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SAAL Supply Chain to Manage Changes and Achieve Anti-Fragile Sustainable Construction Operations under Iran's Turbulent Conditions

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Abstract

Using the principles of uncertain thinking in complex industries such as the construction industry and also in Iran's economic crisis makes this thinking one of the main solutions available. For this reason, in such industries, it is necessary for Iranian managers to examine the entire supply chain in an integrated manner. Because a break in a section will be effective along the chain. In the economic conditions of Iran, this effect causes the loss of money and sometimes even the impossibility of continuing the project. For this reason, such studies are extremely important. Therefore, the main purpose of the study is to present the concept of such an integrated and inseparable model along the supply chain. In order to create such integration, it was necessary to look at other industries as the first experience in Iran's construction industry. For this reason, the basic study method has been used with the purpose of descriptive and developmental research. Computers lead to increasing the speed, accuracy and reducing the cost of repetitive and control processes, the experience of developed countries in the field of facilitating the control of regulations has caused the linking of regulations with technology, and in addition, the experience of other industries in creating integrated networks. It shows that such systems can improve performance. The SAAL supply chain control tower concept as a technology-based system is able to fill this gap to increase productivity, efficiency, infrastructure value, and reduce project life cycle costs by increasing collaboration and communication between the stakeholders of a project. The purpose of implementing a control tower in construction projects is to reduce the number of mistakes from design to maintenance and after. The result of this research shows how it is possible to create value by using the control tower to manage changes and achieve a stable anti-brittle construction under chaotic conditions.

Keywords: Chaos, Anti-Fragile, Sustainable, Control Tower, SAAL Supply Chain

Introduction

Due to economic and social conditions, Iran's construction industry has been in chaos for some time. In addition, the conditions of construction projects are becoming more complicated, leading to project failure. Among the most important factors in the failure of these projects are the increase in execution and preparation time, rework, lack of efficient human resources, uncertainty, and inappropriate management (Soheil Sadeghi, Akbarpour et al., 2023; Abbasi et al., 2020).

The main task of the project manager is the successful presentation of a project. To measure the success of a project, goals must be defined first because goals are flexible. These goals are different according to the characteristics of the project. The main classical indicators of project management success include time, cost, and quality. However, according to the conditions, other indicators are also proposed (Meng & Boyd 2017; Henkel, Marion Jr & Bourdeau, 2019).

In this regard, the issue of changes and rework is one of the things that can affect the project's success. The experiences of designers, employers, and contractors indicate that project changes can cause problems and challenge the project's success. These changes may cause an interruption in the work process, affect the quality of the product, and increase costs. All these factors can cause problems and contractual claims. Controlling and reducing the negative effects of these factors through change management can be an effective step in preventing the wastage of financial resources, workforce, and time (Griego & Leite, 2017; Arashpour et al., 2014). Changing the reality of projects is necessary. Changes in construction projects are inevitable. Changes usually occur at each stage of the project and have significant

effects. Lack of integration, uncertainty, lack of timely and effective communication, change of environment, and increased project complexity are the main factors of project change (Dai, Liao & Zhang, 2023). The sooner the identified changes and solutions are presented, the less negative impact they will have on the project. The root of the changes can be classified into five categories: (1) related to the customer, (2) related to the design, (3) related to the project, (4) related to socio-economic conditions, and (5) related to the contract (Yana, Rusdhi, & Wibowo, 2015).

If these things are properly managed and paid attention to, they can be guided to achieve the project's goals. Otherwise, they will have negative effects on the project. Among the adverse effects of unmanaged changes, we can mention quality reduction, cost, and time increase. Changes can also create positive effects in construction projects, including using modern science and technology, value engineering, etc., if identified in time and properly managed (Dai, Liao & Zhang, 2023; Yana, Rusdhi & Wibowo, 2015).

Reducing wastage and optimising resources are always counted among the needs of the construction industry, and on the other hand, achieving a valuable product in the construction industry is considered a goal that can only be achieved by paying attention to their values and promotion. Also, in most cases, value is mentioned next to continuity and continuous improvement and, of course, in the opposite direction (Magar & Honnutagi 2018; Aravindh et al., 2022). To help companies, various frameworks such as agile, lean, or even resilient operations, have been developed. However, many seem more like road maps and recommend a sequence of diverse tools that are used regardless of the complexity of human factors. Thus, it is not surprising that many Iranian construction companies have failed and are not able to use their advantages. Moreover, under conditions of chaos, none of these frameworks can show their effectiveness, as when black swans occur, such as COVID-19 (Soheil Sadeghi, Sadeghi, et al., 2023a).

The concept of the supply chain control tower in the construction industry, which was presented in our previous articles, is able to fill the labour productivity gap, increase the productivity, efficiency, and value of the infrastructure, and reduce the costs of the project life cycle, and reduce the consumption time of To increase the cooperation and communication of the stakeholders of a project. Project managers can use the supply chain control tower as an excellent tool to simulate project conditions, prevent rework and waste of time and money, and even predict events and think of solutions and change procedures. The supply chain control tower is a better decision-making basis than traditional projects (Patsavellas, Kaur & Salonitis, 2021).

To achieve an integrated model and use its capabilities, all the components and specifications of the model must include: Plans, specifications of the primary building model, standards, regulations, product manufacturer specifications, cost and procurement details, environmental conditions, and resource procurement conditions, and shipping and warehousing, contracts, and all proposed processes work together (Soheil Sadeghi, Sadeghi et al., 2023b). The process is about the various information sources that feed the documentation, which becomes an integral part of the supply chain model (Bennett et al., 2023). However, like all scientific categories, the control tower has wide dimensions. Proponents and Critics of this method have predicted that if the control tower is managed correctly, it can reduce the loss of information that goes from the design group to the supply group, from the supply group to transportation, and from transportation to storage. They are transferred to the construction and safety group, the owner, and the maintenance group (Bennett et al., 2023; Vlachos, 2023).

