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IDENTIFICATION & MITIGATION OF FACTORS IMPEDING EFFECTIVE COMPLETION OF ORIGINAL EQUIPMENT MANUFACTURER (OEM) INTENSIVE CAPITAL PROJECTS - A STUDY OF SPECIFIC PUBLIC SECTOR IN PAKISTAN

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ABSTRACT

The study focuses on identification of factors causing delays and risks associated with OEM intensive capital projects in Pakistan. It is an exploratory research in which framework conceptualisation based on a literature review was used as a starting point for the empirical study. A series of thirty semi-structured interviews with concerned professionals sought to identify delay factors and check its salience. The qualitative analysis of data was conducted for three purposes. First, to identify new factors that contributes towards timely completion of overhauling projects which were not identified in literature review. Secondly, get confirmation for the key factors identified from literature, and lastly to reduce the number of most affecting factors identified, and build a framework with a 'manageable' number of factors, as a wide range will divert the focus of organisation from what they should concentrate on to deliver the project on time. The results conclude that obsolescence is the most significant factor and the subsequent factors are supply chain, resources management and project management which are taking a toll towards project delay. It was also observed during the study that obsolescence is a phenomenon and can be mitigated to a great extent by improving supply chain and project management practices.

Keywords: *Supply chain management (SCM), Obsolescence, Capital projects, Mitigation, Acquisition, Inter-dependencies.*

1) INTRODUCTION

In last couple of decades the rapid globalization has changed the concept of machinery design due sudden advancement in the field of electronics (Paul & Gaulbitz, 2011). Now machines have short product life cycle because manufacturers have to improve their designs on regular basis for better control compared to previous variant (Solomon, Sandborn, & Pecht, 2000). Therefore, to market new product, manufacturers have to discontinue supportability of their previous product. This led previously available product obsolete with induction of its new variant. Regular induction of new products with short product life cycle and continuous up-gradation of existing one has adversely affected the progress of public sector (Solomon, Sandborn, & Pecht, 2000). The technological advancement and change in business concept have transformed mechanical machines into controller based. This has increased the working efficiency and accuracy however, the same has drastically reduced machine life cycle with use and throw principle (Paul & Gaulbitz, 2011). Further, short product life cycle has augmented the intricacies involved in overhauling capital projects of public sector core machinery.

Since, capital projects related to up-gradation/retrofitting of public sector core machinery are considered relatively cost effective option when compared to new buying or development (Byers & Webb, 2013).Therefore, timely delivery after overhauling capital assets like sea going platforms, aircraft of commercial airlines and railway engines/carriages in operational state is considered mandatory to maintain the competiveness of the public sector. According to Ahmed *et al.* (2003), delay is generally acknowledged as the most common, costly, complex and risky problem encountered in projects which are heavily OEM dependent. Kumaraswamy *et al*. (1998), surveyed the causes of delays in mega projects as seen by major stake holders, and examined the factors affecting productivity. The study revealed the cause as difference in perceptions among stake holders depending on their experiences, possible injustice and lack of effective communication. David *et al*. (1987), identified that timely availability of raw material and explicit/implicit resources are significant factors for successful completion of projects. However, smooth completion of these overhauling projects remains a grey area due copious risks, short product life cycle and cost involved. As a result, majority of these projects become unviable because of cost over run during execution stage. Subsequently usage of capital platforms remain mired with reliability issues. Sufficient amount

of literature review has been carried in order to identify the existing factors taking the toll and making the projects unviable.

2) LITERATURE REVIEW

There is a pressing requirement to have platforms stationed at some distant location in order to exert sovereign control over an area of the sea to counter rapidly changing geopolitical scenarios. Coyle & Gardiner (1991) highlighted that if platforms are not on deployed location then a short fall between requirement and availability occurs. The capital platforms like aircraft, ships etc. are hybrid of machinery/systems and needs repairs/maintenance on requirement or as per pre-set schedule. Therefore, system needs to be put out of service for defect rectification and routine maintenance to avoid catastrophic failures. To maintain high system availability it is necessary that spare parts required for undertaking the repairs and maintenance work must be present well before time (Sleptehenko, Heijden, & Harten, 2003). Further, Sleptehenko & Harten, (2003) have proposed two methods to improve system availability i.e. increasing spare part inventories and secondly investing for additional repair capacity. Moreover, Cohen, Zheng, & Agrawal, (1997)has pointed out that such a trade-off from OEM will not be so simple in the presence of existing complex supply chain structure for spare parts availability and supply network. However, aspect of supply chain for non-availability material/spares and its effect on timely completion of projects have not been covered in the said study.

