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REDUCING COSTS BY INTEGRATING THE THEORY OF CONSTRAINTS AND THE JUST-IN-TIME PRODUCTION SYSTEM

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Abstract:

The JIT system is described as a philosophy that combines modern and old technologies. It is a production and inventory management system that aims to produce and deliver goods exactly at the moment they are needed in the production process or by the customer, making its application possible in all areas of business from production, purchasing and delivery. The JIT philosophy is to operate a simplified and efficient production system, capable of optimal use of resources, in preparation for meeting the real demands of consumers with the required quality and quantity, on time and at an appropriate price. The goal of JIT is to remove all activities that burden the facility with indirect costs and unnecessary expenses, and to eliminate waste, including excess inventory, excess production and waiting times, and to avoid production obstacles, through integration between the main aspects of the subsystems and highlighting them in a homogeneous formation, and an interactive system through integration with the theory of constraints to remove all obstacles. This can lead to significant cost savings and increased efficiency, as it requires a high level of accuracy and responsiveness to changes in demand and production requirements.

Keywords: Theory of Constraints- Just-in-time production system- Cost reduction

INTRODUCTION:

With the increase in global competition and developments in the industrial environment, the need for more innovative systems and theories in the fields of improving corporate performance and raising companies to the ranks of global companies has increased. These companies face major challenges represented by internal and external restrictions imposed on them by the industrial environment and competitive factors, which prompted many companies to use more than one method in an attempt to lift or reduce these restrictions in order to increase the value of the company by increasing profitability, whether by reducing costs or by resolving the bottlenecks it faces and reaching the cost of the product or service more accurately through more accurate measurement methods. One of the innovative methods through which the cost of the product is calculated accurately is the just-in-time production system supported by the theory of constraints. Therefore, applying the system with the theory was a qualitative leap for companies by improving performance.

The first topic: Research methodology

First: The research problem:

The research problem is how to clarify the mechanism of the theory of constraints in a company that uses the just-in-time production system as a cost-effective system, and improving the performance of companies in the modern industrial environment requires an accurate work mechanism and extensive studies in order to achieve profitability goals and survive in an open global market in which competition has become an essential element for survival with the scarcity of available resources.The importance of the research: The importance of the research lies in the fact that the integration between the theory of constraints and the just-in-time production system is of great importance in

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improving the performance of companies in the modern manufacturing environment and that this improvement is reflected in the profitability of companies and thus survival, competition and continuity.

Second: Research objective:

The research aims to address the concept of the theory of constraints, its importance, the nature of the just-in-time production system, and to propose methods of integration between the two and its role in improving companies' performance.

Third: Research Hypothesis:

First Hypothesis: Using the Just-in-Time Production System achieves an effective reduction in costs and improves the applied cost system.

Second Hypothesis: The Theory of Constraints provides appropriate methods for solving problems facing the production system as well as bottlenecks

Fourth: Research contents:

To achieve the research objectives, the researcher divides it into the following topics:

- The second topic: An analytical study of the theory of constraints. (TOC) and its tools to improve production and reduce costs
- The third topic: An analytical study of the just-in-time production system (JIT) and its mechanisms to reduce costs
- The fourth topic: The proposed framework for integration between the just-in-time production system and the theory of constraints With the aim of reducing costs and improving achievement.The fifth topic. Results and recommendations

Section Two
- The concept of the theory of constraints and its tools to improve production and reduce costs.

First - The concept of the theory of constraints, origin and development:

(TOC: constraints of Theory) With the increase in competition in the current era and the great industrial progress witnessed in the last century, pressures on administrations and companies have increased in order to exploit their resources in an optimal manner to achieve the lowest level of costs while maintaining quality and type for the purposes of competition in the market. However, some economic resources may be characterized by relative scarcity for some companies, which means developing a production method that works to increase the benefit from these elements in a manner that works to increase their total marginal contribution. This matter has been addressed using methods, the most important of which is the method of marginal profit per unit, except in the case of relative scarcity in one resource. If the scarcity in more than one resource becomes successful, it requires the use of more accurate and objective methods. Among these methods is what is known as (the theory of constraints), which includes addressing the determination of the optimal production plan in light of multiple constraints.The theory of constraints is one of the most important concepts used in directing relatively scarce elements. The basic idea of the theory of constraints is that there is one or more activities in the company with specific resources or capacities that represent constraints on the production processes. Accordingly, the processes must be scheduled and organized in order to exploit the activities in which there is a bottleneck, in addition to organizing other activities that do not suffer from a bottleneck.