This result is achieved if each group is allowed to enter all the information they prepare during their activity in the information model of the building supply chain. This pre-imported information and the information entered during construction can give the building many values and turn the project into a sustainable, anti-fragile project resulting from uncertain thinking with the ability to continue construction operations under chaotic conditions. This research seeks to investigate the issue of how to continue the operation under the conditions of chaos while reducing waste, increasing values, and achieving a stable and anti-fragile construction. While explaining the issue of what role the supply chain control tower plays in reducing waste and increasing value, how can using the control tower and change management achieve stable anti-fragile construction under chaos.

The literature review shows that so far there has not been a study to use the SAAL supply chain control tower, the areas involved in it in the construction industry, especially in Iran. In addition, in previous studies in the field of supply chain, the parts of the supply chain have been examined separately. But in the conditions of chaos, the necessity of a complete and simultaneous investigation is emphasised. In this study, special attention has been paid to this point. In addition, technological tools have not been used in Iran

to predict the upcoming changes and examine the effects of the solutions presented in a simulation model. This study tries to fill the gap between these cases. In this study, the four sustainable, anti-fragile, agile and lean approaches of supply chain and control tower are fully investigated in all areas. For this purpose, first a literature review is done regarding the literature of this field, then with their help, the research results are presented in Section 3, and then the research model for using the control tower is presented. The parts of this study are in Fig. 1:

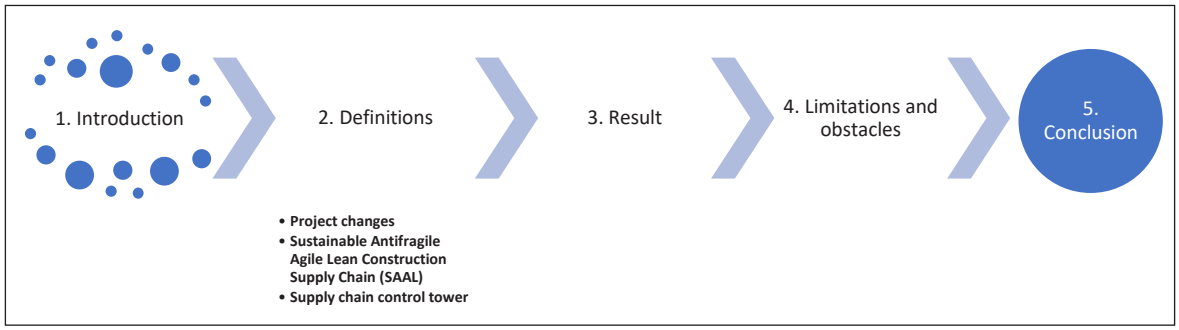

Fig. 1: Sections of this Study

Definitions

Project Changes and Change Management

Almost all construction projects change different conditions in their life cycle. Changes could be classified into two groups: 1) avoidable changes and 2) unavoidable changes. Avoidable changes are changes that can be predicted or are selective. Unavoidable changes are those that cannot be predicted or chosen. The influence of internal and external elements can cause project changes. Internal elements are issues related to the project, organisation, and participants (Dalporto & Venn, 2020). One of the most important internal factors is the owner's factors, or design consultants. External elements include unpredictable natural conditions, such as the political or economic environment, government intervention or policies, economic or legal issues, and third-party factors (Vlachos, 2022).

All groups in the construction process can initiate changes. However, all changes must be approved by the employer before implementation. The summary of the start of change orders is as follows (Vlachos, 2022; Arefazar et al., 2022; Silva et al., 2022): 1- The owner can request a change order, and usually, the scope changes. 2- The engineer may make a change due to different site conditions or revision of government regulations, etc. 3- Project management of the company or person may cause change, and its source is usually in the plan. 4- The contractor may make a change due to mistakes in design, value engineering, or mistakes in predicting needs. Any change in the project's plan, assumptions, and limitations is called a change. Examples of types of changes include (Silva et al., 2022; Padala, Maheswari & Hirani 2022):

1. Change in project goals. 2. Change in the executive team of the project. 3. Change in the method of carrying out activities. 4. Change in standards. 5. Change in assumptions such as a change in the exchange rate, inflation rate, etc. 6. Change in restrictions such as the list of vendors approved by the employer. 7. Change in the scope of the project and work breakdown structure. 8. Change in the schedule and implementation priorities of activities. 9. Change in conditions Employer's approval. 10. Change in the communication management plan and project coordination procedure. 11. Change the activity progress measurement system. 12. Change in project human resources management plan. 13. Change in the risk management plan. 14. Design and architecture change.

Changes occur throughout the life of the project. The diagram below shows that the more changes are made in the initial phases of the project, the greater the impact on the entire project life cycle, and with the passage of time and the use of the project, the number of changes and their impact on the cost will decrease (Fig. 2) (Padala, Maheswari & Hirani, 2022).

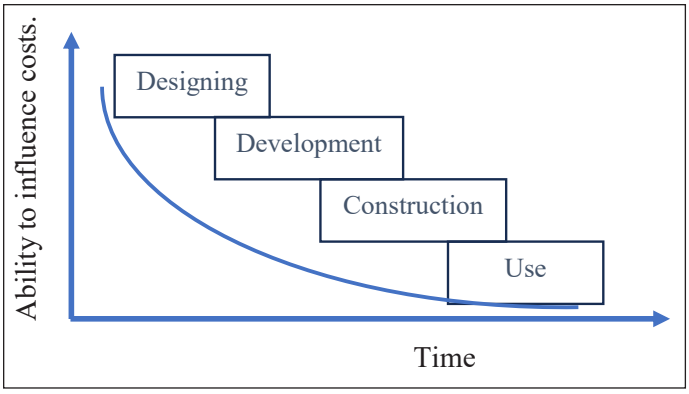

Fig. 2: Impact of Changes in Each Stage on Cost (Padala, Maheswari & Hirani 2022)

