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## Implementation of poka-yoke in Indian manufacturing industry by: enablers, barriers and questionnaire based survey

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### ABSTRACT

In today global economy, the survival of companies depends on their ability to rapidly innovate and improve. As a result, an increasing search is on for the methods and processes that drive improvements in quality, costs and productivity. In the manufacturing industry Poka- Yoke method has become an important approach in order to produce quality products. The meaning of this method is poka-mistake, yoke-prevent or we can say that mistake preventing method. This method is very important tool by rejection in operation of a system may be eliminated. Various techniques may be applied to reduce or eliminate rejection and error in manufacturing process. It is the concentration on removing the cause of defect that is important. The main objective of this research work to identify various enablers, barrier and some case study with the help of questionnair based survey and subsequent statistical analysis.

**Keywords:** Poka Yoke, Failure Modes and Effects Analysis (FMEA) and the Integration of the Poka Yoke into the PFME, Mistake-proofing.

### 1. INTRODUCTION

Poka-Yoke is comprised in the techniques of preventing the faults, being in fact a quality management system and which may be translated by “avoiding the accidental errors”, “eliminating the errors” or „self-protecting operations”. The human errors come especially from tired, troubled, Absent-minded or unmotivated persons. The main objective of Poka-Yoke techniques is that of obtaining zero faults products, by using simple devices of fixing, assembling, warning and other related devices, which prevent people to make mistakes, even if they wanted to. These devices known as Poka-Yoke are normally used for stopping the machine and warning the operator if something is wrong. The anti-error devices apply in all the fields where equipment is involved and even in the offices and they are devices aimed at preventing and detecting the errors. At the same time, the Poka-Yoke concept may be implemented in other activity domains, such as selling, purchasing or developing products, where the errors cost can be very high. These mechanisms can be electric, mechanic, procedures, human or of any other kind able to prevent the inappropriate achieving of a process stage.(Paun A., Sergiu D., Vladut V., Gagenu P) [27].

Managers of sheltered work centers can also of ordinary companies, can realize about the great potential of Poka-Yoke as an easy means of flexibility and accessibility (Miralles C, HoltR, Marin-Garcia A, Canor-Daros L) [14]. The aim of Poka-Yoke method is to eliminate human errors in manufacturing process and management as a result of mental and physical human

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imperfection. The main idea of this method is preventer cause, which may result in errors and use relativity cheap control system for determiners compliance of the product with the model (Dudek-Burlikowksa M., Szewieczek D) [1].

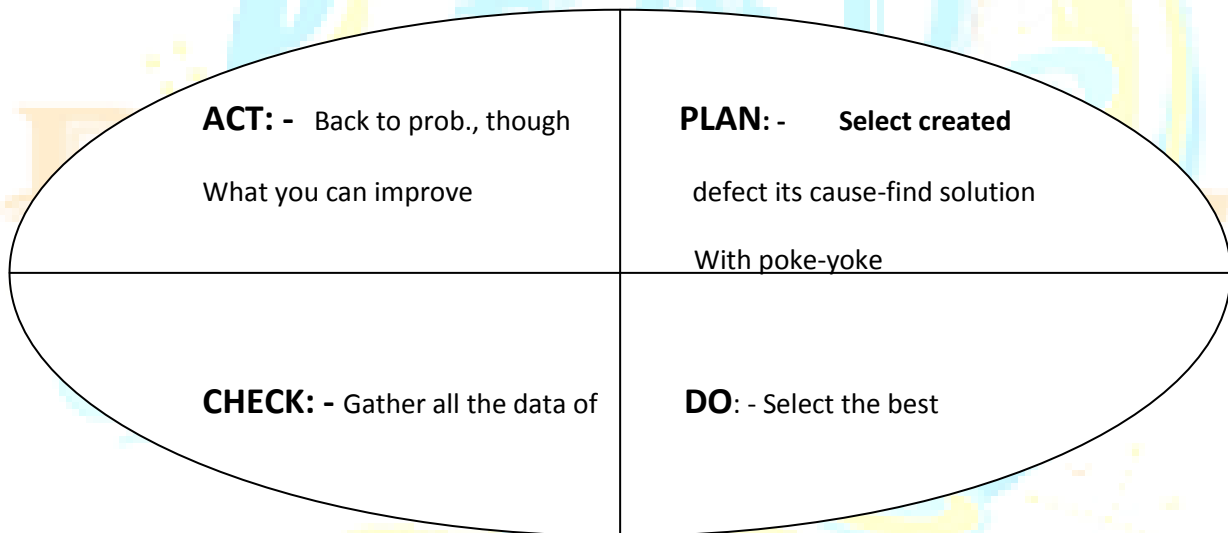
Poka-Yoke method was introduced by Shigeo Shingo in 1961, when this was one of engineers Toyota Motor Corporation. This method in other word is to prevent defect & error originating in the mistake (Chakrabarty, A. and Chuan, T.K.) [23]. In the year 50 Shingeo Singo being an advocate of statistical process control system in Japanese companies realize that such a solution would never improve the manufacturing process. It is therefore started in Japanese organization to improve a zero quality control (ZQC). One of its improving the principal ZQC is just Poka-Yoke method.