Capital natured projects in developing countries heavily depend on systems and procedures defined by OEM. Correct implementation of these procedures is possible when the required set of resources are timely available to ensure optimization of efforts in capital projects. Effective application of resources can allow organizations to enhance competitive advantages by acquiring capabilities and resources which are necessary and valuable (Peteraf, 1993). Good control of these strategic resources including explicit (systems, equipments & spare parts) as well as implicit (Information, communication etc.) proves out to be a power tool for handling unforeseen events (Peteraf, 1993).Said study mostly covers benefits of resources related to business environment and it slightly touches the advantages of intangible implicit resources because same are deeply imbedded in management system and difficult to replace (Barratt & Oke, 2007). However, their impact on the performance of OEM dependent projects have not been elaborated in

aforesaid research.

The literature given in PMBOK broadly deals the project in two very important phases; conceptual phase and operational phase (C. S. Lim & M. Zain Mohamed, 1999). According to study these phases are first conceptualized, tested and if these qualify then project is perceived to be successful. However, author reiterates here that project success in terms of time, cost, performance, quality and safety will real depend upon that how the "project management" functions and the individuals perceive project success from their own perspective. Same concept has also been highlighted by Cicmil, Williams, Thomas, & Hodgson, (2006) where role of project actors and managers is termed as 'implementers' and then converged their role to address the issue of control-time/cost and planned scope of work.

Another important factor was highlighted during literature review process is obsolescence causing late availability of platforms. This problem has adversely affected Canada's submarine program (Byers & Webb, 2013) where project director of Victoria class submarine program in 2005 has reported the reasons of delays as shortage or lack of spare parts. Main cause explained in study is either OEM no longer exists or has shifted on to other designs. Therefore, Canadian submarine HMCS Victoria was made operational after cannibalization from HMCS Chicoutimi. In this particular case submarine was made available for operations after abandoning the requisite operations of a similar class submarine with an overall delay of three years. Resultantly, Canada had to pay a huge price that includes $11 million, extra time of three years and another platform of same class to make the submarine available for operations and deployment.

In congruence with the conceptualization narrated during literature review and considering the current scenario of maritime sector arena in Pakistan this has been concluded that qualitative approach should be adopted for further procession and validation of existing study. This will check robustness of present system, confirm the existing factors and help to find additional factors contributing towards delay in completion of mega overhauling projects. This warrants a comprehensive research methodology to un-earthed contributing factors buried in the data.

3) RESEARCH METHODOLOGY

This research may not conclusively test a single theory, but instead must emphasis on generation of a theory based on actual findings and data. The paper uses exploratory approach to identify key factors by analyzing circumstances encountered in different overhauling projects undertaken by various organisations. The empirical analysis was carried out using a frame-work derived from literature review. This paper examines various factors having impact towards successful completion of overhauling projects. The research methodology comprises of following steps which resulted in arriving on conclusive results:

3.1) Research Design

As a qualitative research interview method has been used as a tool for collection of relevant information (Bilal Atif 2014).A convenience sampling method was used to collect information from thirty three professionals working in various tiers of overhauling projects. It was made sure that all respondents were having different educational backgrounds and field work experience. The number of participants was considered good enough because sample size of 6-30 is considered adequate for a qualitative study (Bilal Atif 2014).

3.2) Data Collection

In order to collect information and data, semi-structured interview method was used to identify contributing factors based on individuals experience and observation about working on various overhauling projects. Further, due exploratory nature of this research, empirical data required to cover information from various overhauling projects undertaken during last two decades in order to reduce the risk of getting only a narrow view on identification of factors responsible for the late delivery of project by the organisation. Interview method has been validated for information collection of qualitative studies by many previous scholars (Bilal Atif 2014).