Managing project changes is like changing the default flight path. The autopilot system measures and corrects the existing and original routes thousands of times per second. Projects are the same. Projects are constantly exposed to successive turbulences, and most of the managers' energy is spent on headwinds and weather changes. Most managers prefer to focus on the initial setup and get on track according to the initial plan, but this needs to be corrected. A pilot is expected not to enter a storm; if he falls into it, he can escape it by knowing which way to go. Because managers must make decisions, they must always be aware and alert. In addition to acting as a military radar, they must also be able to predict the future. Because they can make the right decisions, keep the organisations away from the leading crises, and even create an opportunity from the crisis in which they are caught to bring the organisation and people to the safe shore. This needs awareness and vigilance (Padala, Maheswari & Hirani 2022; Silva et al., 2022; Elhegazy et al., 2023; Ghodousi & Eslamian, 2022; Soheil Sadeghi, Sadeghi et al., 2023b).

Resilient and flexible systems are like the pilot overestimating the importance of the initial decision and underestimating the role of modification when the role of modification is v (Soheil Sadeghi, Akbarpour et al., 2023). There is no such thing as a perfect plan because it is impossible to predict threats (Soheil Sadeghi, Sadeghi & Hajjam, 2022). An airplane needs a gyroscope to maintain balance according to the pressures and maneuvers, to find the destination and track the position of a compass, to control and monitor the status of the dashboard and control tools, to automatically guide the autopilot (Soheil Sadeghi, Sadeghi et al., 2023a, 2023b), to manage critical moments inside the technical cabin, such as the cabin resources management and the direction of data recording of black box events, which records thousands of data every second, including the pilot's conversations and environmental information, which is vital to black box thinking in projects (Saman Sadeghi, 2022; Soheil Sadeghi, Sadeghi & Hajjam, 2022). Considering the nature of construction projects, such equipment is needed in an atmosphere full of uncertainty. In this research, we are looking for the management changes that result from using the control tower and its effect on sustainable anti-brittle construction under chaotic conditions.

Sustainable Anti-Fragile Agile Lean (SAAL) Construction Supply Chain

One of the main goals of supply chain management is to ensure proper flows of products and information to supply them in the right place at the right time. Therefore, it is very important to consider flows of resource among supply chain nodes. New supply chain networks try to integrate both areas of operations and financial aspects to maximise the value created and measured by the Shareholder Value Analysis. The main reason for an increase in value creation is due to new operational and financial aspects, because the results show that with appropriate financial decisions, creating more value for the company's shareholders is achievable (Biglar, Hamta, & Rad 2022).

Sustainable Supply Chain

A sustainable supply chain is a way of managing the supply chain that makes it possible to use the least amount of cost, workforce, equipment, time, and space, considering environmental, cultural, and social issues. The maximum possible exploitation should be done for the production of products. At the same time, the manufactured products should be in maximum harmony with the customer's needs and environmental issues (Attia et al., 2023). Sustainable construction is an approach towards using sustainable thinking in the way of building structures in sync with the environment, at an affordable cost, with low pollutant production and low energy consumption, recyclable or with a long life, which, according to the type of environment and the resources of the environment and by considering the social and cultural issues of that area, it is built and also improves the micro-economy of that area and causes macroeconomic development as well (Duong et al., 2023).

Anti-Fragile Supply Chain

Some things benefit from shock; They thrive and grow when exposed to randomness, disorder, volatility, and

stressors, and they love adventure, risk, and uncertainty. Anti-fragility is more than resilience or sturdiness (Lotfi et al., 2023). Resilient resists shocks and remains the same; it is anti-fragile, but it gets better than it was. This supply chain type benefits and strengthens against shocks and stressors rather than being damaged. With the help of the anti-fragile chain, crises and chaos can act as a transformative factor to create growth and positive changes instead of being extremely harmful to the work environment and the project (Taleb, 2014).

Agile Supply Chain

To gain a competitive advantage in the changing business environment, companies must align their operations with suppliers and customers to achieve an acceptable level of agility. Subsequently, agile supply chains have distinctive competitive designs and seek to value customers and employees. Therefore, an agile supply chain can appropriately respond to changes in the work environment (Masi & Pero, 2023). Supply chain agility may be defined as: the ability of a supply chain to respond quickly to changes in the market and customer needs. So, the agile supply chain can be considered a structure to satisfy customers and employees (Singh et al., 2023). The supply chain structure is supported by four principles: comprehensive change and uncertainty control, innovation management structures and virtual organisation, collaborative relationships, and flexible and intelligent technologies. These four principles are tied together through a methodology to integrate them into a coordinated and integrated system and Transfer strategic competitive capabilities (Yongliang & Sharon, 2022).

Lean Supply Chain

Using lean thinking in construction, seemed impossible initially due to existing procedures and saying, "Construction is different." This issue has been raised as a disease in construction. In the past two decades, many innovations in other construction industries have shown that construction has acted entirely differently and ignored this method (Le & Nguyen, 2022). "Lean" manufacturing or production method is a systematic method of continuous improvement based on examining business processes and removing waste. This method focuses on reducing additional costs and waste and optimising inefficient procedures. When successfully implemented, lean management and production can help organisations improve their processes to reduce and eliminate waste (Meng, 2019). Leaning and its implementation can be summarised in four components: work system planning, operating organisation, governing thinking, and concluded contract. In fact, lean affects all project elements, and its full implementation is achieved through the effective interaction of these four factors (Le & Nguyen, 2023; Aravindh et al., 2022).

Although several companies have tried to use these approaches, only some have had stable results and success. In past research, the exact details of why these initiatives fail have been discussed, and it has been concluded that the common root causes that cause the initiatives to fail are the lack of supply chain integration, lack of employee involvement, lack of leadership commitment, and misunderstanding. Tools and techniques, and finally, avoiding business systems. The SAAL supply chain is an answer for proper response and optimal use of conditions, especially critical conditions and uncertainties, to create blue oceans, even in the face of black swans, while maintaining sustainable development.

