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Critical Success Factors for Technology Management in the Post Pandemic World

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ABSTRACT

The requirement to achieve the successful implementation and operation of technology is more urgent than ever, given the changes to society imposed by the pandemic and post-pandemic events. The identification of critical factors for the success of technology has become paramount for organisations, irrespective of their sector. This paper accesses a literature review of current and seminal sources together with empirical research to discern a framework for examining the topic. A thematic analysis was performed to identify the key areas for critical project success factors. A summary of these areas for practice was then formulated, in order to assist both practitioners and academics in this sphere.

Critical Success Factors (CSFs) in Technology Management are defined as the principal areas requiring satisfactory results in order to ensure the successful delivery of systems' objectives. The use of 'hard', namely objective, and 'soft', namely subjective, information can be required to measure these factors. CSFs are also dynamic, in that they may change over time and thus require ongoing reflection and revaluation, to potentially redefine them in order to accommodate the organisation's current environment.

A semi-structured interview was held with an experienced project manager. The main themes were then discerned, using an inductive, grounded approach. The focus was on determining the critical factors for change management, as applied in this sphere.

Keywords: Critical Success Factors; Technology Management; Change Management; System Agents; IT Methodology; Holistic View

INTRODUCTION

The initial definitions are provided, as a basis for the examination of this topic. Technology management can be defined as "the control and organising of the methods, systems and devices which are the result of scientific knowledge being used for practical purposes" (Blair, G., Grant, V., & Woodcock, H., 2020). This is used in an organisation to support and enhance its objectives. Critical Success Factors "are, for any business, the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization," according to Rockart Rockart, (J.F., 1979)

These can be utilised to create a definition in respect of CSFs in Technology Management, which are for any organisation's technologies, the limited number of areas in which results, if they are satisfactory, will ensure successful delivery of systems' objectives. An example can be provided of a supermarket with the objectives of improving returns to investors, market share and new product success. The CSFs in Technology Management could be based on the website (developed to allow online purchases), stock control system, digital advertising campaigns and the Management Information System, for example. A public sector example could also be given, for instance a hospital, where the objectives are excellence of health care and meeting the future needs of the health care environment. The Technology Management CSFs could be located in the areas of provision of patient care data, procurement and inventory systems, together with a budgetary control system, for instance (J.F., 1979)

METHODOLOGY

The methodology employed for the empirical research was qualitative (Blair, G., & Pagano, R.,2021, & Easterby-Smith, M., Thorpe, R. and Lowe, A., 1991). A selection of appropriate articles was made from the academic journals, in order to inform the topic, namely critical success factors for the management of technology. A semi-structured interview was held with an experienced change practitioner, who has experience of running IT and systems projects. The key themes were extracted from both the literature and the interview, using an inductive, grounded approach. These themes were discerned and then organised using an 'open coding' technique, without a prearranged structure. The objective was to identify the CSFs for technology projects, including the process of change management in this area. A contingency framework was constructed, in order to summarise the findings from this study as per (Blair, G., Pagano, R., & Burns, B., 2019). This should assist practitioners and, hence, provide a contribution to both theory and practice in this area.

LITERATURE REVIEW

A review of the literature was conducted in order to identify important sources in respect of this topic. These were then analysed and the principal themes were selected. The objective was to consider the main aspects of CSFs in technology projects.

Dynamic Feedback Loop

CSFs require constant review, in order to ascertain their continued value to the organisation. The success factor should be created or amended, after review of the prevailing circumstances. This should provide the current managers with the required information to manage effectively. The focus here is on the technology management aspects, thus the effective operation of systems in order to support and, potentially, develop the organisation. Kolb's model of experiential learning (Kolb, D.A., 1984) is suggested as an appropriate vehicle for this activity. The action in respect of the CSF is then reviewed, considering the accumulated information. This is then checked against the current situation and a decision to intervene, including the nature of the intervention, is then made. CSFs can thus be created, amended and deleted, in accordance with the appraisal of the organisation's needs

in respect of the current environment. The circumstances of the pandemic and post-pandemic era have heightened this requirement for assessment, in respect of the imposed changes to organisations' operating environments. The use of outdated CSFs can actually be harmful, in that decisions will be made and attention given to spurious areas, whilst the new critical aspects may be neglected. Organisations tend not to learn from successful activities (Gino, F. and Staats, B., 2019) so poor practice may persist, including the perpetuation of outdated CSFs and failure to identify new ones that are relevant to the current environment. This may be due to an overreliance on past performance and a tendency to avoid consideration of failure. This may lead the organisation to stagnate in terms of its technological performance.

