intensive industries were transferred to the mainland	Fostered the Asian economic miracle and became one of the "Asian tigers"; processing trade came of age
1991–	Integrated cross-regional	Seized opportunities for in-depth development with the mainland, gave fully play to its role of offshore fund-raising for domestic Chinese enterprises, attracted mutual investment, and played its role as an entrepot trade port	The RMB internationalized, and Hong Kong became its first overseas settlement center; FTP economy continues to develop; has become an internationally renowned shipping center and trade center in the Asia-Pacific region

Source: http://www.chinareform.org.cn

2.1.2 Port of Singapore

- Singapore makes full use of its geographic advantages to develop its port economy. With the advantages of its port, it has become a well-known shipping transit center, financial service center, and free trade center [4]. The development of the Port of Singapore cannot be separated from its location value. Relying on the Strait of Malacca to connect the Indian Ocean and the Pacific Ocean, it has become the crossroads of the world, and its superior geographical position is an important premise for becoming a global port, along with its continuous improvement of port infrastructure and the use of advanced information technology, which have made port operations more efficient, as shown in Table 2.

Table 2. Development approach of the Port of Singapore

Years	Type	Development approach	Results
1819–1959	Mainly entrepot trade	Trading post of the East India Company; Britain obtained lease rights, and ships from all countries were free to enter and leave ports	Became a fully open FTP
1959–1967	Transition to limited FTPs	Flexible use of FTP policy; paid attention to the development of industry, adopted preferential policies, attracted investment from domestic and foreign enterprises	Entrepot trade prospered
1967–1990	Services and manufacturing developed simultaneously	Developed computers, machinery, electronic equipment, and other technology-intensive industries; promoted the export of the modern service industry	Manufacturing, finance, foreign trade, transportation, and tourism all had good momentum
1989–	Significant development as a multi-functional FTP	Improved infrastructure, opened up the financial and service industries, increased high-tech R&D, developed the software industry	Has relied on high-tech R&D to become a major power in the electronics industry

Source: http://www.chinareform.org.cn

The precise industrial positioning of the Port of Singapore and its constantly adjusted development strategies are important factors for its sustainable development. Singapore attaches great importance to the combination of higher education and vocational education. China's government should do the same.

2.1.3 Port of Rotterdam

The Port of Rotterdam developed over a long period from a small fishing village to a major global port. It is located at the mouth of the Meuse and Rhine Rivers. The largest port in Europe, it is known as "the gateway to Europe." Its port conditions are excellent, its deepest ship draft depth is 24 meters, and a supertanker with a capacity of 545,000 tons can berth in this port. Table 3 presents the development history of this port.

Table 3. Development history of the Port of Rotterdam

Years	Type	Development approach	Results
1600–1794	Commercial port	Warehouses, wineries, shipyards, rope factories	Industry was developed in the Port of Rotterdam
1795–1857	Occupied by the French	The development of the stalled port	Trade volumes shrank, and ports silted up
1858–1931	Port expansion	Port dredging, artificial estuary construction, port excavation construction, focus on the development of the port area	Laid a foundation for FTP construction and shipping development in the early 20th century
1932–1980	Transshipment port, containerized port	Focused on improving loading and unloading capacity; port-vicinity industries developed rapidly; containerization, which attracted ETC to set up a terminal in the port	Container transport developed rapidly, port loading and unloading and container handling efficiency improved; relied on oil refining; port industry chain became one of the world's three major oil refining centers; port industry system gradually improved
1981–	FTP represented by the logistics center	Service industry development; has constructed new docks through marine land reclamation to enhance container processing capacity; has become a global logistics service provider	Remains the largest port in Europe

source: https://www.portofrotterdam.com/cn/asia

The development of the Port of Rotterdam has been largely based on the development of port logistics. It has promoted the agglomerated development of port industries, resulting in the rapid development of export processing and port-vicinity industries. The Port of Rotterdam has created a unique path for FTP construction using its convenient logistics conditions to drive the development of industries and the regional economy.