In simpler words, SAAL supply chain is considered as a new management approach to increase productivity in order to develop anti-fragile sustainable construction. Fig. 3 shows the motivations and barriers of the SAAL supply chain approach.

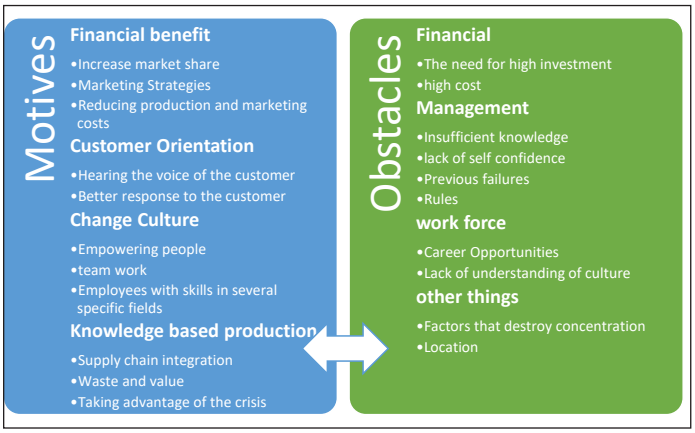

Fig. 3: SAAL Supply Chain Barriers and Drivers (Soheil Sadeghi, Sadeghi & Hajjam 2022)

Leadership, delegation, acceptance and change management can be considered as a systematic and logical process that includes a number of steps that are called the principles of the SAAL flow (Fig. 4). Such an approach tries to lead to large-scale changes with initiatives and changes on a relatively small scale and clear goals in gray conditions with the help of methods that are in conflict with each other, but their ultimate goal is to create value and sustainability. This approach is trying, from design to start-up, from order to delivery of raw material, then

to the delivery of the final product in the hands of the consumer, the flow of value must be a flow without any stoppages, losses, or repetitive and recurring process (Soheil Sadeghi, Sadeghi et al., 2023a).

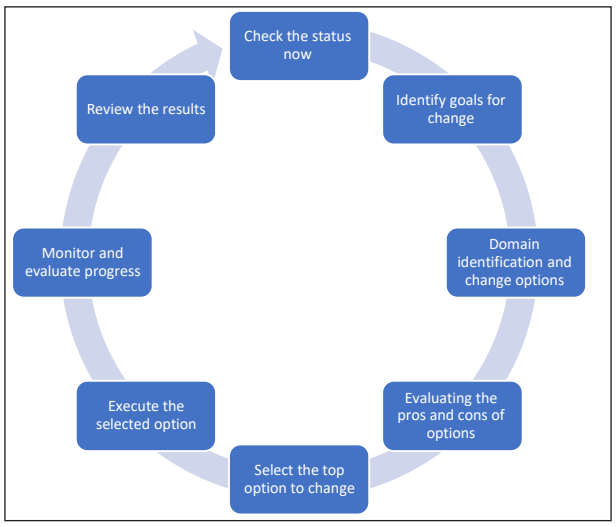

Fig. 4: Models of Organisation Change (Van de Ven & Sun, 2011)

A well-known model for process leadership is presented by Katter and is based on research on change in a wide range of organisations. His model consists of eight steps to promote change. These cases highlight areas where there are significant benefits to change management. A lack of employee participation in change initiatives is often why projects fail. Katter updated its Octagon model in 2012, where the eight stages became eight accelerators (Fig. 5) (Rojas et al., 2022).

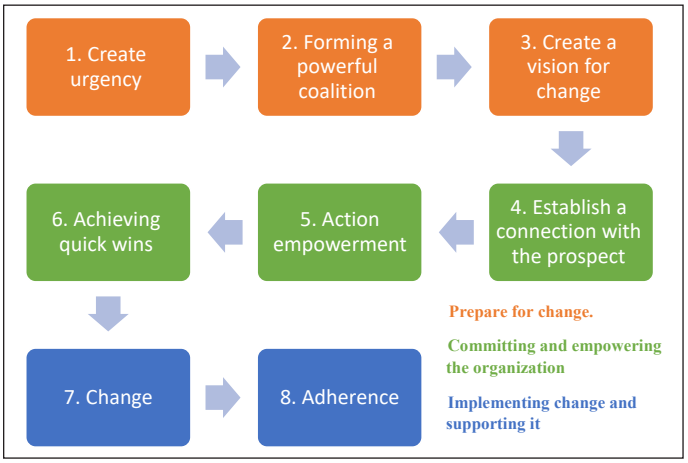

Fig. 5: Katter Model to Advance Changes (Rojas et al., 2022)

From the literature review results, it is clear that the transformation of SAAL includes a change in company culture. In addition to the straightforward implementation of tools and techniques to eliminate waste (equipment, processes, and resources) and take advantage of situations, there is a need for a fundamental change in managing relationships with customers, suppliers, and employees. Therefore, such a change cannot be considered a quick transformation because much time is needed to change the culture. According to the change classification, change is considered "evolutionary," that is, a large-scale change that takes place over a long period (Soheil Sadeghi, Akbarpour et al., 2023; Soheil Sadeghi, Sadeghi et al., 2023a).

Supply Chain Control Tower

Considering that the construction industry is multidisciplinary in nature, effective interaction between all members of the project supply chain team is mandatory. Control towers are a concept that has recently entered the literature of project and construction management. The control tower has attracted the attention of most disciplines involved in construction, from architecture, civil engineering, information and communication technology, project management, logistics, and even safety. However, the control tower is a fast and highly effective method primarily used in operations management (design and construction) and logistics (Vlachos, 2023; Soheil Sadeghi, Sadeghi et al., 2023b).