(Ketola J., Roberts K.2001) [24]. The method poke-yoke is based on convenience that it is not acceptable to produce even very small quality of defective products (Ishikawa K.,) [26]. For the companies, production of products in 100% without any defect is not only challenge, but necessity for companies.( Feng, Q. and Manuel, C.M) [20]. The name Poka-Yoke, Shiegeo Shingo established in 1963, it is translated as “resistance to errors” (avoid yoker errors resulting from in attention (Poka).

Poke yoke has three basic functions to prevent or reduce defects (Shimbum N.K.) [22]

- Shut Down
- Control
- Warning

All the rules of poke-yoke used in the companies shall be connected with continuous improvements cycle PDCA. Below is a graphical proposal of such approach in figure1



**Figure1: PDCA Poka-Yoke link with the method in an organization selected**

Shingo did make a clear distinction between a mistake and a defect. Mistakes are inevitable; people are human and cannot be expected to concentrate on all the time, or always to understand completely the instructions they are given. Defects result from allowing a mistake to reach the customer, and are entirely avoidable. The goal of Poka-Yoke is re-designing/engineering the process so that mistakes can be prevented or immediately detected and corrected. Self-checks, and successive checks are used together to gain maximum feedback in the shortest time so that the servicing process is both understood and managed. Although the immediate result is that defects are identified and prevented from progressing, the real aim is to modify the process so that future defects are designed out (F.Z. Krumenauer, C.T. Matayoshi, I.B. Silva, M. Stipkovik Filho, G.F.Batalha,) [21]. Chase and Stewart state that Poka-Yoke involves a three steps process of (Chase R., Stewart D., 1994) [13].

- Initially identifying an error
- Tracing the error to its source
- Then developing and implementing the related safe.

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In the era of quality and use of such methodology as implementation, zero defects, continuous improvement, six sigma and method of quality: FMEA, QFD, and SPC. It is the worth set of general measure to prevent mistakes. (H. Lachajczyk, M. Dudek-Burlikowaska [15].

One cannot prevent all mistakes, but can make it easier to do the job right, although mistake will still happen. Instead of allowing processes to continue after a mistake has been made, Poka-Yoke could be used to stop them (Shahin A., Ghasemaghahi M.) [9].

Poka-Yoke for prevention of errors who classified the subjects into three ways :

- Task to be done
- Treatment according to customer
- Tangible and environmental features of service facility.

Poka-Yoke allows processes to run smoothly as they are fail-safe solutions. Although the immediate result is that defects are identified and prevented from programming, the real aim is to modify the process so that the future defects are designed out (J.Ketola, K. Roberts.) [7].

The main objective of Poka-Yoke techniques is that of obtaining zero faults products, by using simple device of fixing, assembling, warning and other related devices, which prevent people to make mistake. These devices known as Poka-Yoke are normally used for stopping the machine and warning the operator if something is wrong. (Paun A, Sergiu D, Vladut V, Gageanu P) [27]. In the era of quality and use of such methodology as implementation, zero defects, continuous improvement, six sigma and method of quality. FMEA, QFD, SPC. It is worth set of general measure to prevent defect. Poka-Yoke are designed to make life easier and improve the performance of the work without implement; they are closer to the philosophy of universal design than to accessible design and offer an easy way of making work more accessible for all kind of workers (Miralles C., Holt R., Marin-Garcia A., Canor-Daros L.) [19]. The Poka-Yoke is a technique for avoiding human error at work. A defect exists in either of two states; the defect either has already occurred calling for defect detection, or is about to occur, calling for defect prediction (J. Lee, A. Ali & M. Koc.) [8].

