Identification of Success Factors of Dam Engineering Projects in Australia

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Abstract:

There lacks a well-established research on success of projects suggesting working on project success models and improving project performance for specific fields although there exist a huge amount of research outputs and diversity of the project management topics. Dam engineering projects have significant economic, social and environmental impacts. However, their performance over the life-cycle including strategic planning, design, construction and operation has not been systematically studied. Improving dam engineering projects performance is the area that is unknown to researchers and project managers and hence, the purpose of this paper is to fill-in the knowledge gap in this area based on an extensive literature review. It finds a complete list of potential Success Factors as main components for success of dam engineering projects.

Keywords: critical success factors; dam engineering; project management; project success

1. Introduction

Our understanding of project success has changed in recent years. In a recent definition, Kerzner (2014, p. 46) compared the traditional project success definition of completion of project within the triple constraint of time, cost and scope with a new definition with ‘value’ as an important element in success. He defined project success as “achieving a desired business value within the competing constraints”. Walker (2015, p. 311) emphasised on client satisfaction in understanding project success and stated that success of a project is based on “the difference between the client's expectation at the beginning of the project and his satisfaction at its completion”. Project success notion is complicated and ambiguous and highly context dependent (Jugdev and Müller 2005). According to Cooke-Davis (2002) from scientific perspective, project success remains an important concern. Such an ambiguity and concern would cause a serious challenge for researchers and there is a rising criticism of research on both general project management and project success in particular (Soderlund 2004). According to Ika (2009, p. 7) “the only thing that is certain in project management is that success is an ambiguous, inclusive, and multidimensional concept whose definition is bound to a specific context”. Any study on project success must include decision on determining the success for different stakeholders’ perspective, criteria and project phases. In most studies, if success was defined and measured, it is not clear from whose perspective and what time of project life cycle. In order to understand project success, it also needs to be defined in terms of project Success Criteria and Critical Success factors (CSFs) (Turner and Rodney 2009). This research paper focuses on introducing a list for Candidate Critical Success Factors (CCSFs) for dam engineering projects in Australia based on literature review.
Because projects are used for achieving certain objectives, the effort to determine the factors contributing to project success is important for organisations and project managers (Soderlund 2004). Several lists of success factors have been introduced with little agreement on the most important CSFs. The lack of consensus on project success definition provides the opportunity to work on presenting a framework for success of a specific industry as without understanding what constitutes project success, it is not possible to determine what contributes to success. Any preventive or corrective action must take into account the link between the success factors and the criteria as the importance of each success factor might be different in achieving a specific success criterion. Very limited knowledge exists for determining project success factors in dam engineering industry in Australia. Therefore, the problem facing dam engineering projects in Australia is the lack of a comprehensive framework that can be used to increase the chance of achieving objectives of projects in different phases of project life-cycle and to reflect the critical factors influencing the success of this type of projects. The paper identifies the gap in knowledge of project success in dam engineering industry then the list of potential success factors and their descriptions for the research will be presented in section 3. Research hypotheses and methodology for the PhD research will be presented in section 4 and summary of the paper is presented in conclusion section.

2. Research hypotheses and methodology

In order to address the research problem and answer research question and also to fulfil the hypothesis is set out for testing based on extensive literature review including critical success factors theories. The hypothesis is about identification of applicability of CCSFs in each phase over life-cycle of dam engineering projects.

For the purpose of this research following hypothesis is introduced for testing:

“There are specific CSFs for each phase over life-cycle of dam engineering projects in Australia.”

The purpose is to explore success components of dam engineering projects and identify CSFs from list of CCSFs for each phase of dam engineering projects in Australia. The research will include literature review and establishment of the theoretical framework; data collection and hypotheses testing. The adopted research techniques include Delphi technique in a quantitative way to collect the data. Major statistical analyses will also be conducted to analyse the collected data.