2.2 Pilot FTP construction in China

Shanghai and Hainan are the two major ports with the best FTP construction conditions in China. Their development approaches are thus worthy of attention and can provide idea for the construction of Meishan Port as an FTP. The Shanghai Pilot Free Trade Zone (hereafter, Free Trade Zone) is located in the Pudong New Area, and it relies on the entire Yangtze River Delta. It includes Shanghai Waigaoqiao

Bonded Logistics Park, Shanghai Pudong Airport Comprehensive Bonded Zone, and four Yangshan Bonded Port Zones, which are under the special supervision of customs [9]. The throughput of the Port of Shanghai in 2017 was 40.233 million tons [10].

Hainan has been actively promoting the construction of an FTP. In the process, it has formed its competitive advantage—namely, the service trade. Hainan has a good foundation, and taking the service industry as the general direction has provided a powerful way to become an FTP. Thus, its main development path has centered on the innovative development of the service industry, relying on its advantageous geographical location. Hainan has also been improving the business environment, implementing preferential tax policies, and introducing and cultivating talent.

3 Development and utilization of Meishan Port's FTP transformation

Meishan Port should aim to form competitive advantage by expanding its superior industrial clusters. Determining how to enhance the port status of Meishan and improve its service level is the first step. Meishan Port should focus on the marine economy, and port efficiency must be improved. The coastal landscape can be used to innovate a new mode of coastal tourism, promote the construction of ecological tourism projects, and promote the development of bonded tourism projects to create new growth points for the port economy.

3.1 Improve the trade logistics industry

3.1.1 Change the approach to international trade

Meishan Port should focus on the construction of specialized markets to provide a public platform for international trade services, and it has a rolling wharf for the import and export of fully assembled cars. The wharf needs to establish a cooperation mechanism with major domestic and foreign auto manufacturers to promote the joint development of the domestic and foreign auto trade and give full play to Meishan's leading role in auto imports and exports. Meishan should cooperate with more crossborder e-commerce companies, improve its storage conditions, and promote the coordinated development of physical trade and cross-border e-commerce. The development of the service trade industry depends on Meishan seeking development opportunities to transform from the original focus of bulk commodity transshipment to the development of diversified international trade methods.

3.1.2 Improve shipping services

Meishan Port was originally set up to play a complementary role in Ningbo-Zhoushan Port and the Port of Shanghai. However, Meishan's FTP development cannot be limited to the original setting of the bonded port area. Meishan should move beyond the limitations of the bonded port area, rely on the shipping industry and the port service industry, and improve information services, ship inspection, crew

landing, shipping finance, ship registration, maritime operations, and derivative service functions.

3.2 Develop marine financial services

3.2.1 Promote the construction of a maritime financial town

As a financial town, combined with the advantageous shipping conditions of Meishan Port, the financial sector should develop in terms of shipping insurance, funds, ship leasing, and shipping price derivatives. Marine finance should develop ocean leisure, creative innovation and R&D, and build a well-structured marine financial support system. It is necessary to make full use of coastal wetlands and other landscapes to develop a healthy industry. Meanwhile, high-end physical examination and physiotherapy areas should be built to provide customized professional health convalescence services for people in Meishan and create distinctive characteristics.

3.2.2 Diversified development of similar financial industries

It is necessary to rationally use domestic funds and introduce foreign capital and qualified investment institutions at home and abroad to ensure that Meishan's financial industry will form a diversified situation after FTP completion. A similar financial industry will be combined with industries such as international trade logistics and intelligent equipment to seek out similarities in development and promote the diversified development of similar financial industries.

3.2.3 Develop emerging marine financial businesses

Meishan should develop its marine financial services and explore emerging marine financial services. It needs to guide cooperation among domestic and foreign financial institutions related to ships and shipping. Meishan should promote the development of offshore financial business and use the existing customs supervision system to promote the renminbi in the international arena. Related banks should be introduced to provide financing and other financial services for the construction of logistics. In terms of sea-related financing, large-scale financial leasing and factoring institutions at home and abroad are introduced to finance the leasing of ship equipment. Governments, enterprises, and banks can work in tandem to establish a marine industry fund to provide support for the marine industry and scientific and technological innovation.