The philosophy of the theory of constraints:

The philosophy of the theory of constraints is to find a solution to the problem of determining the optimal production mix in the presence of relatively scarce resources that represent constraints (bottlenecks) that limit the capacity of the entire system and thus work to reduce profitability and performance as a whole. The goal of the theory of constraints is to maximize profitability by addressing these constraints within the available capabilities without causing a fundamental change in the cost structure. This theory emerged as a result of the criticisms directed at the contribution margin method (marginal profit) that was used as a means to rationalize decisions related to the optimal production mix in the short term, as Robinson indicated in his

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article, "Contribution Margin Analysis is No Longer Useful for Managing Cost Strategies," and according to his point of view, the contribution margin ignores the appropriateness of fixed costs, in addition to the fact that this concept has been around for between fifty and sixty years. (Laksab, 2004: 70-71)

• Types of constraints: The theory of constraints is based on the fact that every company faces two types of constraints, some of which are considered internal and external constraints, while others consider them material and political constraints. The types of constraints can be classified as follows:

A - Internal constraints: These are the ones that limit the company's ability to meet the demand for its products and are divided into:

Energy resource constraints: This type is one of the most important internal constraints imposed on the production process represented by machines, equipment, individuals and any other tangible resources. This constraint appears when the outputs of the constraint are unable to meet the needs of the market, and the amount of production stocks in operation is a function of this constraint.

• Administrative policy constraints: These are among the most difficult constraints to discover because they have a long-term and invisible impact and arise as a result of implementing some policies in the company, such as the necessity of adhering to a specific rule.

B - External constraints: These are a set of determinants that make the company late in meeting the needs of customers and are divided into:

Raw materials constraints: This constraint arises in the event of a shortage or lack of raw materials in the short or long term for one or more of the components necessary to manufacture a specific product.

On-demand: This type is one of the most important external constraints imposed on the production process and the amount of stock of a complete production or the operation of a production line with a part of the full capacity of the output of the constraint is a function of this constraint. The constraints imposed by policies are more difficult to discover because they are not arranged and because they are rules that show how things should be done and thus exceed the possibility of creating constraints. Production cannot take up more space than the scope of operation through the bottleneck and the goal of the theory of constraints (Horingon et al., 1996: 1257) is to increase the contribution of outputs while reducing investments and operating costs and it is classified as ways to maximize operating profit when there are some scarce resources and others that are not scarce.

Steps to apply the theory of constraints:

The decision-making process is carried out by applying the theory of constraints to achieve improvement There are five steps to apply the theory as follows:

1. Determine the constraints: This is done by identifying the constraints that limit manufacturing capabilities, i.e. identifying the weakest links in the system. It is noted that there is a possibility of more than one weak link, so the weakest link is chosen to take its role in the improvement, and so on for the rest of the weak links.
2. Determine how to exploit the constraint to the maximum possible extent: i.e. exploit the constraint in its current state with the most efficient and effective possible.
3. Attach all other operations to the necessity of exploiting the constraint: i.e. make everything subordinate to supporting how to exploit the constraint as in step B, and this is done by modifying and adjusting all the activities of the other parts of the system in a way that helps achieve the maximum possible efficiency and productivity of the constraint, even if it requires reducing the production speed in resources that are not bottleneck centers.
4. Lift the constraint: If the constraint is still present after completing step (3), we must work more to lift the constraint after ensuring that we have done everything we can in step (2, 3). The only way to improve the performance of the system as a whole and that constraint specified in the manufacturing environment is by increasing

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investments to increase the resource capacity. This step will be able to break the constraint because there will be no constraint in energy or otherwise, as the constraint has been completely eliminated and the constraint will be broken.