3. Dam engineering projects

Studies and research on the area of project success are very limited in dam engineering industry. In one of the studies Singler (2014) determined CSFs for dam removal projects and suggested following success factors: competent project managers, effective regulations and regulators, effectiveness of dam safety measures, suitable funding. As Hoover dam project had a large impact in modern project management, Kwak et al. (2014) studied the project and introduced that project success during construction was the result of competent project manager, well-defined project mission, creating a design review team, close cooperation between government and project parties and appropriate supply of necessary material. When it comes to Australian dams engineering industry, the conducted research is even more limited. One of the studies focusing on partnering for Dondeloup dam in Western Australia was by Hellard (1995) who worked on CSFs. The research was limited to project partnering and the
dam was among different structures that he studied, so the study was not based on the structure type, but the focus was on success of partnering of civil engineering projects. Review of the literature shows lack of research in the area of success of dam engineering project. Identification of the gap creates an opportunity to conduct such research that would benefit both academics and professional project managers working on such projects. Hence the research questions introduced for the research problem is:

“What are the CSFs over whole life-cycle of dam engineering projects in Australia?”

4. Candidate Critical Success Factors (CCSFs)

According to Khan, K et al. (2013), there is no universally agreed model or list of CSFs that can be used for all projects. In fact, many researchers have attempted to list CSFs, but it is impossible to list a definitive set of all CSFs for a successful dam engineering project from the literature. Therefore, in this research a list of CCSFs have been identified and listed from the literature so that the CSFs could be identified from the long list of CCSFs trying to make the input to the research as comprehensive as possible. Table 1 presents the list of CCSFs.

<table>
<thead>
<tr>
<th>CCSFs</th>
<th>References</th>
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<tbody>
<tr>
<td>Top management support</td>
<td>Cooke-Davis (2002); Hartman and Ashrafi (2002); Slevin and Pinto (1986); Ward (1995); White and Fortune (2002); Phua (2004); Iyer and Jha (2005); Baccarini and Collins (2003); (Osorio et al. 2014)</td>
</tr>
<tr>
<td>Project manager capabilities and commitment</td>
<td>(Chan, Albert and Chan (2004); Chua, Kog and Loh (1999); Jaselskis, E and Ashley (1991); Ogunlana et al. (2002); Shahid Tabish and Jha (2012); Yang et al. (2010)</td>
</tr>
<tr>
<td>Effective communication</td>
<td>(Bryde and Robinson (2005); Chua, Kog and Loh (1999); Doloi et al. (2012); Leung, Ng and Cheung (2004); Wang, X and Huang (2006); Yang et al. (2010); Osorio et al. (2014)</td>
</tr>
<tr>
<td>Adequate risk analysis and management</td>
<td>(Barber (2005); Cooke-Davis (2002); Wang, SQ, Dulaimi and Aguria (2004); Yun et al. (2015);</td>
</tr>
<tr>
<td>Effective scheduling</td>
<td>(Jaśkowski and Biruk (2011); Jha and Iyer (2007); Shahid Tabish and Jha (2012)</td>
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<tr>
<td>Clear scope and work definition</td>
<td>Chan, Albert P. C., Chan and Scott (2004); Doloi et al. (2012); Jha and Iyer (2007); Leung, Ng and Cheung (2004); Turner, J. R. and Cochrane (1993); Butler et al. (2004); Nguyen, Ogunlana and Lan (2004);</td>
</tr>
<tr>
<td>Effective technical review</td>
<td>Chua et al. (1997); Cooke-Davis (2002); Munns, Bjeirmi and Munns (1996)</td>
</tr>
<tr>
<td>Proper completion of previous phase(s)</td>
<td>Gunduz and Yahya (2015); Chua et al. (1997); Sanvido et al. (1992)</td>
</tr>
<tr>
<td>Build competent project team</td>
<td>Hyvari (2006); Khang and Moe (2008); Osorio et al. 2014; Pinto, J and Slevin (1989); Pinto, JK and Slevin, DP (1988); Turner, J and Müller (2005)</td>
</tr>
<tr>
<td>Authority of the Project Manager</td>
<td>Erling et al. (2006); Pinto, J and Slevin (1989); Pinto, JK and Slevin, DP (1988)</td>
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</table>
Each of the CCSFs is explained below:

4.1. Top management support

Top management support is one of the most cited CSFs but many top managers are still unaware of its importance on project success (Baccarini & Collins 2003; Madanayake 2014). The effect of top management support is wide and its effect covers a variety of project aspects from quality or user satisfaction to better communication, enthusiasm and involvement (Young & Jordan 2008). Adequate and timely access to resources is essential for effective execution...
of project processes and activities, and this is not possible without positive reaction to the resource allocation requests and support by the top management (Alexandrova & Ivanova 2013). Project managers are dependent on the authority, direction and support which are all somethings that the top managers have a great influence to provide the project manager with and should be convinced that the project is worthwhile to support it (Baccarini & Collins 2003).