Many organisations fail to learn from their experience, especially from success (Flyvbjerg, B.,2021). Their rationale is dominated by an aversion to failure, which leads to a lack of risk-taking and experimentation, required to develop new capabilities. There is also a reliance on past performance, embodying an assumption that success will continue. The bias is, hence, towards action rather than reflection, thus discounting an essential requirement for experiential learning. The suggestion is to avoid overreliance on external expertise and utilise in-house staff to generate improvement.

Flyvbjerg B.(2021) examined megaprojects, namely large, capital-intensive projects, comprising international and infrastructure, for example, and discerned that several key elements could greatly improve their prospects of success. These were, speed, modularity and standard technology. The emphasis should be on delivering modules quickly, permitting learning to occur and inform the next iteration of the work, also allowing rapid scaling of the project. The technology employed should be existing and proven, as innovative, experimental designs will probably lead to delays and cost overruns. The project should, ideally, be delivered in modular form, allowing for early implementation and successful outputs. These modules should permit rapid scaling to fulfil the project objectives. This paper noted that estimates were more likely to be accurate in the short term, for example up to one year in advance. The requirement is thus for speedy delivery, in order to ensure that accuracy is maintained. Longer term planning is correspondingly less accurate and may lead to revisions that introduce delays and further costs to these projects. Illustrations of successful megaprojects that have followed this scheme are provided, such as building a large car battery plant, satellites and a subway system.

An empirical study of technology projects in an engineering company was recounted by Kaufmann and Kock (2022). It was established that project management effort increased in importance as the complexity of the project increased. This study showed evidence of a link between the critical factor of project management activities and the generation of profit on sales for projects. The latter relationship was more important as the complexity of project increased. The additional effort of project management was shown to increase profits in regular projects but the marginal gains decreased with increased effort, in respect of this factor. The authors note that it is important to check the absolute costs of additional project management effort against the absolute increase in profits, to determine whether this is a viable option.

System Agents

The initial and ongoing requirement is to identify the existing data movements and sources. A study of the IT systems in relation to the human input should be undertaken (Agerfalk, Par J.,2020). The technology and people can both be regarded as components of the system. The processing of data into information can then be comprehended, in respect of the organisation. This will assist in formulating appropriate Critical Success Factors for the management of the concern's technology. The procurement of the requisite information in order to measure

these CSFs will also be enabled by this 'mapping' of information 'flows' and processing.

An example of this systems-based approach is given by Porter and van den Hooff (2022). A facility is provided for a sales team, comprising mobile devices that communicate with a central information system. The critical success factors of sales performance and standards can be directly addressed via tailored targets, real-time capture of sales data and the provision of the opportunity for rapid feedback from management. The key objective of increasing customer satisfaction can also be fulfilled by the system providing the sales force with more time, as administrative tasks have been reduced, due to the new arrangements. The dual advantages of sales agent autonomy and management control can thus be achieved, contributing to the CSFs and improving the level of trust from the personnel.

Success management is viewed as a critical factor in project management by Takagi and Varajao (2019). The requirement is to incorporate the activity of managing successful outcomes into project management methodologies and guides to best practice. This paper cites a model to provide a system of success management, which involves defining the critical success factors then measuring and monitoring them throughout the project, ending with a final review. The suggestion is that methodologies and guides could adopt this system, in order to explicitly address the problem of project failure.

Project Team

The recruitment, training, promotion and reward of staff is central to an IT Strategy. These staff are usually located in teams, in order to coordinate their work.

One the key areas discerned from the literature review is the use of teams to deliver organisational objectives. These are, thus, an area for the identification of critical success factors in technology management. One study considered project team resilience, defined as the ability of the team to cope with pressure, conflict and tension (Pavez, I., Gomez, H., Laurie, L. and Gonzalez, V.A.,2021).The development of 'cognition-based trust' was needed, founded on the demonstration of competence, reliability and dependability by team members. 'Affect-based trust' can be engendered, comprising the development of an emotional connection between team members. These lead to an improved 'group potency', defined as the ability to perform difficult tasks and accommodate large workloads.