3.3) Settings

Five organisations were identified as potential firms to participate in the semi-structured interview. Due to budget, time and personal access restrictions, only organisation engaged in overhauling of sea going

platforms was identified for interviews. Despite difficulty in getting agreement from organisation to participate in the study, semi-structured interviews were carried out on five different overhauling projects conducted by the organisation in the last couple of decades. The selection of only organisation engaged in overhauling of sea going platforms to participate in the study may raise a question of data bias, because the framework was developed using interview data from a specific geographic context. However, the framework developed from interviews was not different from the initial framework' outlined from literature review. Therefore, organisation based frame-work is considered quite robust. The study involved thirty semi-structured interviews comprising 15% higher managers/managing directors, 20% general managers, 55% managers/ foreman and 10% team members. The qualitative analysis of data was conducted for three purposes. First, to identify new factors that contributes towards timely completion of overhauling projects which were not identified in literature review. Secondly, get confirmation for the key factors identified from literature, and lastly to reduce the number of most affecting factors identified, and build a framework with a manageable number of factors, as a wide range will divert the focus of organisation from what they should concentrate on to deliver the project on time.

3.4) Interviews

Since Karachi being the port city, therefore, it was selected for the study. Quite a rich data was available as all the sea going platforms are being overhauled in facilities available in the city. The interviews were conducted between Feb 2015 and Jan 2016. Each interview lasted between 1 to 2 hours, the average was one and a half hour. The focus of interview was to know individual's point of view regarding factors causing delays in delivery of capital overhauling projects. The data from semi-structured interviews was collected using voice recordings and taking simultaneous notes so that maximum information can be un-earthed. Later the recorded answers were converted into a text form in MS-word files so that the analysis of collected data can be performed to draw some conclusion.

4) DATA ANALYSIS

The data analysis was carried out using thematic analysis widely used as an appropriate technique for exploratory research and theory building purposes (Gabriela & Stephen, 2015). Thematic analysis determines the presence and frequency of themes emerging from verbal data and deeper meaning embedded in data by using commercially available software packages. In this study Nvivo software was used which allowed scoring reliability to increase and coding inconsistencies to reduce substantially with the help of computer-assisted counting, weighing and theme identification processes. The output is a conceptual map presenting significant themes, their relevance within the text, and their relationship towards each other, using relative word count with the help of computer-assisted coding processes. The global result obtain during thematic analysis shown in Figure 1 depicts relevant factors attributable towards delays in timely delivery of projects. Large sized alphabetical words indicate factors which were more frequently coded, i.e. suggested by most of the respondents.

Figure 1: Results of Thematic Analysis

5) RESULTS AND DISCUSSION

The respondents covered different project completion durations in a balanced way as most of respondents had experience of project durations between 2 to 6 years. Respondents had experience on projects covering a wide range of costs. However, more than 90% respondents did not have an idea of projects' typical cost. This happened mostly in public sector organisations where the project managers do not focus project cost but only focus on scope, quality and time. The respondents appeared well qualified to provide valuable information as 57% had more than 20 years of project management experience with 10% of them had a graduate certification and rest of them were having associate engineering certificate. The information collected from interviews revealed that a broad perspective is prevailing among the project team regarding factors that can be attributed towards delays in the delivery of overhauling capital projects.

5.1) The major overhauling project delay causing factors with their dependencies/themes derived from sub-themes shown in boxes as well as relationship to each other are mentioned in Fig 2:

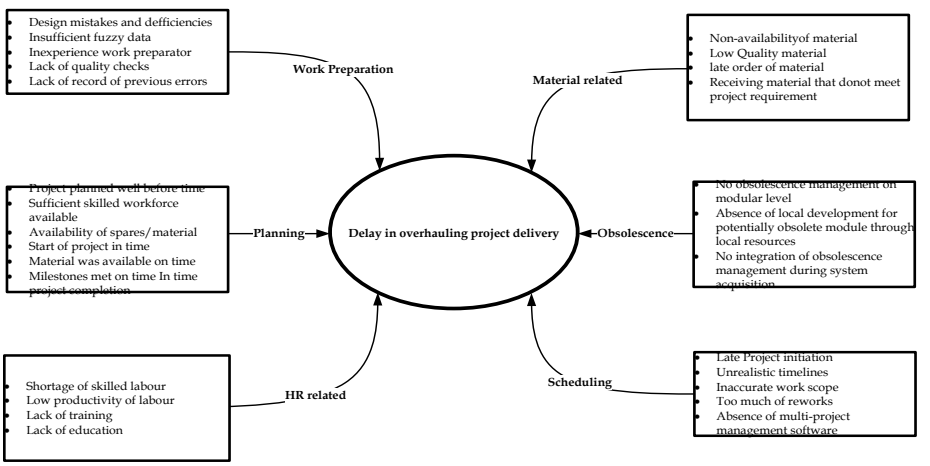

Figure 2: Major Project Delay Causing Factors

5.2) The most repeated causes of material non-availability is shown in figure-3. During interview it was highlighted that due to non-utilization of innovative technology there is a "communication" and

"coordination" gap causing non-conforming deliveries. Moreover, spares identified during setting to work stage are mostly not readily available and are arranged by OEM on receipt of order. Further, it has been observed that the causes highlighted in the figure are frequently being faced by most of the organisations.

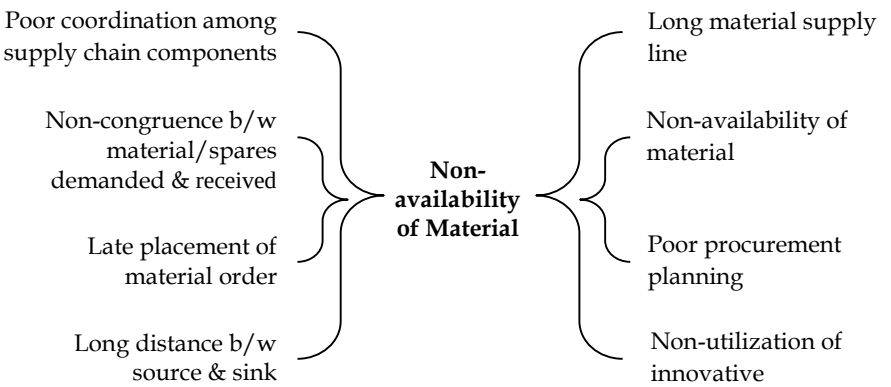

Figure 3: Causes of Non-Availability of Material

5.3 The most significant variable identified during interviews is "obsolescence" taking a toll towards delay in project delivery. The glaring and most repeated causes of obsolescence identified during aforesaid data analysis which are contributing towards delay in project delivery are shown in figure 4 below. During the interview respondents highlighted that obsolescence is a dependent variable that can be controlled by re-alignment of inventory levels, supply chain and by improving project management practices. According to the respondents system analyses with OEM is not being done at the time of purchase for modules that can have supportability issues due short product life cycle. Further, non-availability of spares from OEM is contributing towards delay in project delivery because modular systems are not being analysed for modules and sub-modules that can face supportability problems due obsolescence. Moreover, local resources are not being explored for timely development of modules that can come across obsolescence. During the interviews the respondent highlighted the need of purchasing sufficient number of spares to ensure through life supportability of systems that are vulnerable to obsolescence.