Producers should face the challenge of a competitive market as price-quality. The quality levels they should reach require and enforce the utilization of inspection systems. The enterprises become more and more convinced that measuring the component parts in primary phases improves the product quality and diminishes the control time. The companies wanting to obtain the maximum quality should eliminate the errors systems. Although many preventing and control techniques were developed, they are rather inefficient. Effectively removing errors can not be achieved without a good understanding of their real characteristics. The mistake appears when a necessary action is not accomplished or is inappropriately accomplished, a forbidden action is performed or essential information is not available or is incorrectly understood. The objective of implementing Poka-Yoke in Indian industries is to remove errors before they present rejection. Shingo, a main manager of the Toyota Production System, introduced the concept of 'Poka-Yoke' in Japan, translated as 'mistake proofing' in English. His objective was to eliminate or minimize the requirement for inspection (which is believed as waste in lean philosophy) by eliminating errors before they occur rather than detecting and mending activities which simply make it fall under unfavorable category of "rework". In another word, mistake-proofing is an interference device to determine whether the product is of acceptable quality or not. Some simple examples of mistake-proofing devices exist in everyday life (for instance, the tethered gas cap which prevents you from leaving it behind, or a 3.5 inch diskette which can only be inserted if oriented correctly) . In production, mistake-proofing is implemented using simple objects like fixture, jigs, warning devices, color coding. For instance of color-coding, according to diameter, length and kind of application, the color of nails or screws can be varied in order to minimize the error occurrence. This method releases the worker's mind from concentrating which is necessitated to distinguish between nails or screws. Consequently, he/she can do their job with more confidence and calmness. In addition, the amount of time that workers spend daily on distinguishing the size of the nails and screws is a significant amount of time. This can be saved by applying the simple methods of mistake-proofing. (Sadri R., Taheri P., Azarsa P., Ghavam H.) [18].

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the machine and warning the operator if something is wrong. The anti-error devices apply in all the fields where equipment is involved and even in the offices and they are devices aimed at preventing and detecting the errors. At the same time, the Poka-Yoke concept may be implemented in other activity domains, such as selling, purchasing or developing products, where the errors cost can be very high. These mechanisms can be electric, mechanic, procedures, human or of any other kind able to prevent the inappropriate achieving of a process stage.

Each organization having implemented a quality management system and also plans and objectives recording in the improving strategy of organization should have intellectual capital resources which permitting for creating of quality processes and the same finished product. Management processes, their evaluation, monitoring and improving most assisted in eight fundamental principles quality management and quality: methods, tools and techniques. This form of management strategy of future organization calculated leading to increased efficiency of companies and preservation its position on the market. Thinking and action companies should be oriented to the processes to be included in the quality management system. The aim of Poka-Yoke method is to eliminate or minimize human errors in manufacturing processes and management as a result of mental and physical human imperfections. For the main part is to eliminate errors independent (so-called problem resistance to stupidity while-en. fool proof). The main idea of this method is preventing causes, which may result in errors and use relatively cheap control system for determining compliance of the product with the model. In the described organizations Poka-Yoke method in connecting with the quality methods ensure of high quality of produced engine elements, as well as by the continuous monitoring process all allow to minimize cost, and sharing not great effort to improve. Such behavior organization calls for effective implementation of the objectives which are compatible with the system both by the highest quality management and management as well as all workers. Use of Poka-Yoke requires strong basis in the overall quality management. Necessary are clear indications to distinguish between a defective and correct product and therefore company regularly carry out training crew. It should not be forgotten that the method Poka-Yoke requires an immediate reaction and the correction as well as a result in the operation. Errors arise from various reasons, but most of them can be prevented if only people are be able to identify the problem at the time of formation, define the causes and make appropriate corrective steps. Prevention of defects in the process before their appearance is the best way of defects reduction and thus reduce the costs. (Szewieczek D, Dudek-Burlikowska M.) [5].

A Poka-yoke device is any mechanism that either prevents a mistake or defect occurring or makes any mistake or defect obvious at a glance. It is the concentration on removing the causes of defects that is important. Poka yoke is a way to help people do things right the first time. It does not violate or negate good engineering practices. Instead, it expands on those practices to include ways to help people do the job right as well as quickly. One cannot prevent all mistakes, but can make it easier to do the job right, although mistakes will still happen. Instead of allowing processes to continue after a mistake has been made, Poka yoke could be used to stop them. Poka yoke is not a new concept. It has been used in the safety area for many years. What is new is to apply those concepts to areas of those processes outside of safety?

Mistakes-proofing involves a change in the mindset of an organization as first the belief that “it is unacceptable to allow for even a small number of product or service defects” must be promoted and accepted by the employees. The concept of Poka-Yoke can be applied to virtually every type of project by exploring ways to present how an activity is supposed to be done, make it impossible to do it incorrectly, or make it obvious (known) when it has been done incorrectly. Poka-Yoke devices are categorized by three attributes: Smartness, simplicity and inexpensiveness. Mistake-proofing also releases workers from tedious and Repetitive activities while giving them an opportunity to maximize their roles in building quality, in the process, by decreasing product deficiencies and the related cost of rework (Michael Fisher ) [3].