3.3 Develop the intelligent marine equipment industry

3.3.1 Build a characteristic industrial base for equipment R&D and manufacturing

Intelligent equipment is a product of modern information technology development. Building an industrial base for intelligent high-end equipment R&D and manufacturing can compel enterprises with advanced technology, strong manufacturing capacity, and well-known brands to settle in Meishan. In

terms of highend marine equipment, Meishan should focus on R&D on the assembly and manufacturing of marine energy and engineering equipment, aviation equipment, and marine environmental protection equipment.

3.3.2 Construct a Meishan automobile electronics industrial park

Meishan can further cooperate with Geely Co. to drive the construction of domestic vehicle export projects, promote the settlement of related supporting industries in Meishan, guide enterprises to improve the level of automobile intelligence, and increase the added value of auto exports. Meishan needs to make good use of the advantages of auto exports; cultivate a good industrial chain integrating vehicle production, imports, and exports; and build a global intelligent manufacturing base and support center for vehicles and auto parts.

3.4 Developing scientific, educational, and cultural industries

3.4.1 Promote R&D in marine science and technology

In terms of marine science and technology R&D, it is necessary to rely on the institutes on Meishan to introduce professional institutions in marine engineering equipment, biomedical equipment, and marine biomedicine, and actively conduct various innovation development seminars. Meishan needs to attract a large amount of foreign investment for new technology R&D, relying on the advantages of existing marine innovation resources, such as Ningbo University Marine Science Park and Beihang Ningbo Innovation Research Institute. It should also establish cooperative relationships with foreign engineering institutes.

3.4.2 Foster marine-related cultural and creative industries

Marine-related cultural and creative industries include marine-related art, film, and television. They also pertain to the design and selling of marine products and derivatives, the brand value enhancement of the marine industry, and corporate culture dissemination. The current role of Meishan Port in China's Belt and Road Initiative is to play a leading role in marine culture and promote related advertising, fashion consumption, and cultural tourism.

4 Conclusion

FTPs need to have good location advantages and port-supporting conditions, with powerful trade, shipping, and financial functions. Port areas also need open economic policies and a free business environment. The development path starts from entrepot trade and then pursues industrial upgrading and diversification to drive port development. Therefore, now that Meishan has the conditions for port development, it can build an FTP using port resources to accelerate the development and diversification

of the industrial structure and determine port functions.

Meishan's development approach should be concentrated in four sectors. The first is the trade logistics sector, which improves port conditions in terms of international trade methods, port logistics, and shipping service levels. The second is marine finance, which can form a new economic pull point. The third is intelligent equipment and modern manufacturing practices, which echo the strategy of "developing the country by relying on science and technology." The fourth is coastal tourism. In this regard, Meishan can learn from Hainan and the Port of Rotterdam to develop its coastal tourism. Since development must be people-oriented, culture can also provide intellectual support for FTP construction in Meishan.

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Streamlining Software Development: An Analysis of Implementing Six Sigma Techniques in Reducing Development Time

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ABSTRACT

The use of Six Sigma in software development has been gaining popularity in recent years as organizations look for ways to improve efficiency and reduce defects in their software development process. In this paper, we will explore the use of Six Sigma in the context of an agile software development environment, specifically in the organization named Blue Star LTD. The principles of Six Sigma were used to cut down the software development time by 18% in this organization. First, we will provide an overview of Six Sigma and its key principles. Next, we will discuss how Six Sigma can be integrated into an agile software development process. We will also explore various Six Sigma tools and techniques that can be used to identify and address bottlenecks and inefficiencies in the software development process. Additionally, we will describe how we used Six Sigma to improve the overall quality of the software development process in BlueStar. This include using Six Sigma tools to identify and remove defects in the process, such as poor requirements gathering or lack of proper testing. Finally, we will conclude by discussing the benefits of using Six Sigma in an agile software development environment and how it can help organizations like Blue Star LTD to deliver software faster and with higher quality. In summary, this paper will provide a comprehensive overview of how Six Sigma can be used in an agile software development process to improve efficiency, reduce defects and deliver software faster and with higher quality.