4.2. **Project manager capabilities and commitment**

Technical, administrative, leadership and other project related skills of project manager is an important component during project processes and activities (Salleh 2009). Competence and commitment of project manager and how they manage project teams affect the project performance and outcomes (Marzooqi & Ahmed 2016). A study by Alexandrova and Ivanova (2013), showed that project manager capabilities and commitment was ‘extremely important’ for 80% of the respondents to achieve project success indicating the importance of this project success factor. This study provided additional evidence supporting the previous studies that indicated project managers’ skills and commitment is one of the most important CSFs over project life-cycle.

4.3. **Effective communication**

Numerous researchers in the area of project success have emphasised on importance of proper and effective communication for project success. Dam engineering projects are complex and cross-disciplinary making effective communication even more important. Effective and proper communication between teams members and other project parties leads to more realistic expectations, better relationships, less ambiguity and more effective teamwork (Dong, Chuah & Zhai 2004). Some communication methods such as face-to-face meetings might be more effective than other such as emails. Although all methods have advantages over others, combination of different methods should be used for more effective communication (Frank Cervone 2014). As dam engineering project involve many teams with different expertise and different organisations, ‘effective communication’ is certainly a factor that should be examined in exploring CSFs for such projects.

4.4. **Adequate risk analysis and management**

Adequate risk analysis is referred to in the literature as one of the potential CSFS for projects and is defined as effective identification and management of potential issues and problems that might undermine the success of a project. Risk analysis and management consist of making decisions on the available information on situations that may or may not occur (de Bakker, Boonstra & Wortmann 2011). The likelihood and consequences of the risks should be accurately determined to achieve adequate risk analysis leading to project success by improvement in project planning, budget and design related activities (De Bakker, Boonstra & Wortmann 2010). Raz, Shenhar and Dvir (2002) found out that risk analysis and management are more important and applicable to projects that are prone to have more associated risks. As dams are high risk projects with specific approach introduced to manage risks of these project in Australia, adequate risk analysis and management is chosen as a candidate CSF for this study.
4.5. **Effective scheduling**

Effective scheduling is another factor that affects many aspects of project success and has been widely cited by many researchers as a CSF for projects. Effective scheduling for different activities in organisations and projects has evolved over the years and become a vital activity that heavily affects success or failure of most projects undertaken in different industries (Brako, Joseph & Brako 2017). Effective scheduling is proper preparation of a detailed plan including actions and required steps of the work that needs to be performed during project process and determining what resources are needed, and estimating timeframe of activities (Van Eynde 2017). As an important component of projects, ‘effective scheduling’ is select as a candidate CSF for this study.

4.6. **Clear scope and work definition**

Clear scope and work definition has an important role in achieving project success and this has been reflected in the literature numerous times (Butler et al. 2004; Nguyen, Ogunlana and Lan 2004). This is about determining precisely what is going to be the outputs of the project and determine the deliverables and all the required project work to support achievement of the successful delivery. It also includes general philosophy and mission of the project. If the project scope and work definition is ill-conceived, this would lead to poor work arrangements and wrong decision makings from the beginning of the project (Munns, Bjeirmi & Munns 1996). The work definition and project scope should be realistic and understandable (Dong, Chuah & Zhai 2004; Wateridge 1998). Adequate definition of the work and agreed-upon project scope lead to no or minimum changes in the project scope and work and teams efforts remain effectively and efficiently within the defined project scope throughout the project avoiding project overruns (Dong, Chuah & Zhai 2004). As an important factor that really matters in different contexts, ‘clear scope and work definition’ is chosen as a candidate CSF for this study.