The control tower represents a system based on information technology, which, before starting the construction process, all the information related to the design, calculation, structural systems, resources (materials, human resources, and equipment), and even the energy of the building in the form of a multi-dimensional model (Trzuskawska-Grzesińska, 2017; Dalporto & Venn, 2020). This model helps the design and technical team of the project to see and check the results of their work in a simulated example (Soheil Sadeghi, Sadeghi et al., 2023b). It is not only effective in the geometrical modeling of building performance and operation process simulation but also in the design and construction processes to a great extent.

In addition to creating greater coordination between the project's stakeholders, the control tower specifically helps architects and executive engineers to anticipate problems before implementation and take action to resolve them

(Trzuskawska-Grzesińska, 2017). As one of the most compelling new tools in the construction industry, the control tower significantly reduces unwanted changes, rework, and accidents. This tool ensures the integrity of the entire project by exchanging information on time and as a comprehensive information bank, and it creates a continuous and correct information flow that makes information constantly available to all project stakeholders (Dalporto & Venn, 2020). Organisation, management, mindset and culture, information structure and data flow, tools and software, strategy, resources, business partners (stakeholders), mindset, education, and open standards are among the most essential perspectives of the control tower (Sharabati, Al-Atrash & Dalbah 2022; Midkiff 2021). One of the most common mistakes is to assume that the control tower has a model or database. Another mistake is that people usually think the control tower is error-free, but it is not.

The traditional construction methods of steel and concrete skeleton buildings, which are still common in Iran, need help to achieve the necessary optimisation in terms of cost and quality of construction work. This lack of optimisation can be seen in all the implementation phases of construction projects, including planning, design and calculations, implementation, and operation. Some of the worst problems related to these traditional methods are consistency and mistakes, which, in addition to increasing the cost and time of construction, lead to a decrease in the quality of work (Soheil Sadeghi, Sadeghi et al., 2023b).

The control tower is one of the newest methods presented to overcome these problems. To benefit from the advantages of the control tower, companies and organisations must have the necessary knowledge about how to implement it (Midkiff, 2021). Nevertheless, in Iran, an attempt has yet to be made to introduce and use the control tower. The main reasons are low maturity level, people's resistance to change, and a lack of knowledge about implementing it.

In general, the role of people in successfully implementing the control tower is much stronger than the tools. It should be noted that the implementation of the control tower may cause changes in the organization. These changes include (Dalporto & Venn, 2020; Soheil Sadeghi, Sadeghi et al., 2023b; Vlachos, 2023) (Fig. 5):

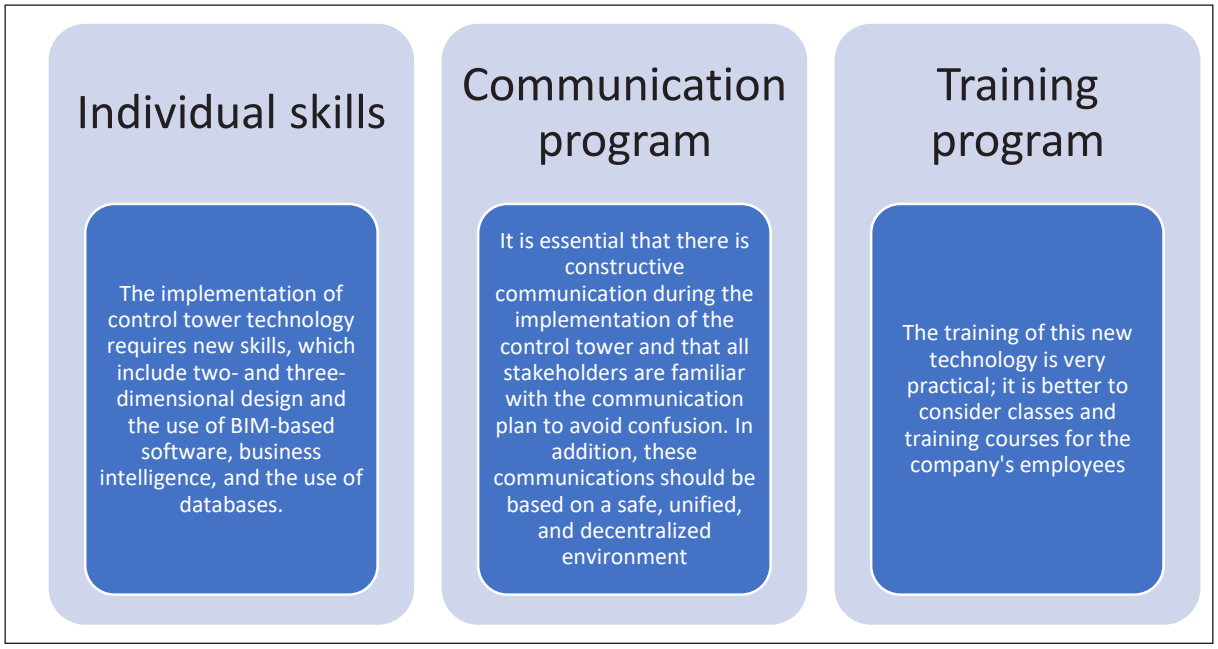

Fig. 6: The Changes Achieved Through the Implementation of the Control Tower

According to the studies, the control tower is different from the traditional form of a construction project in cases such as technical documents, design, construction management, information communication, and cost (Table 1).