A Poka-Yoke device is a good solution for avoiding the errors when it presents the following characteristics:

- Can be used by all the workers;
- Is easy to fit up;
- Does not require the operator’s continuous attention (it would be ideally he ignores it);
- Has a low purchasing price;
- Reacts very quickly and prevents and corrects the error.

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## 2. METHODOLOGIES/ TOOLS/ TECHNIQUES

Under this step we are concerned to get various ideas from various researches that is already been done to get some insight about the topic. Following are the Methodologies/ Tools/ Techniques Identified from literature review:

**Table 2.1: Methodologies/ Tools/ Techniques Identified from Literature Review**

S. no.	Methodologies/Tools/Techniques	Researchers
1	FMEA, QFD, and SPC	(Pande P.S., Neuman R.R.) [6].
2	benchmarking, brains storm, Analytical Choice of Constructional Materials (ADMK)	M. Dudek-Burlikowska [10]
3	Statistical Process Control,	J. Michalska [12]
4	Poka-Yoke rules, Deming's rules, 5S	J. Paquin, J. Couillard, D. J. Ferrand, [16]
5	Zero Quality Control (ZQC)	J. Ketola, K. Roberts [25]
6	DFM (Design for Manufacturing) DFMA (Design for Manufacturing and Assembly) [2].	M. Koc and J. Lee [11]
7	CAD (Computer Aided Design) and CAM (Computer Aided Manufacturing)	R.K. Yin, [28]
8	VSM – Value Stream Mapping, DMAIC (Define, Measure, Analyse, Improve, Control)	M. Rother, J. Shook [4]
9	Quality System Final (QSF)	M. Sokovic, D. Pavletic, E. Krulcic, [17]

## 3. IDENTIFICATION OF ENABLERS AND BARRIERS IN IMPLEMENTATION OF POKA-YOKE IN INDIAN INDUSTRIES

### 3.1 Problem statement

It has been tried to find out various factors which support implementation of poka-yoke in Indian industries from the literature review and expert opinions. Literature was reviewed to identify factors to implement Poka- Yoke in Indian industries. Keeping the fact in to mind the any Poka- Yoke process cannot be successfully implemented until the enablers supporting the process are not identified. Enablers are the pillars which ensure smooth implementation of Poka- yoke process and if not identified with utmost care may lead to variance in result. The factors for the implementation of Poka-Yoke in Indian industries are: Quality of Raw Materials, Quality of Technological Design, Inspection and Examination, Brain Storming, Methods of Production System, Personnel Involved in Technical Process, Handling Complexity of Work, Training, Management Support, Cost Evaluation, Feedback Mechanism, Customer Relationship Management, Automation, Technology, Self-Service, Layout , Audit and Review, Color Coding. Computer Integrated Manufacturing, Quality Function Development, Benchmarking, Failure Mode and Effect Analysis, Zero Quality Strategy, Maintenance, Synchronization, Single Minute Exchange of Dies, Quick Change Jaw & Fixture Concept Design, Warning Device, Equipments and Environment, Software Tools.

Keeping the fact in to mind the any Poka- Yoke process cannot be successfully implemented until the barriers are not identified. Barriers are the obstacles which oppose smooth implementation of Poka- yoke process and if not identified with utmost care may lead to variance in result. The factors for the implementation of Poka-Yoke in Indian industries are: Difficulty in Change, Hostility, Fear of Job Loss, Old Ideology, Inappropriate and Ineffective Methods , Traditional Way of Working, Complexity in Planning, Too Expensive, Reluctant Top Management, Limited Feedback, Complexity of the Process, Design error, Lack of Training, Lack of homogeneity, Influence of Surroundings , Breakdown in Process , Wrong Parameters during Implementing, Inaccurate Service of Devices , Technological Error, Poor Control System, Lack of Monitoring, Discontinuity in Process, Inappropriate Staff Training , Lack of Technical Assistance, Lack of Knowledge about Poka-Yoke Methodologies,

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Insufficient Interdepartmental Communication , Difficulty in Identifying Process Parameters , Time Consuming, Internal Resistance, Lack of leadership from top executives.