Team performance is viewed as being of paramount importance by the literature (Haas, M. and Mortensen, M., 2016).Teams are viewed as requiring a clear brief, providing their objectives. A strong structure should also be created, organising the members into logical groups with defined rules. This should provide a supportive context for the members in order to maximise their commitment and contribution. The requirement is for members to develop a shared mindset, focussed on the team objectives. The requisite team outputs should follow, with members being developed individually and in terms of their collaborative ability.

Global project teams are also considered, in respect of distributed software developments (Drechsler, A. and Breth, S., 2019). Training on cultural awareness was regarded as a critical requirement, to maximise the benefits of using such a team. The continual evaluation of implementation progress by suitably qualified personnel was viewed as being important for quality control. The use of a system of knowledge control with a clear development process was also recommended, to enable the efficient use of personnel and team working. Global teams are said to require an appropriate organisational structure together with an effective communications infrastructure. These factors should enable knowledge transfer to occur on the team, facilitating the delivery of the requisite outputs.

Structure

The organisation will have an orientation within its market environment. If technology is a primary function in the value chain, for example in the case of delivering a technology product, then both innovation and market success are required.

The organisational structure is viewed as a key aspect for technical project delivery. Case surveys of major UK government projects were analysed (Winch, G.M. and Cha, J., 2020). The strategic level of the organisation determines the objectives then commissions and allocates resources for projects. The operational level develops the business cases, establishes governance arrangements and manages the programmes, comprising multiple, related projects. The technical level focuses on the project delivery, utilising technology, systems and IT methodology. The requirement for a clear, efficient organisational structure to deliver complex, multiple technical projects is stated

IT Methodology

The employment of an appropriate IT methodology is cited as being important to technology projects. This is a set of tools and techniques to assist in organising and delivering projects. The two principal methods are the traditional approach (PRINCE2) and the Agile approach.

Traditional Approach

The central premise of the traditional approach is to determine, justify and approve the business case then deliver it in stages that progressively complete the work. The aim is to deliver the prescribed benefits. The principal theme is to create value via the project. The business case must therefore be created and reviewed, as required, throughout the project and afterwards, in order to ensure that its assumptions are still valid and potential benefits are maximised. A social commitment should be developed, that is the contribution made to the organisation's environment (in terms of the stated benefits, to be realised via the project) (Nielson, P.A. and Persson, J.S., 2017).

Agile Approach

The central premise of the Agile approach is that prototypes are created and amended, based on a review that includes a customer representative. The final, agreed prototype can then be implemented as required. Serrador and Pinto (Serrador, P. and Pinto, J.K., 2015) surveyed project managers in a large sample of projects from the international environment. They tested overall project success, efficiency and stakeholder satisfaction. The variables were: perceived quality of vision and objectives; project complexity; and the experience of the project team. The result was that the only significant variable, in terms of project success, was the quality of vision and objectives. These are then signified as critical to the success of projects that utilise this methodology.

A further survey of practitioners of the Agile methodology defined critical factors affecting the success of these projects (Tam, C., Moura, E.J. da C., Oliveira, T. and Varajao, J., 2020). The two key areas were identified as: team capability, which embraced technical expertise, motivation, training and flexible leaders; a high level of customer involvement throughout the project. The criteria for success comprised quality of technical solution and level of satisfaction of the principal stakeholders.

Selection

The selection of an appropriate IT methodology for a technology project is an important requirement. Development projects tend to utilise an Agile approach whereas implementation of established products tend to employ the traditional approach. There are also hybrid methodologies that combine the features of both of these approaches. An evaluation should be undertaken to determine the most suitable methodology for the technology project.

Technology Life Cycle

Technology has a life cycle that needs to be considered (Blair, G., Grant, V., & Woodcock, H., 2020). All technical artefacts will have stages of development and implementation; maintenance

and renewal; and ultimately disposal and replacement (Labuschagne, C. and Brent, A., 2005). The requirement is to consider this life cycle in terms of resourcing. The development of technology, implementation into use, running of support activities then removal, disposal and replacement with new technology are essential to the organisation. Addressing the life cycle ensures that the requisite technology is in place, therefore the organisation is operating efficiently from a technological perspective. The associated activities can thus be critical to an organisation in the maintenance of its strategic position. If competitors manage this aspect in a superior manner then the organisation may lose customers and market share, for example. Delaying the decision to replace outmoded technology, for instance, may have economic consequences, in that users will be operating below optimum efficiency levels. Larger scale projects together with a strategic business perspective entail the consideration of the life cycle of the technology under review.