Table 1: The Difference between the Implementation of the Project by the Watchtower and the Traditional Methods in Construction Projects (Soheil Sadeghi, Sadeghi, et al., 2023b)

Items	Implementation of the Project by Traditional Methods	Implementation of the Project by the Control Tower
Technical documents	Independent 3D views, analog shapes, graphics in nature.	An interdependent multidimensional vision, digital forms, and informational nature.
Designing	Linear, separate, cooperation of experts when problems occur, short design time.	The company of experts from different fields in the initial stages of the project, centralised, dependent on a model, interconnected, average design time.
Management	Individually managed, non-collective decision-making, difficulty in coordination between project members.	Collectively, this includes sharing information, ease of coordination between project members, and adding a task under the title of central model management.
How to communicate information	Based on paper, analog, and two-dimensional loss of information.	On a digital basis, in a virtual way, there is no loss of information.
Costs	Failure to identify additional work steps, unexpected expenses, increase in construction time, increase in cost.	The return of the cost spent in producing the information model, eliminating costly and useless operations, reducing construction time, and reducing cost.

The control tower can be used for the following purposes (Soheil Sadeghi, Sadeghi, et al., 2023b): 1. Suitable construction drawings: production of construction drawings for various building systems; for example, construction drawing sheets can be produced quickly and right after the completion of the BIM model. 2. Revision of standards: It is possible that even before the implementation of the project, the employer, consultant, and supervisor can use the established model to review and check the regulations and take into account the best solutions to observe safety issues and prevent accidents. 3. Facilities management: using the control tower allows the project managers to know what facilities they need at each stage and to predict and prepare the necessary facilities in advance, examine the conditions according to different scenarios and risks, and prevent possible delays. 4. Estimated costs: The integration of different data from different software in a platform that has the feature of estimating costs by default, they provides the possibility of accurate estimation of final costs automatically and sensitive to any changes, however small, by integrating with BI platforms. 5. Construction order: the control tower, with the help of the BIM model, extended reality, and BI, can be effectively used to control the sequence of materials arrival, construction, and the timing of receiving the building components, in addition to the possibility of simulating the change of the construction process according to the changes. The accident is also possible. 6. Detection of conflict, interference, and collision of construction activities: because all the data is made in different forms, such as three-dimensional according to the BIM model or dashboard with scale, most of the construction operations are visually visible and as a result of the interference Construction systems and operations are easily visible. For example, this process can check whether the piping interferes with the metal structure, walls, and ducts. Alternatively, the operation of a unit itself, such as plumbing, causes the interference of electrical wiring in that unit or other units. 7. Imaging: authentic three-dimensional images - not imaginary images - at the same time, images of operation diagrams can be easily and quickly viewed from different parts of the tower. Control the output direction.

So it is received by reviewing the articles that have been published in connection with the control tower, Previous studies that have evaluated control tower projects are not in the field of construction, but in other industries such as automotive and medicine, they express models and methods that evaluate the technological and organisational maturity of project teams and quantitatively measure the benefits of control tower projects.

Result: Change Management with a Control Tower Approach

In the traditional approach to change management, attention has been paid to the efficiency of information and the flow of documents. Such as requesting changes and revising the plan. Focusing on responding to the need for change, creating change strategies, and revising plans is common among project control and construction companies. Control tower is a technology

that, if implemented in a construction project, can be very useful in managing information and data. A broad definition of the control tower describes it as a common platform for efficient information exchange and sharing between different disciplines and units. The control tower is effective in approving and promoting changes in the project; Nevertheless, Certain deficiencies such as the inability to produce a comparable process change deviation report, the uncertainty of two-way links between external analysis software and design tools such as BIM and reporting tools such as Power BI, having a powerful user interface and lack of sufficient artificial intelligence for analysis and providing an alternative solution, are still noticeable.

Control tower-based change management can be defined as a dynamic process that identifies needs and reasons for changes, implements changes in the model, flows information about changes, analyses and evaluates the consequences of changes and minimises their negative effects or exploits them. facilitates One of the biggest advantages of the control tower in the field of change management is that it allows to change or modify the project components in real time. The information stored in the model can be sorted and modified in any way.

To implement the control tower, BIM-based software is used to help visualise the applied changes. Extended reality platforms are used to simulate projects and events, blockchain technology is used to record information and data so that it is not possible to change and also to enter into contracts. IoT and GPS are used to control and record data and monitor projects and operations. Business intelligence is used to simulate activities and key performance indicators and examine scenarios. Artificial intelligence is used to provide solutions and recommendations to optimise performance.

The control tower ensures that any changes made at any stage of the project will be immediately visible in any view, and these changes will be manageable by the stakeholders of the construction project. However, even if the control tower is used in a construction project, it seems impossible to eliminate project changes. The problem with relying only on old technologies such as relying on MIS, BIM, or ERP is that the conditions of the world, especially Iran, are constantly changing, and people can predict these changes to some extent. Currently, the user in these systems is only able to. A limited number of changes have been observed, and the new model is affected by them, not the ripple effect of these changes. Nevertheless, in the control tower system, this possibility is provided by the simultaneous operation and integration of these systems. Therefore, in the SAAL approach, the principle is not to face or endure the situation but to accept and exploit that goal. Fig. 7 shows the diagram of the control tower and other management systems.