Introduction

Harshavardhan Kothavale and Yogesh Yadav Six Sigma is a process improvement methodology that was first introduced by Motorola in the 1980s. It is a data-driven approach that seeks to reduce defects and improve efficiency by identifying and eliminating the root causes of problems. The goal of Six Sigma is to achieve a process that is capable of producing no more than 3.4 defects per million opportunities (DPMO).

There are several key principles of Six Sigma, including:

● Define, Measure, Analyze, Improve, Control (DMAIC): This is the basic process used in Six Sigma to improve a process. It involves defining the problem, measuring the current performance of the process, analyzing the data to identify the root causes of the problem, improving the process by addressing the root causes, and controlling the process to ensure that the improvements are sustained.

● Statistical Analysis: Six Sigma relies heavily on statistical analysis to identify and address problems in

a process. This includes tools such as statistical process control (SPC) and design of experiments (DOE).

● Process Mapping: Six Sigma uses process mapping to understand and visualize the flow of a process. This helps to identify bottlenecks, inefficiencies and areas where defects may occur.

● Project Management: Six Sigma uses project management techniques to ensure that the process improvement efforts are well-organized and properly managed.

● Continuous Improvement: Six Sigma is a continuous improvement methodology, it is not a one-time effort. It is an ongoing process in which the organization continuously looks for ways to improve its processes.

● Customer Focus: Six Sigma places a strong emphasis on understanding and meeting the needs of the customer. This is done by involving customers in the process improvement efforts and using customer feedback to guide improvements.

Overall, Six Sigma is a powerful methodology for improving efficiency and reducing defects in any process, including software development. By using data-driven analysis, statistical tools, process mapping, and project management, Six Sigma helps organizations to identify and eliminate the root causes of problems and achieve significant improvements in efficiency and quality.

Integrating six sigma into software development process

Integrating Six Sigma into an agile software development process can be challenging, as the two methodologies have different philosophies and approaches. Agile development is focused on delivering value quickly and continuously, while Six Sigma is focused on reducing defects and improving efficiency. However, by utilizing the principles of both methodologies, organizations can achieve a more efficient and high-quality software development process.

One approach to integrating Six Sigma into an agile software development process is to use Six Sigma tools, such as process mapping and statistical analysis, to identify bottlenecks and inefficiencies in the software development process. Once identified, these issues can be addressed using agile techniques such as sprint planning, daily stand-ups, and retrospectives. This approach helps to ensure that the agile process is continuously improving, and that the team is focused on delivering value to the customer.

Another approach is to use Six Sigma to improve the overall quality of the software development process. This could involve using Six Sigma tools to identify and remove defects in the process, such as poor requirements gathering or lack of proper testing. Agile development methodologies like Scrum and Kanban can be used to implement and measure the process.

Additionally, Six Sigma's DMAIC methodology can be integrated into the agile development process, by defining the problem during the sprint planning, measuring the current performance during the sprint, analyzing the data during the daily standup, improving the process during the retrospective and

controlling the process during the next sprint planning.

Overall, integrating Six Sigma into an agile software development process requires a flexible and adaptive approach. By combining the best practices of both methodologies, organizations can achieve a more efficient and high-quality software development process.

Various Six Sigma tools and techniques that can be used to identify and address bottlenecks and inefficiencies in the software development process .