Environment

The environment is a potential area for determining critical success factors. These areas can be stated as: power; innovation; recycling; and regulation (Blair, G., and Pagano, R., 2021). The government use of regulation will apply constraints to organisations. The proposed ban on the sale of new diesel and petrol cars from 2030 by the UK Government (2021), for example. The development of a hybrid or totally electric powered vehicle is thus critical to the car industry. The current gas supply shortage in Europe, accompanied by an increase in power bills, has also created problems for organisations. The incentive is thus for organisations to use alternative sources of power, such as solar, hydro and wind. The ability to innovate in order to make a positive contribution to the environment, could provide another potential source of CSFs in technology management. The requirement to recycle waste has become more urgent, given issues such as the amount of plastic waste in the ocean. This will probably be an area of increased regulation, due to the potential damage that waste can cause to the environment. The need to consider the environment as a central theme and possible area for the assignment of CSFs for the organisation's systems is therefore paramount.

The requirement to utilise environmentally-friendly techniques is a critical success factor for many organisations, as embodied in a circular business model (Atasu, A., Dumas, C. and Wassenhove, L.N. van, 2021). The three strategies are defined as: retaining product ownership, so moving towards a leasing or rental sales model; extension of product life, so defer redundancy and replacement; and design to facilitate recycling. The appropriate strategies are dependent on the industry, organisational resources and the product. The motivation to implement this CSF comes from the leadership, which includes regulation and technological progress (for example, in recycling processes).

An article on megaproject organisations, which are designed to run large, capital intensive projects, comprising international and infrastructure, for example, proposed a new perspective on critical success factors (Gil, N.A., 2023), The principal dilemma is viewed as the tension between the requirements to get the project commissioned and the full realisation of value, including social and environmental objectives. The former will be tightly constrained, in order to justify the usually large budget and, thus, demonstrate value for money. The normal project criteria will apply, such as delivery of stated objectives and implementation to the required standard, within the specified timeframe and budget. This does not necessarily maximise value for the key stakeholders, though. Social and environmental objectives will tend to be neglected, for example the United Nations Sustainability Development Goals, in favour of narrower financial criteria. The CSFs for these projects, it is proposed, need to be extended to embrace wider criteria and, hence, create more value to benefit a wider perspective of society.

Findings

A semi-structured interview was held with an experienced manager, who has had responsibility for major projects. The aim was to discern the critical factors for successful change management, as could be applied to the practice of technology management. The important themes were extracted, utilising inductive, grounded techniques. These were then compared with the themes from the literature, in order to give an academic context to this analysis.

Define the Specification

The respondent stated that a principal aim was to 'Understanding what people really want rather than what they think they want.' This meant discovering the actual requirements of the change, rather than any superficial ones. This could only be obtained via a constructive dialogue with the main stakeholders and an experienced project manager. The latter should have the skill to discern the true objectives from these individuals or groups and, hence, define the specification for the change. This is present in the literature, for example on the technology life cycle (Blair, G., Grant, V., & Woodcock, H.,2020).

Listening Skills

The primacy of listening skills was stated as, 'The key is listening - vent outside the room to a neutral person.' It is important for the project manager to encourage the principal stakeholders to talk about the project and to listen, in order to comprehensively understand the work. Any negative emotions should be suppressed. The primary brief is a listening role, so the work can be discussed more openly with a neutral person, perhaps in the project manager's own organisation. This will allow the expression of feelings and thoughts without prejudicing the relations with the stakeholders. It may also help to determine solutions and alternative courses of action, as well as define the project requirements.

Power

'You need to have an understanding of local politics as well as understand the power bases, which can change throughout the project.' The importance of understanding the local context, in respect of the project, was highlighted. The distribution of power and local political issues need to be comprehended, so that the projects can be managed in an optimum manner. Understanding this scenario helps the project manager to develop a strategy, based on key support and issues. The project environment should be monitored because the situation could be dynamic, which may necessitate changes to the prevailing strategy.