4.7. **Effective technical review**

All projects need a review component for technical matters that helps identify any technical gaps in project implementation (Joseph 2014). This is a well-defined continuous review of the project activities and outputs to find and fix the project technical defects (Chua et al. 1997; Cooke-Davis 2002; Munns, Bjeirmi and Munns 1996). This could be conducted by establishment of the project peer review group covering different areas of project technical practice. This could happen at different stages of project such as different milestones, completed tasks and near project completion. As dam engineering project are highly technical which need complex expertise, ‘effective technical review’ is chosen as a candidate CSF for this study.

4.8. **Successful completion of previous phase(s)**

The way that previous phases of a project were delivered affects performance of the current phase. Many activities of the current project phase rely on the information provided in previous phases, hence, the success of previous phases has an important role in how well the project is delivered in a specific phase (Chua et al. 1997; Sanvido et al. 1992). The importance of having design phase completed properly before start of the construction phase of civil engineering project was shown by Chua, Kog and Loh (1999). As this study covers whole life-cycle of projects from planning to operation, ‘successful completion of previous phase’ seems to be a
suitable candidate CSF to realise how importance of this changes as the project moves from one phase to another.

4.9. Build competent project team

Build competent project team is another factor affecting project success which is widely mentioned in the literature. In a research by Alexandrova and Ivanova (2013), 70% of the respondents considered competent project team as ‘extremely important’ CSF and ‘highly important’ by another thirty percent of the respondents. Building competent project teams is about proper recruitment, selection and training of project team members. In order to build a competent project team, the required skills, knowledge and qualifications should be determined based on project objectives and complexity; and project team should be selected wisely to ensure they have the necessary skills and commitment to perform their functions effectively (Baccarini & Collins 2003).

4.10. Authority of the Project Manager

Authority of the Project Manager is another factor that has been widely referred to as a CSF for different types of projects (Pinto and Slevin 1988). In a study by Spalek (2005), it was shown that high authority of the Project Manager has 85% influence on the project success. As the project manager is the representative of organisations and senior management, authority of the project manager is the power that enables the project manager to act in the name of them (Pollack & Algeo 2014). This includes the authority of decision making related to team and project activities. In addition to being committed, the project manager should have enough control over the project in order to be able to make decisions, develop plans, and make necessary changes during the course of the project (Baccarini & Collins 2003).

4.11. Monitor performance and feedback

‘Monitor performance and feedback’ is about comprehensive control of information during project implementation and to keep eye on performance related to targets, milestones and team members in order to keep the project on the right track. Proper control and feedback system provide adequate monitoring enabling project managers to compare project performance and achievements with the project objectives (Baccarini & Collins 2003; Gioia 1996; Jaselskis 1990; Jiang, Klein & Balloun 1996). This will lead to higher chance of project success as project managers become able to anticipate problems and undertake preventive or corrective actions making sure that project deficiencies are not overlooked (Baccarini & Collins 2003).

4.12. Adequate resources

‘Adequate resources’ is another factor affecting project success mentioned in the literature. Adequate resources such as funding, people, equipment, facilities, and time, which are important to ensure success of projects, should be provided, maintained and managed properly over life-cycle of the project (Baccarini & Collins 2003). As important expertise and capital for organisations and projects, project team members and other project participants must be provided with the best possible resources enabling them to work effectively and collaboratively (Mistry & Davis 2009). As problems and obstacles arise during project implementation, the presence of adequate resources, in particular funding, help project managers and team members overcome difficulties and deliver projects successfully (Yeoh, Koronios & Gao 2006). All
project activities need adequate resources assigned to them and dam engineering projects are not exceptions.

4.13. **Realistic cost and time estimates**

‘Realistic cost and time’ estimates specially in early stages of projects has been mentioned in the literature as an important CSF. The importance of realistic cost time estimations was described by Arestegui Carvajal (2014) for achieving successful complex projects; in his case: underwater tunnel projects. Every project manager is dependent on realistic cost and time estimates to allow for successful cost management and scheduling (Torp & Klakegg 2016). By breaking down the process into little tasks and steps, it is possible to estimate the time and cost precisely to avoid preventable failure of the project later in the project.