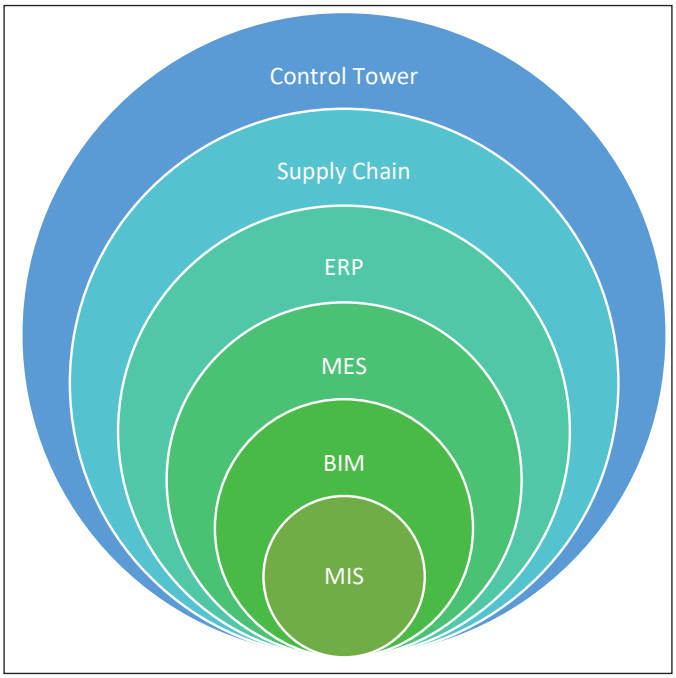

Fig. 7: Control Tower Project Management System

As can be seen in Fig. 7, this possibility is provided in the control tower system by the simultaneous operation and integration of these systems. Therefore, in the SAAL approach, the principle is not to face or tolerate the situation, but to accept and exploit that goal. For this reason, by using the features of the control tower software and platforms, users are able to see the components to modify, delete, or add. Graphic display and filtering options are also available to identify elements. One of the practical features of this system is the possibility of comparing and visualising the selected parameters of a model. The user can easily compare the selected versions, the changes made to a specific component in successive edits, and then follow the results. In order to develop and apply anti-fragile sustainable construction with the help of SAAL supply chain control tower, only the requirements (Fig. 8) can be enough.

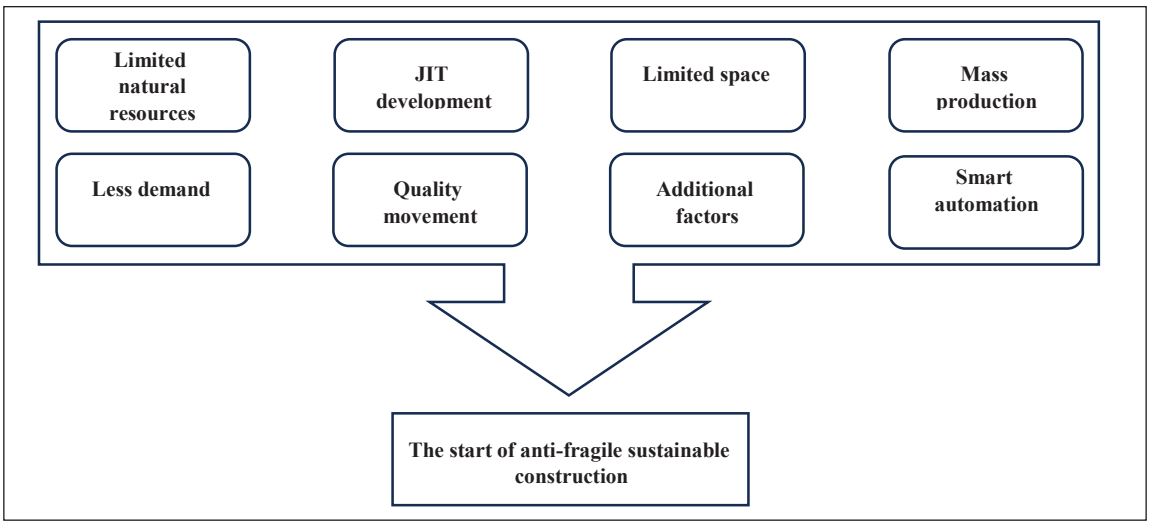

Fig. 8: Start of Anti-Fragile Sustainable Construction with the Help of a Control Tower

Features such as measurement, visualisation, and analysis of changes to models provide benefits for all stakeholders of the construction project. In addition, the control tower can highlight successive modification of models, information changes, component characteristics or relationships between components caused by changes made in the model. One of the goals of the control tower development is to provide an efficient and automatic tool that supports the change management process. As a technology, the control tower should provide both the possibility of presenting and analysing the consequences of changes. The potential of the control tower should be used to use it automatically or semi-automatically for analysis. So that all project stakeholders are able to review and compare the impact of model changes on project costs. In fact, one of the goals of implementing a control tower in construction projects is to reduce the number of mistakes and exploit crises. Changes in the process of developing and improving models are inevitable. Workflow on anti-fragile sustainable construction projects from SAAL supply chain perspective with the help of a control tower, according to Fig. 9.

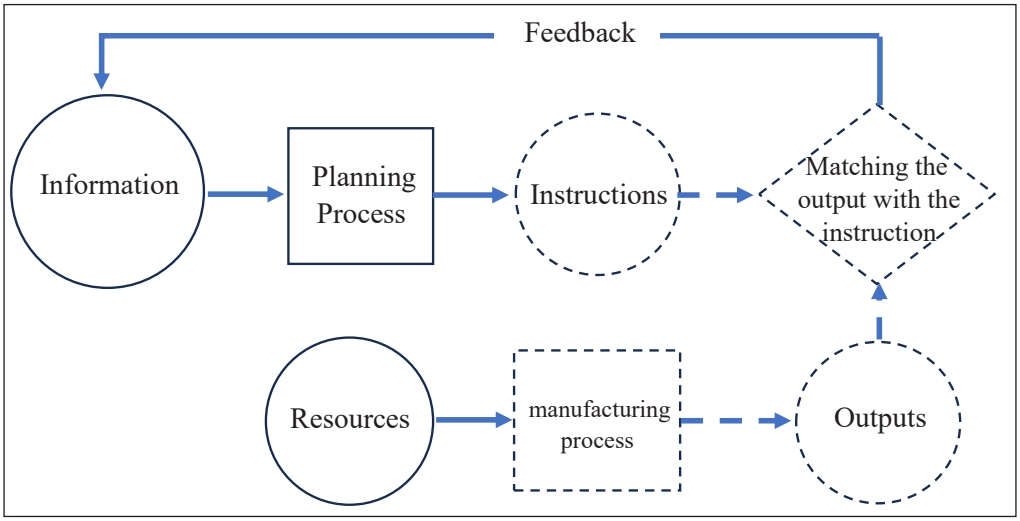

Fig. 9: Overview of Workflow Control on Construction Projects from the SAAL Supply Chain Control Tower Perspective