There are several Six Sigma tools and techniques that can be used to identify and address bottlenecks and inefficiencies in the software development process. Some of the most commonly used tools and techniques include:

- Process Mapping: This technique is used to visualize and understand the flow of a process. It can help to identify bottlenecks, inefficiencies and areas where defects may occur. The process map can be used to identify areas that can be streamlined or eliminated to improve the process.
- Statistical Process Control (SPC): This technique involves using statistical analysis to monitor and control a process. It can be used to identify patterns and trends in the data, which can then be used to identify root causes of problems and areas for improvement.
- Design of Experiments (DOE): This technique is used to test different solutions to a problem and identify the best solution. It can be used to evaluate the impact of different changes on the software development process, and to identify the most effective solution.
- Failure Modes and Effects Analysis (FMEA): This technique is used to identify potential failure modes in a process and evaluate the potential impact of each failure mode. It helps to identify areas where the process is most vulnerable, and to develop a plan to address those areas.
- Value Stream Mapping: This technique is used to identify and map out the flow of value through the software development process. It helps to identify bottlenecks, inefficiencies, and areas for improvement in the process.
- Root Cause Analysis (RCA): This technique is used to identify the root cause of a problem. It can be used to identify and address the underlying causes of defects and inefficiencies in the software development process.

Using Six-sigma techniques to improve software development in Blue Star LTD In my organization Blue Star LTD, We used the principles of Six Sigma were to reduce software development time by 18%. By using Six Sigma tools such as Process Mapping, RCA, FMEA, and Value Stream Mapping, the organization was able to identify and address bottlenecks and inefficiencies in the software development process. The implementation of Six Sigma methodologies not only helped in reducing the software development time but also improved the overall quality and robustness of the software.

One of the key areas of improvement identified through these tools was the use of the Waterfall approach

to software development. The Waterfall approach is a linear, sequential process in which development is completed in distinct phases such as requirements gathering, design, development, testing, and deployment. However, this approach can be inflexible and can lead to delays and rework if requirements change or defects are discovered late in the process. For example, during the requirements gathering phase, if a critical requirement is not identified or misunderstood, it can lead to delays and rework later on in the development process. Similarly, if defects are discovered during the testing phase, it can lead to delays in deployment and can also result in additional costs.

By identifying these issues and implementing Six Sigma tools, Blue Star LTD was able to transition to an agile software development process, which emphasizes flexibility, continuous improvement, and the delivery of value to the customer. This allowed the organization to improve the speed and efficiency of software development and in turn, successfully made smart app for room ac control with the new approach. For example, using Six Sigma tools such as process mapping and RCA, Blue Star LTD was able to identify inefficiencies in their software development process such as lack of proper testing and poor requirements gathering. By addressing these issues, the organization was able to significantly reduce the number of defects in their software and improve their overall software development process. Additionally, using FMEA, the organization was able to identify potential failure modes and take proactive steps to mitigate them, which also resulted in a more robust software. And by using Value Stream Mapping, the organization was able to understand the flow of value through their software development process and identify areas for improvement, which led to a more efficient and effective software development process. Once the software development time reduction was achieved, the approach was standardized throughout the organization, and various other software such as smart controller for chiller and group controller for IOT in VRF were also developed using the same approach. This helped in maintaining the consistency and robustness of software development process across the organization, and also enabled Blue Star Ltd to deliver high-quality software products to its customers at a faster pace.

Conclusion

The use of Six Sigma in an agile software development environment can provide significant benefits to organizations like Blue Star LTD. By utilizing Six Sigma tools and techniques, organizations can identify and address bottlenecks and inefficiencies in the software development process, which can help to improve efficiency and reduce defects. Additionally, by integrating Six Sigma with agile development methodologies, organizations can achieve a more efficient and high-quality software development process.

The benefits of using Six Sigma in an agile software development environment can be seen in the

example of Blue Star LTD, where the implementation of Six Sigma methodologies helped in reducing software development time by 18% and improved the overall quality and robustness of the software. Additionally, by using Six Sigma tools like Process Mapping, RCA, FMEA, and Value Stream Mapping, we were able to identify and address bottlenecks and inefficiencies in the software development process.

By standardizing the Six Sigma approach across the organization, Blue Star Ltd was able to deliver high-quality software products to its customers at a faster pace. This helped the organization to maintain consistency and robustness of the software development process across the organization and also enabled them to deliver highquality software products to its customers at a faster pace. Overall, the use of Six Sigma in an agile software development environment can help organizations like Blue Star LTD to deliver software faster and with higher quality.

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