5. Go back to step (1) to avoid laziness or inactivity: According to the concept of improvement within the theory of constraints, when overcoming the constraint or removing its effect from the system, another constraint will appear, but it does not affect as strongly as the previous constraint. Here, we must go back to the first step (1) to search for the causes and so on. Steps for implementing the theory of constraints.(www.12manage.com/methods_goldrattTU)

Section Three: The concept of just-in-time production

Just-in-time production is a shift in the opposite direction of the conventional accounting thinking regarding inventory control of all types - raw materials, semi-finished products and finished products - in traditional manufacturing systems when a certain production process completes its operations on a certain quantity of production it pushes it to the next process regardless of whether that process is ready to receive it or not, which leads to an accumulation in the inventory of incomplete and finished products and thus freezing funds and inefficient operations, especially if unwanted increases in inventory spread along the production line. In just-in-time production, production flows according to what is called an input for manufactured products, and this idea of pull involves the final production pull stage sending a signal to the previous production point with the exact amount of materials or parts needed for all products during the next few hours, and only this amount of materials or parts is provided, with the same signal sent back to each previous production point in a way that maintains the flow and flow of materials easily and without inventory at any point, and thus all production points respond to the pull created by the final production journey, which in turn responds to customer orders The goal of this philosophy is to bring the warehouse of all types to the lowest possible level with the aim of reducing the cost of keeping inventory to zero, by eliminating the causes of inventory accumulation, which may be due to the company's feeling of the need for inventory to secure the risk of stock out or the lack of coordination between production points or the belief that large production batches are more economical than small batches, and by using the just-in-time production system, all these reasons that cause inventory accumulation disappear. The just-in-time production system aims to complete production on time and with the appropriate quality and quantity for what is required, which achieves the following:

- Eliminating activities that do not achieve additional value for the production activity.
- Eliminating downtime and breakdowns.
- Production with standardized specifications and delivery on demand. Disposing of inventory and linking the production cycle (Al-Kassasbeh, 2011, p. 15) Basic components of the just-in-time production system The success of implementing the just-in-time production system requires the availability of a set of basic and necessary components, which can be explained as follows:

Production-to-order

Based on the just-in-time production system, production is only carried out based on customer requests. Upon receipt of purchase orders, production begins immediately and is then delivered to them without going through the storage process, thus eliminating storage costs. Production quantities should be relatively small from the product on a regular basis to meet actual orders. This requires following the policy of multi-tasking production centers so that the production center can, through several diverse machines, specialize in completing different processes of the product. There is no doubt that achieving this requires a specific arrangement of machines within the factory so that incomplete production units do not move from one place to another in the factory, which allows Workers to focus their efforts

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on the product from start to finish. The following figure shows one of the forms of factory arrangement according to the just-in-time production system. This method may be taken, despite most economic units seeking to do so, as follows:

1- It may lead to the emergence of the waiting variable among customers because the process of preparing and executing orders requires some time

2- Some companies that use the just-in-time production system resort to keeping a minimum of complete inventory as a safety net to face any potential circumstances that may occur in the future.

However, by using information technology and by linking to customer databases, it is possible to identify their needs and the specific dates for them, including determining production and timing and not needing inventory. 55.P,2014,Matarneh))

Continuaus product flow improvement

The implementation of the just-in-time production system requires constant work to overcome and remove any restrictions or bottlenecks that may occur during the performance of various operations, and reduce and eliminate unnecessary activities and work that hinder operation and production and search for appropriate solutions and treatments to achieve the smooth flow of operations and reduce production time, which is expressed by the following equation:Production time = operating time + inspection time + travel time + waiting time

The operating time is the time during which the actual work is done on the product, and the inspection time is the time during which it is ensured that the product is of high quality, while the travel time is the time required to move materials or incomplete parts from one production point to another, and the waiting time is the time the product takes waiting to be worked on or moved or the waiting time in the warehouse until shipping. The only activity that adds value to the product in all these activities is the operating time, so various other activities must be reduced to a minimum ,et.al,2013,p15) Kootanaee)