Relationship Development

'The pandemic and continuing homeworking means that establishing the human connection is harder - information gathering is more formal than informal,' according to the respondent. The development of relationships with staff and customers has been hampered by the constraints of the pandemic. Virtual working has reduced the opportunity for social interaction, which would formerly have occurred, thus impacting on the development of such relationships. This has also affected information gathering, as the nuances that informal relations can ascribe to the process and the data will be absent. In perspective of Construction Projects of Nepal different project analysis illustrates the same to magnify the losses due to pandemic such as Covid-19 in a responsive way (Mishra A. K., 2020; Maskey, A., & Mishra, A. K. 2018; Mishra, A. K., Pokharel, A., & Aithal, P. S., 2023 & Mishra, A. K., Sudarsan, J. S., & Nithiyanantham, S. 2022). This all study found in similar manner the impact of pandemic on-performance that is why the changing technology need to be adopted even in construction projects for suggestive performance enhancement (Mishra, A. K., Pokharel, A., & Aithal, P. S., 2023 & Mishra, A. K., Sudarsan, J. S., & Nithiyanantham, S. 2022).

The pandemic has, thus, led to a loss of knowledge of how to behave. Establishing new relationships is more difficult. New staff will need training in operating in a non-virtual, office environment. Socialisation may also be required in order to assist team building and enhance team working

in the organisation (Blair, G., & Pagano, R., 2020 & Pavez, I., Gomez, H., Laurie, L. and Gonzalez, V.A., 2021). The literature references the theme of team building and development, in a virtual environment. The use of virtual training to enhance the learning process for personnel engaged in project management, for instance, is also cited (Blair, G. and Pagano, R., 2021).

Holistic View

The respondent stated that, 'it is important to cultivate an holistic view, in order to understand the consequences of behaviour.' A comprehensive perspective of the project should be obtained, in order to try to anticipate the outcomes of actions associated with this work. This is an essential requirement for the project manager. A clear study of the organisational context is needed to perform this management function, namely to effectively define, anticipate and deliver the prescribed change. The use of an holistic view is mentioned in the literature on systems as per Checkland (Checkland, P. and Scholes, J.,1990), and also to understand risk management (Blair, G., Woodcock, H. & Pagano, R., 2021) as well as inform decisions on outsourcing and offshoring (Blair G, Woodcock H, Pagano R., 2022).

Principal Qualities

The main qualities for this activity are outlined, 'Key qualities for successful change management are: 'open-minded' attitude; preparation; creativity; adaptability; future-proofing; patience.'

The change manager should be prepared to accommodate different views and be flexible in terms of attitude and actions, in order to successfully deliver the change. Careful project preparation is needed to ensure that the necessary resources are available and the key stakeholders have been consulted. An element of creativity is usually required to deliver the outcomes. The solution should be designed so that it accommodates future operating conditions, thus provides a durable outcome. A meticulous, patient approach is required, in order to ensure that all of the necessary work is performed and any problems resolved.

Focus on Results

The respondent stated that you 'need enthusiasm for the change and its 'end point'.' The project manager should focus on delivering the final objectives. The aim should be to implement the desired outcomes within the agreed parameters, such as time and budget. The project manager should assume the role of champion for the change and, thus, lead and support the project.

Simplify Solutions

'If your solution is too complicated then it is wrong. You need to keep it simple.' The requirement for simplification of solutions was mentioned. This is especially important for communication to stakeholders. Projects usually require a level of creativity and this will need to be translated for the different categories of stakeholders. The level of complexity will vary depending on these categories, for example, senior managers will require a summary rather than a detailed technical explanation.

The qualities and approach required of a project manager are cited in the literature, for example, in respect of leading change (Blair, G., Barratt, S. & Pagano, R., 2022; Blair, G., & Pagano, R., 2020). and employing a strategic approach (Blair, G., Barratt, S., & Pagano, R., 2021).

Discussion

The principal areas for critical success factors, in respect of managing technology, can be summarised (see Diagram 1). These areas comprise: team; structure; methodology; technology life cycle. The system variables are scale, complexity and the environment, which determine the propensity to utilise the identified key areas. Larger scale systems will generally need to focus on structure, as well as team aspects. More complex systems will usually need to consider the technology life cycle stages, as well as the IT methodology employed.