4.14. **Adequate change management**

A project manager should keep track of all changes that happen over the implementation of the project having a proper approach to cope with them by using a formal and useful change management principles and processes in place (Dong, Chuah & Zhai 2004). As project progresses, changes in the scope of work, team members and work condition and other usual changes happen and the ability to respond effectively to the changes has an important role in success of project (Wateridge 1998). Levasseur (2010) examined project success rates and showed the chance of project success increases significantly having an established change management system. Projects are core elements of different type organisations and successful continuation and delivery of them can be ensured through a proper change management (Ghanim, Munassar & Dahlan 2013). As a CSF frequently mentioned in the literature (Wong and Tein 2003; Butler et al. 2004; Osorio et al. 2014), ‘adequate change management’ is chosen as a CCSF for this study.

4.15. **Political support**

Given the fact that many projects that require government funding are influenced by ruling parties, support from political figures and parties are important (Jacobson & Ok Choi 2008). Public project are heavily influenced by political situation of the day and hence need to be pinpointed by political support (Garbharran, Govender & Msani 2012). This could be achieved by spending the time up front to have a proper strategy to sell the project to influential political figures to avoid years of fight against the opposition that could be avoid from the start. In the study by Alhashemi (2008) on public-private partnership projects, political support was the main factor among the factors examined for project success. Other researchers have also mentioned ‘political support’ as a CSF (Li et al. 2005; Aerts et al. 2014; Ng, Wong and Wong 2010; Yuan et al. 2010); making this a suitable CCSF for this study.

4.16. **Public support**

This has become a fact in modern era that success of development and implementation of projects require a wide public support (Kušlijić & Marenjak 2013). Support from society helps the project achieve its objectives as it increases the chance of final approval of the project and possibly funding. A successful project needs to receive support of the public stakeholders which could be achieved by the help of effective communication to receive their feedback and concern regarding the project (Tran 2016). As many benefits of projects are quantified based on how
much the society is willing to pay for it during operation, it is important to attract support for public projects from wide range of public stakeholders and the society in local, state and national scale (Garbharran, Govender & Msani 2012).

4.17. Stable economic condition

Stable economic condition refers to the constant positive macroeconomic condition and absence of unusual economic fluctuations. In a study Sharaffudin and Abdullah (2017), public agencies considered a stable economic condition as the most important CSF for their projects. Constant growth and low inflation, reasonable interest rates and friendly economic policy for investors contribute to stable economic condition subsequently increase the chance of project success (Cheong Yong & Emma Mustaffa 2012). Many other researcher (Zhang 2005; Chou and Pramudawardhani 2014; Solomon and Akinsiku 2012; Verhoest et al. 2015) have also mentioned 'stable economic condition’ as a CSF for projects, making this a suitable CCSF for this study.

4.18. Effective problem solving and decision making

‘Effective problem solving and decision making’ has been referred to in the literature as an important project success factor (Baccarini and Collins 2003; Cheng 2002; Aneesha and Haridharan 2017). This using suitable methods for finding solutions to the problems that the project faces and adaptation of an approach to select course of actions among different decision alternatives to come up with the best decision. Knowing how to be competent in problem solving and decision making is really important for projects and is largely achieved by effective utilisation of knowledge resources in the project team (Lin et al. 2015). Despite the fact that huge amount of effort is spent on careful planning of projects, it is almost difficult to predict all problems that might happen during a project and it makes it vital to be responsive and capable of applying appropriate problem solving and decision making processes for project (Baccarini & Collins 2003).

4.19. Clear definition of roles, responsibilities and accountabilities

‘Clear definition of roles, responsibilities and accountabilities’ is an important factor enabling project to achieve success (Jawad, Ledwith & Panahifar 2018). Successful team building is not just about choosing the right people for the roles but also knowing what they have to do and when they have to do it leading to increased efficiency of teams (Beleiu, Crisan & Nistor 2015). Before building teams, it is important that roles and responsibilities are defined properly because it is not possible to find the match person for each job without knowing exactly what kind of responsibilities we are looking for. Project manager is responsible for defining to set the roles, responsibilities and accountabilities to determine what is expected from the job of the people in different positions (Frese and Sauter 2003; Chan, APC et al. 2004; Beleiu, Crisan and Nistor 2015).

4.20. Teamwork

Project members must work together as a team. To create a teamwork between project team members, a sound working relationship and realistic expectations are needed (Baccarini and Collins 2003; Esmaeili, Pellicer and Molenaar 2016). Project team members should share the same goal, have strong team working ethics, be compatible and work in harmony with each
other (Baccarini & Collins 2003). Working in teams in essential part of project based working environment. Teamwork is effective and efficient combination of actions by different people of a project. Teamwork helps increase efficiency, create new ideas, improve communication, share the workload and bring learning experience.