Limited Number of Suppliers

In order for the company to achieve remarkable success in implementing the just-in-time production system, it must comply with the culture of a limited number of suppliers who are willing to supply small quantities in repeated batches. Instead of supplying the needs of the entire month or the entire week, the supplier must be prepared to supply on a daily basis and in the exact quantities required from him. This is helped by establishing close working relationships with these suppliers in a way that ensures obtaining quick services from these reliable suppliers. Accordingly, the selected suppliers are exempted from the necessary and routine bidding and contracting procedures, and their time and attention are focused on implementing the long- and short-term delivery schedules prepared by the company. This system benefits both the company as it is able to receive materials on time, which makes the need to maintain large quantities of inventory unnecessary, which reduces storage and handling costs, as well as the suppliers as they obtain long-term supply contracts that ensure the continuation of their work as long as they achieve the delivery terms agreed upon with the company (Rahman,2016,23)

Effective Preventive Maintenance

The just-in-time production system means that the company does not accept any type of malfunctions that affect the production movement, due to the lack of inventory and commitment to delivery dates to customers according to orders. This requires that the company have machines that have the following: 6

A- High efficiency: This is achieved through specific timetables for periodic and preventive maintenance that prevent any malfunctions in the machines so that delivery dates to customers do not conflict or are delayed.

B- Flexibility: The machines should be highly flexible to allow them to be used to accomplish multiple tasks instead of one process, and thus have several products in the production line instead of one product (Al-Rawi, 2012, 106)

Total Quality Control

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In order for the production system to operate successfully on time, the company must establish a total quality control system for spare parts, raw materials and finished products so that no defects are allowed in any of these elements. The quality control process begins with suppliers, and a supplier who fails to deliver defect-free goods is quickly excluded and replaced by another who can meet quality standards. What is known as continuous monitoring is also applied, in which workers play the role of inspectors and detect any defects. Sometimes this monitoring process is applied in an automated manner, where digital control machines and robots inspect the production as it moves from one cell to another, i.e. the machines are programmed to perform the inspection process as part of the manufacturing process, striving to reach a level of zero defects.(Al-Atroshi, 2013, 33)

Comparison between traditional production system and just-in-time production system

Below is a table comparing traditional production and just-in-time production(Mohammed Saleh:882000;)

sequence	Traditional system	Just in time production system
1	Flexible production system based on production flow system	Flexible production system based on
2	Requires large inventory	Gradually reducing inventory to reachPerformance
3	Depends on process flow between production stages	Relies on manufacturing cells
4	Specialization is in one job	Lack of specialization and familiarity with all works
5	Quality control is average	Comprehensive control over quality and performance
6	Cost system is complex and expensive	Simplified and low-cost cost system
7	Depends on financial performance measures	Relies on financial and non-financial performance measures

Section Four: A proposed framework for integration between the theory of constraints and the just-in-time production system

In this research, we discussed the nature and features of both the just-in-time production system and the theory of constraints, and we knew that if we dealt with each of them separately without the other, there would appear to us an apparent contradiction between them. However, a deep understanding of the contents of the just-in-time production system and the contents of the theory of constraints makes it possible to create a link between them and benefit from this link, and this is what we discuss below (Chakeravorty, 2005, p88).

Points of difference between the just-in-time production system and the theory of constraints

Variation	On time production	Theory of Constraints
Inventory Policy	It aims to reduce inventory of all kinds and even get rid of it completely and use the pull input.	It depends on the DBR production schedule using and including the necessity of maintaining safety stock.
Contribution of productive resources	All resources have the same ability to produce outputs in relation to the needs of the factory.	The inequality of the ability of productive resources to produce outputs, where the ability of bottleneck centers to produce is less than any other resource
Batch Sizes	equal payments	Unequal payments
General System	market pull	Push from choke points and pull towards choke points
Improvement Efforts	It starts everywhere in the	Starting from the choke points,

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	system "Continuous Improvement Portal"	the entrance to the systems