Smaller scale systems probably need to concentrate on the team aspects, in respect of CSFs. Simpler systems could primarily focus on IT methodology, to organise the work.

The environmental aspect is critical to many technologies and, increasingly, has to be considered by organisations, on a voluntary and compulsory basis (Blair, G., and Pagano, R.,2021). Corporate Social Responsibility policies are used to state the former with government regulation dictating compliance with the latter. The pandemic has increased the importance of the virtual aspects of technology, due to the restrictions on movement. The need to adopt a web communications platform, so that personnel could meet virtually as a substitute for in-person meetings, was vital to many organisations, in order to continue their normal operations. The increased importance of environmental factors has also been noted. These will apply constraints or generate opportunities for organisations, hence providing a potential source of critical success factors.

The critical success factors identified for managing technology can be summarised by the following points, as per the literature review:

- Develop a comprehensive 'map' of organisational systems, in order to understand the prevailing information 'flows' and sources then determine the critical success factors and their information requirements;
- Develop effective teams with a high degree of trust between the members together with a clear structure and remit;
- Create an organisational structure that commissions, resources and reviews technology to maximise the potential benefits;
- Select an appropriate methodology for technology projects, outlining clear objectives and reviewing them, as the projects progress;
- Comprehend the life cycle for the technology and implement, support and replace, as required in order to maximise the organisational benefits;
- Consider the environmental aspects of the technology and accommodate or contribute to society, as necessary.

The change manager should: develop an holistic view of the project, embracing an understanding of the distribution of power in the organisational context; the specification should be defined; solutions should be simplified, for the purposes of communications; focus on the results of the project; possess and develop appropriate personal characteristics to manage the project or select a suitable project manager.

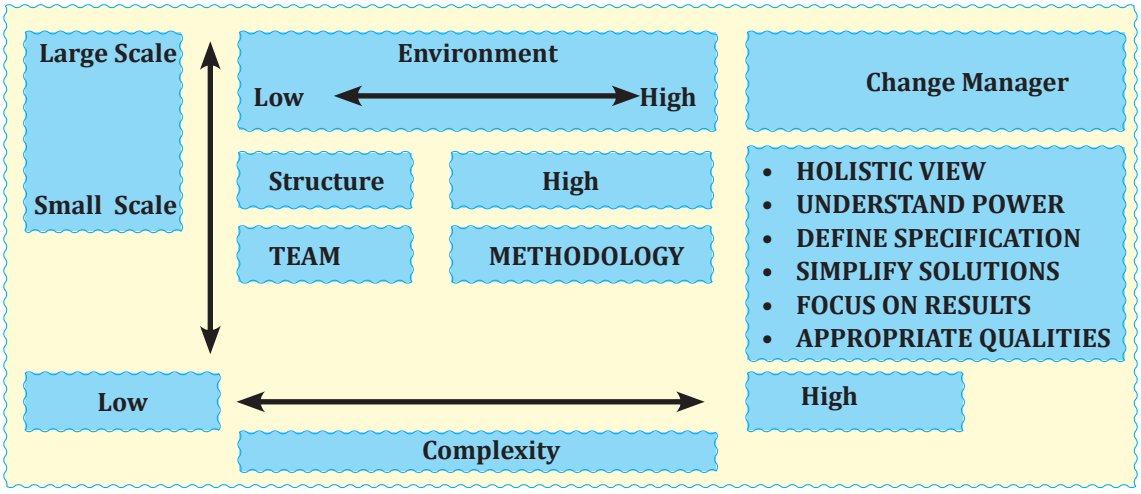

Diagram 1 – Key Aspects of CSFs for Managing Technology

CONCLUSION

This paper represents an initial, exploratory review of the literature and interview with a practitioner, in order to discern key areas for the identification of critical success factors for implementing technology management solutions in organisations, including the change management process. An initial framework is provided to summarise the conclusions and provide a basis for further exploration. This research supplements that detailed in a previous article [32] on the change process for technology management, identifying potential areas of improvement. Future research could be undertaken in this area to extend the findings, for instance via further empirical studies. An additional contribution to practice and academic theory could then be made on this vital topic.

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