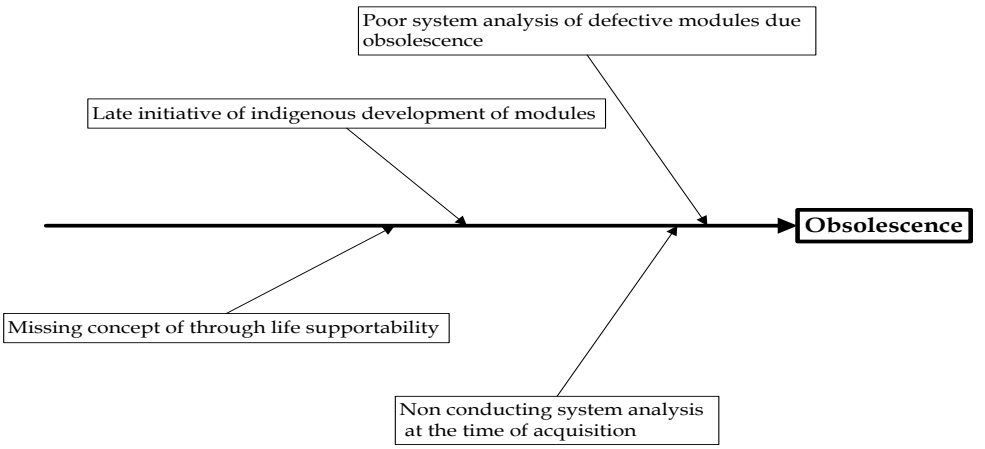

Figure 4: Causes of Obsolescence

5.4 The next significant variable is scheduling/planning process which is contributing towards delay in overhauling project delivery. It was revealed that scheduling process is not geared up to cover fundamentals of project management. The areas affecting timely delivery of overhauling projects explained during the interview and transmuted into themes and subthemes with the help of computer assisted counting weighing and theme identification process are shown in figure 5. According to respondents, an inept staff is usually engaged in planning/scheduling of overhauling projects. Therefore, initial work preparation including analysis of similar completed projects and recording of errors are not being carried out.

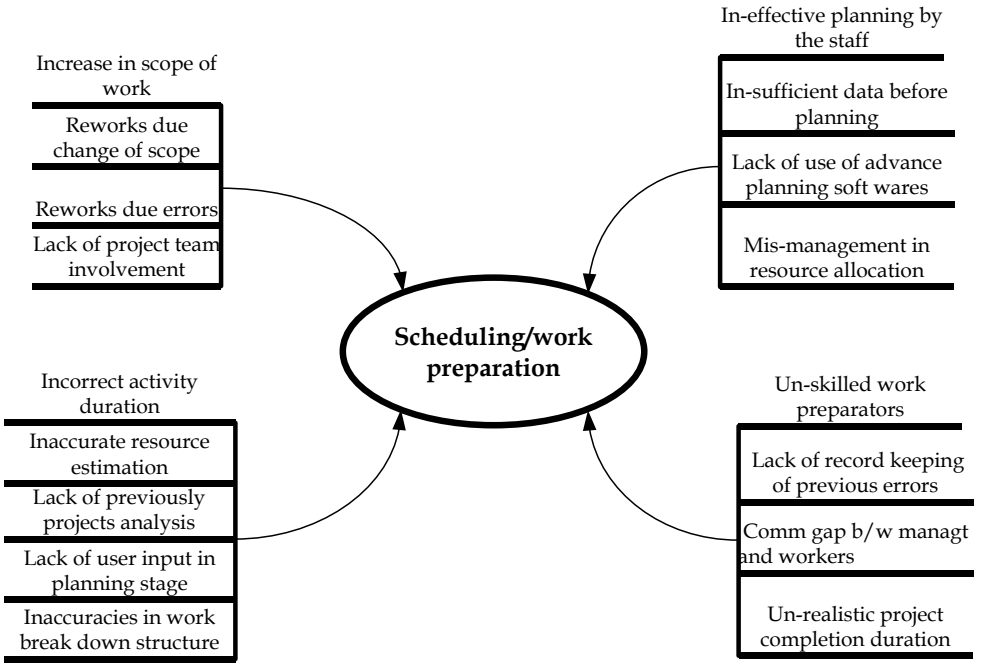

Figure 5: Causes of Scheduling and Work Preparation

This results in arbitrary scope of work which keeps on changing as the project progresses. Frequent change in scope of work generates re-works and errors contributing towards delay in project delivery. In addition, multiple overhauling projects sharing same resources are being done, therefore, in the abscence of multi-project management software,proper resource management can not be ensured.

Another grey area un-earthed during interviews was non-availability of required resources. The respondents informed that inaccurate HR deployment is being done without prior knowledge of planning department. It was suggested by the respondent that in the absence of skilled labour explicit and implicit resources need to be controlled to handle unforeseen events which causes delay in delivery of overhauling projects. The factors which were explained during the course of interview alongwith frequency of themes and deeper meanings embedded in data extracted using commercial software are given in figure:

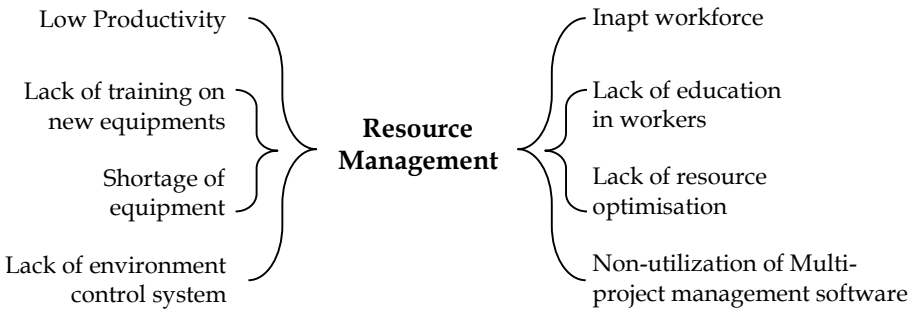

Figure 6: Factors affecting resources Management

6) PROPOSED MODEL

The major delay causing factors as well as their dependencies/ urelationship in overhauling projects assessed by the author through thematic analysis are Material, Obsolescence, Scheduling, Work preparation and Human resource. The relationship of sub-themes with that of main themes and their corroboration with main text was critically analysed. Subsequently, said analysis resulted into a very comprehensive model to understand the role and overall effect of each factor. The proposed model, indicates major factors that can well define on time completion and delivery of overhauling capital project, is shown in figure 7.

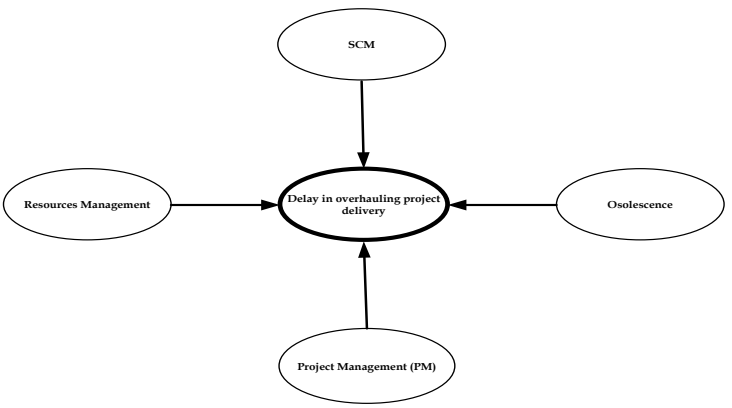

Figure 7: Proposed Model for Factors Affecting overhauling Project Delivery

The main feature of this proposed model based on thematic analysis are as follows:

a) Factor representing non-availability of material, delay in material delivery and poor procurement planning can be mitigated by correct implementation of well integrated Supply Chain (SCM) as a main theme.
b) Lack of preparation during initiation phase results in major reworks, unnecessary equipment degradation and non-productive activities. Same can be mitigated through right scheduling and work preparation. These factors may be combined under the main theme of Project Management (PM).
c) There is a positive relation between availablity of resources and in time project delivery. The effects of non-availability of resources on project delivery can be mitigated by controlling the explicit as well as implicit strategic resources. These sub-themes are redefined by using the term Resources Management.
d) Obsolescence can be controlled by re-aligning inventory management and customer-supplier relationship and better project planning. Therefore, the issue of obsolescence can be mitigated to a great extent by improving SCM and PM practices.

7) CONCLUSION

The study was conducted to identify factors causing delays and risks associated with OEM intensive capital projects related to marine sector of Pakistan. Since it is was an exploratory research therefore an initial framework was conceptualised through literature review and then a series of thirty semi-structured interviews were used as a tool for data gathering. The qualitative analysis of data was focused to achieve three purposes. First, to identify new factors that contributes towards timely completion of overhauling projects which were not identified in literature review. Secondly, get confirmation for the key factors identified from literature, and lastly to reduce the number of most affecting factors during thematic analysis, and build a framework with a 'manageable' number of factors, as, a wide range will divert the focus of organisation from what they should concentrate on to deliver the project on time. The study identified four most important causes of delays having significant impact on timely completion/ delivery of overhauling projects. The broad categories include timely availability of required material or supply chain issues, project management,

resources management and obsolescence. The results conclude that obsolescence is the most significant factor taking a toll towards project delay. However, obsolescence can be controlled by realigning supply chain strategy with that of organizations strategy and improving the project management practices. The outcome of study shall be beneficial to professionals engaged with mega projects and academicians. The results will also help experts to understand various facets of project management for subsequent mitigation of delays. The researchers can make use of these findings to carry out studies of similar nature for other sectors around the world to ascertain causes of delays and suggest ways for mitigation.

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