Examining the differences shown in the previous table, we find that they do not stand in the way of completing the integration process between them. Integration here means taking advantage of both in the field of reducing costs and improving achievement (Al-Kashif, 2006: 88). The just-in-time production system aims to attempt to complete production at the required time, with the required quality, and in the required quantity. Its focus is that the accumulation of inventory is the cause of operating problems. Based on this, the production line is designed so that the flow of production and work continues smoothly in its various aspects and is time-consistent in a way that makes the inventory zero, while removing, filtering and pushing any type of bottlenecks out of the factory. If this system is applied and the production line is implemented as designed and production flows continuously and repeatedly, it becomes the most suitable alternative to the production stages system and achieves: - Reducing the number of parts that make up the production unit. - Reaching the level of zero defects. Dowlatshahi,et,al,2001.1201-1204))The advantages of applying this system are due to its role in improving order execution times and maintaining delivery dates and focusing on identifying production flow stages and profit quality problems, which stimulates the speed of treatment or resolution of any problems by developing production flow and reducing the number of times raw materials and products are handled and making integrated centers adjacent to each other, which ultimately results in reducing costs and increasing production and supporting the quality level, and all of this is reflected in reducing selling prices and strengthening the company's competitive position.

However, the fundamental problem facing this system, especially in light of the strict attraction strategy, is that any malfunction or bottleneck that occurs in any production center leads to the complete stoppage of the production line.

The theory of constraints

It represents an organizational philosophy for achieving continuous improvement, and it believes that improvement comes through improving the economic unit as a whole. The unit remains or perishes as a system, not as operations, and its success or failure is only a function of how the processes that make it up interact with each other. The economic unit, from the perspective of the theory of constraints, is a series of interconnected activities whose strength is determined by the strength of its weakest link, which represents a constraint on the performance of the system that controls its outputs. To improve and support the system, work must be done to eliminate the bottleneck, which constitutes the weakest link in the chain, then the next one, and so on. Thus, improvement efforts are fruitful because they focus on bottlenecks that constitute constraints on the system's work. This philosophy helps to:

- Innovate solutions that lead to improvements, and transform constraints into positive elements, as they motivate management to continuously evaluate the current performance of the system and work to improve it.
- Transform the production system into a chain whose interconnected links seek to support operational processes to transform inputs into salable outputs and achieve the original goal, which is to achieve cash flow.

The practical application of the ideas of this theory has achieved many advantages and improvements (Marton, et al, 2010, p75))

Integration between Just-in-Time Production System and Theory of Constraints

By extrapolating the above, we can say that despite the apparent difference between Just-in-Time Production System and Theory of Constraints, they are similar in very important aspects, including their shared goal of continuous improvement, as both work to achieve quality, reduce inventory

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and reduce costs in general, and the possibility of integration and integration between them is possible. As a system and not as a set of procedures, we find that the ideas of this philosophy are applicable in any factory or organization, even if it is a service organization, due to its focus on simplification and eliminating waste and extravagance, and this is achieved by eliminating activities that do not add value, and by achieving a high level of quality, commitment and continuous improvement of all aspects of activity. In this regard, it should be emphasized that the loss does not only apply to the element of raw materials or working time, but rather extends to include all activities necessary to produce the good or service, which can be excluded without affecting the quality of the good or service. However, this just-in-time production system is used for the long term, and the question always remains: as long as factories operate in an environment of constant change and movement, will they be exposed to any sudden malfunction or problem, especially in the short term? Here, the theory of constraints appears as a suitable tool for short-term decisions, and it has the ability to simplify the production process, and even focus specifically on the element of raw materials, so their integration together will achieve the comprehensiveness of the system and support. It also focuses primarily on the final disposal of inventory of all kinds, and this may seem illogical to everyone, but if the correct literal application of the production system is carried out on time, and the strategy of preventive maintenance and total quality is adopted, achieving zero inventory is a realistic matter, but as previously stated, the environmental variables surrounding the organization may show unexpected problems that require a minimum level of inventory, especially in front of the manufacturing points that are considered a focus of attention and especially a tool and control in the production process, and here the tools of the theory of constraints appear and the idea of safety stock appears to address these problems, (DBR) production and inventory scheduling, and this is important in the intended integration process. ,p41) Robbins, 2011)

The success of the idea of having a minimum safety stock on the production line at the specified time leads to:

- The efficiency of the production line designed on the basis of production at the specified time at high inventory levels, which means that the presence of the safety stock called for by the theory of constraints avoids the problem of stopping in the event of no inventory.
- The efficiency of the production line designed on the basis of the theory of constraints at low inventory levels, and this result means that although the theory of constraints seeks to keep units as safety stock, keeping those units at their minimum level achieves the best performance and here it approaches and integrates with the production system at the specified time which tries to bring the inventory to zero. On the other hand, the theory of constraints can, by focusing on restricted and unrestricted activities, contribute directly to the success of the production system at the specified time, especially to achieve fluidity and balance between the various production resources, and on the other hand, not to expand their provision except within the limits of the requirements of the disciplined line and what suits the restricted resources, which leads to reducing unutilized capacities and maximizing profitability.

On the other hand, a disciplined production line will achieve many benefits if it is integrated with the ideas of the theory of constraints and benefits from the logical thinking process of this theory, which focuses on identifying the things that must be changed in the production line, and any problems it suffers from, then determining how to make the required changes, and producing innovative solutions and then implementing the solutions, which leads to the continuous activation of the production line. Also, the ideas of accounting for achievement as one of the tools of the theory of constraints help support the production system at the specified time by

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always focusing on tracking the money achieved in the present and future from the system, and the extent to which the rate of return and net profit are appropriate for spending, studying selling prices and the amount of variable cost and the size of investments, and also analyzing operating expenses from resources and external contracts

Integration objectives between the just-in-time production system and the theory of constraints

It can be said that creating a kind of integration between both the mechanisms of the just-in-time production system and the tools of the theory of constraints contributes to achieving the goal of reducing costs as well as improving the achievement of the economic unit by achieving the following:

1 Both the theory of constraints and the just-in-time production system treat the cost of labor as an indirect cost and there is no doubt that this is consistent with the variables of the modern manufacturing environment.

2 The theory of constraints works to identify the unused capacities on the production line in the just-in-time and thus the possibility of knowing the constraints that the economic unit is exposed to and limit the flow of the production line and determining the extent of the strength and impact of each constraint.

3 The theory of constraints helps in preparing a timetable for the course of operations before and after the stage of the influential constraint in order to achieve the maximum possible exploitation of the resources and capacities available in the backward activities on the disciplined production line.

4 If the just-in-time production system will seek to identify the stages of production flow and its quality problems, which motivates management to quickly treat and solve any problem to develop production flow and reduce handling times and other procedures, which leads to reducing costs, then the theory of constraints will enable management to have the necessary mechanisms and tools to deal with problems and even make good use of resources that constitute constraints, including improving achievement, and thus their role is integrated in achieving the goal of reducing costs and increasing achievement. Kootanaee, et, al2013)

Section Five

Conclusions and Recommendations

First Conclusions

1 The theory of constraints is a tool for short-term cost management and is very suitable for decision-making in these circumstances. The just-in-time production system is a system for managing the production process in the long term, and therefore integration between them ensures a comprehensive view.

2 The just-in-time production system works to eliminate downtime, reduce inventory to zero, and eliminate breakdowns. The theory of constraints comes to determine the points of interest and focus, especially in the event of any breakdown -as a result of the emergency attraction process that occurs in the just-in-time production system, and thus we can reach the goal of continuous improvement.

3 Working to improve the flow of product means, in return, improving or increasing productivity. To apply the JIT system, it is necessary to work to remove bottlenecks that may occur during the performance of backward operations, and this is what the theory of constraints does.

Recommendations

1 The need to pay attention and strive towards scientific and applied foundations for modern methods, tools and theories of cost management to meet the requirements of the modern manufacturing environment and suitability to the degree of automation and technology applied in most industrial organizations.

2 The need to adopt and apply the tools of the theory of constraints, especially those related to solving bottleneck problems, especially since the constraints facing production processes are characterized by dynamism and continuous change, which means that there is no end to those constraints and tools must be adopted to deal with them.

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3 The need for continuous development and improvement of the skills and capabilities of cost accountants and management accountants to enable them to understand and apply the various philosophies and theories that support the production process and cost systems.

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