4.21. **Favourable weather condition**

Many researchers especially in construction industry have referred to ‘favourable weather condition’ as an important CFS that project managers have no control (Mian, Humphreys and Sidwell 2004; Ihuah, Kakulu and Eaton 2014; Salleh 2009; Sunjka and Jacob 2013; AWUOR 2015). Dam engineering projects heavily deal with river system and are affected by weather condition. It is more important when the real construction works start as different weather condition such as dry and cold weather, floods, winds and thunderstorms that impact on the project. It is also important that climate situation is favourable during operation and different scenarios for climate change may affect operation.

4.22. **Absence of bureaucracy**

Bureaucracy is unnecessary work that significantly complicated administrative process of projects and is caused by excessive reliance on rules and regulations (Kwiatkowski 2017). It leads to slow progress and project implementation and should be avoided in the project by simplifying the procedures (Amendola et al. 2016). According to (Huhtala, Ketola & Parzefall 2006) innovative and successful organisations do not organise and structure themselves bureaucratically. Most employees and project team members prefer a flexible organisation structure and absence of bureaucracy for an empowering work environment (Larsen 2002).

4.23. **Up to date technology utilisation**

‘Up to date technology utilisation’ plays an important role in modern work environments (Dong, Chuah & Zhai 2004; Hartman & Ashrafi 2002). There should be proper technical capability in the project to effectively support the project implementation and delivery (Dong, Chuah & Zhai 2004). Technology has an important role in project management as the current work environment is totally technology-enabled using the latest technological tools for different project activities. Using the latest technologies could help effective and efficient project management practice. Some other researchers (Nguyen, Ogunlana and Lan 2004) have also referred to ‘up to date technology utilisation’ as an important success factor making this a suitable candidate for dam engineering project that rely heavily on technologies due to their technical complexity.

4.24. **Knowledge sharing**

Knowledge sharing is an exchange process in which information, skills and expertise are shared among project team members, community or organisation (Hasmath & Hsu 2016; Serban & Luan 2002). Technology plays an important role in knowledge sharing along with culture, trust and incentives (Cabrera & Cabrera 2002). Knowledge sharing has been expressed as being highly correlated with project success. Motivating individuals to create, share and use knowledge has been mentioned in the literature as an important CSF for projects (Davenport, De Long & Beers 1997; Nesan 2012). Nesan (2012) emphasised on importance of speed in successful knowledge sharing stating that fast access to the information could be facilitated by
proper use of information technology. As dam engineering industry projects are complex with various involved expertise which require share of knowledge between project parties and teams, knowledge sharing is chosen as a CCSF for this study.

4.25. Proper incentives and motivation

An incentive is a measure to achieve motivation for an individual or teams to undertake actions, improve performance and contribute to success. Having an incentive based system is considered to be a key project monument activity (Armstrong 2015). Motivation is the reason behind actions by people and is associated with their desires and needs (Burton 2012). Ryan and Deci (2000, p. 54) stated that “orientation of motivation concerns the underlying attitudes and goals that give rise to action”. People become motivated to achieve certain personal and organisational goals (Burton 2012). ‘Proper incentives and motivation’ has been mentioned in the literature as an important CSF (Chua, Kog & Loh 1999; Gunduz & Yahya 2015; Tabish & Jha 2011) making this a suitable CCSF for this study.

5. Conclusions

Based on literature review findings presented in this paper, undertaking research to identify CSFs based on the list of CCSFs of this paper and present a success paradigm on dam engineering projects in Australia is recommended and will be the aim of the PhD research project of the authors. The dam engineering projects are required to achieve certain goals based on the defined objectives of the project such as meeting the budget, time and stakeholder satisfaction. As there is a lack of prior research on success of this type of projects, the findings of this research could extend the existing body of knowledge to cover dam engineering industry. The findings of this research could assist in addressing these issues and make informed decisions in respect of dam engineering industry projects success. The study will enable project managers to have a much better understanding of what contributes to success of dam engineering industry projects in Australia.

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