As it is clear from the diagram above, using the control tower for change management has significant advantages. The main advantages of the control tower are (Fig. 10):

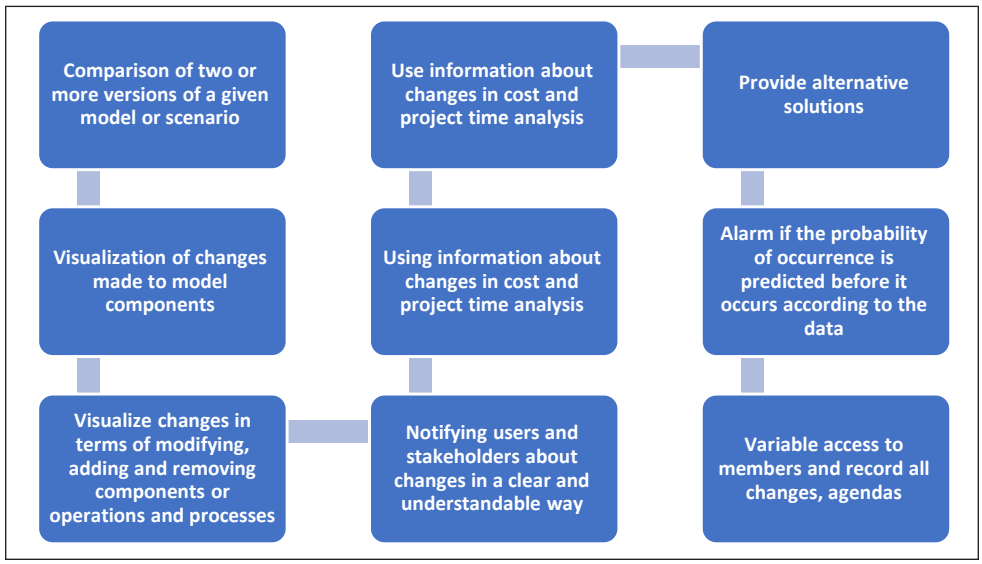

Fig. 10: The Main Advantages of the Control Tower

The implementation of the SAAL supply chain control tower will have many benefits for the managers of the construction industry, its four main pillars, especially for the managers of countries like Iran, are:

- Under chaotic conditions such as Iran's socio-economic system, change management will be very tangible for project managers. Because they have already been informed about it, they will understand where its root is and where they can fundamentally solve the problem so that it does not lead to other events.
- Facilitate anti-fragile sustainable construction operations for managers, this issue is very critical for countries like Iran.
- They can create blue ocean issues with an innovative look to get themselves out of chaos, reduce risks and even create a new value-cost line.
- It provides the possibility for managers to react appropriately according to the conditions, and it provides the possibility to check that reaction before implementation through simulation.

Limitations and Obstacles

Of course, project change management can be improved by using new tools and methods introduced by the control tower. However, in the projects that use the control tower, the role of personnel, design methods and also the communication between the units involved in the supply chain are very important and if it is based on traditional project management, it can only be adapted to the new method to some extent.

In the construction industry, projects have several sides. They also have several disciplines and branches that must work together effectively to meet the expectations and needs of stakeholders and prevent mistakes and conflicts. These challenges with unsystematic management and traditional methods make it vulnerable to errors and conflicts. In Iran, managers of each unit have used different management methods to manage projects, and no standard has been created for cooperation between different design disciplines. These cases and more challenges led to the introduction of the control tower. The control tower can be considered as one of the biggest changes in Iran's construction industry after the use of CAD and BIM, which has the potential to improve the construction industry. However, current management practices in Iranian companies have hindered these developments. Part of this is due to poor project management during planning, and in addition, there is not enough time to optimise construction solutions. The final construction solutions also have errors and different managers and designers may have differences of opinion between their models. One of the reasons is that the construction supply chain process is known as a set of different tasks, and their internal relationships are not considered. An alternative approach, which is used in SAAL supply chain management, is that the construction process is considered as a whole integrated flow.

Conclusion

This article is an analytical-descriptive review of the concept and capabilities of the supply chain control tower in Iran's construction industry. The purpose of this research is to easily define the benefits of using the SAAL supply chain control tower to create an anti-fragile sustainable construction method to improve construction management practices at the operational level of projects. From this point of view, two types of information flow play a vital role in construction management; 1- Information flows that require long-term efficiency, medium and short-term planning tasks and 2- the information flows required for effective implementation and production control in this field. The availability of accurate and timely information in all construction projects and even beyond that is a necessary condition for planning construction tasks. In this way, the use of the SAAL supply chain control tower can lead to an increase in value.

With the help of the control tower, all the construction operations are identified and monitored, so it is possible to change the work process before the crisis or to eliminate the works that do not create value. This system enables us to reduce the number of work cycles and work errors, which leads to a fast, cheap construction process. The control tower relies on a source of information and the possibility of checking collisions and operational inconsistencies (from design to repair to maintenance) to a great extent. In addition, it causes conflicts to be identified, better storage of information and model integration, and creation of a single source of decentralised information. With the help of this system, operation requirements are also simplified and information flow is improved. As a result, it can lead to the reduction of the production cycle time from the conceptual design stage to the maintenance and exploitation of conditions.

In its simplest form, this means exploiting the crisis and eliminating waste, increasing speed and flexibility in every step of the work process. Therefore, the SAAL supply chain control tower will increase values and lead to sustainable anti-fragile construction by maximising labour productivity, resources, and a single source of decentralised information, as well as improving the management of issues related to construction project changes. According to all the cases mentioned, it can be concluded that the control tower is a solution and a practical version for stable anti-fragile construction in Iran's chaotic conditions.

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