## 4. QUESTIONNAIRE BASED SURVEY IN INDUSTRY

### 4.1 QUESTIONNAIRE BASED SURVEY

Questionnaire based survey was conducted in Keeping the fact in to mind the any Poka- Yoke process cannot be successfully implemented until the barriers are not identified. Barriers are the obstacles which oppose smooth implementation of Poka- yoke process and if not identified with utmost care may lead to variance in result. The factors for the implementation of Poka-Yoke in Indian industries are: Difficulty in Change, Hostility, Fear of Job Loss, Old Ideology, Inappropriate and Ineffective Methods , Traditional Way of Working, Complexity in Planning, Too Expensive, Reluctant Top Management, Limited Feedback, Complexity of the Process, Design error, Lack of Training, Lack of homogeneity, Influence of Surroundings , Breakdown in Process , Wrong Parameters during Implementing, Inaccurate Service of Devices , Technological Error, Poor Control System, Lack of Monitoring, Discontinuity in Process, Inappropriate Staff Training , Lack of Technical Assistance, Lack of Knowledge about Poka-Yoke Methodologies, Insufficient Interdepartmental Communication , Difficulty in Identifying Process Parameters , Time Consuming, Internal Resistance, Lack of leadership from top executives, company of various manufacturers where Poka- Yoke has been implemented. In this technique, the factors important Poka- Yoke were listed and the persons responsible for Poka- Yoke were asked to rate the factors from 5 to 1. These results were then collected and ISM was being applied to these factors.

Questionnaire survey method was selected following the previous study to evaluate the importance of the Enablers and Barriers that have been found through literature review. A postal survey questionnaire was used as the research instrument. The questionnaire is focused on the importance of Enablers and Barriers that clarified from literature review. It identifies the respondents' perception of the importance of Enablers and Barriers in the Poka- Yoke implementation process. For each of these factors, a number of elements or statements were formulated through the definition and description of each one in the literature. The respondents were asked to rate the degree of importance of each. Enablers and Barriers in the Poka- Yoke implementation were rated based on a 5-level Likert scale. The rating scale ranged from: '1-Not Important, '2-Moderately Important, '3- Important, '4-Very Important, '5-Most Important. The target respondent in each firm was the chief information officer (CIO), the director of MIS, IT Manager or any person responsible for Poka- Yoke process since they are directly involved in Poka- Yoke process.

### 4.2 DATA COLLECTION

This data collection is an empirical study on Indian Manufacturing Industries that are running Poka-Yoke system. An extensive search was conducted in literature available in the libraries, journals and internet to find Indian Manufacturing Industries that have implemented a Poka-Yoke system. Hence many academicians, practitioners, ERP providers, Professionals from industry were contacted. Out of the 110 sets of survey instrument distributed, 57 usable responses were received. Regarding to this fact the survey response rate is 51.8% .The population may be categorized as follows:

#### 4.2.1 On the basis of Gender

- a) Male - 93%
- b) Female -7%

#### 4.2.2 On the basis of Occupation

- a) Service– 94.5 %
- b) Studying– 5.5 %
- c)Self Employed- Nil

#### 4.2.3 On the basis of type of Industry

- a) Automobiles - 40%
- b)Fasteners – 30%
- c)Information Technology - Nil

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- d) Chemical–5.46 %
- e) Grocery - Nil
- f) Textile - Nil
- g) Power Generation & Distribution -10 %
- h) Electrical -4 %
- i) Electronics - Nil
- j) Refrigeration & Air-conditioning - Nil
- k) Food Industry - Nils
- l) Education –10.54 %

### **4.2.4 On the basis of Scale of the Company**

- a) Small– 4 %
- b) Medium - 36%
- c) Large -60 %

### **4.2.5 On the basis of Annual Turnover (in rupees crores)**

- a) Less than equal to 10–3.6%
- b) Above 10 to 50– 13.6 %
- c) Above 50 to 100–17.2%
- d) Above 100 to 500 - 22%
- e) Above 500– 43.6 %

### **4.2.6 On the basis of Company**

- a) State Owned (Government) -0.35 %
- b) Private Sector–67.2 %
- c) PSU – Nil
- d) Joint Venture – 32.45%

### **4.2.7 annual income**

- a) 0 -2 lacs – 30.9%
- b) 2-4 lacs – 50 %
- c) 4-6 lacs – 14.5%
- d) 6-8 lacs – 4.5 %
- e) 8- 10 lacs – Nil

### **4.2.8 On the basis of Awareness level**

- a) Yes - 100%
- b) No - Nil

## **5. RESULTS AND DISCUSSION**

The general aim of this thesis work is to study the effectiveness and difficulties encountered in the manufacturing company during the production process. Poka-Yoke (P-Y) Techniques implementation and also the major success factors that contribute to the implementation of product quality and less wastage of product and less time consume and better quality product achieved shortly. The objective of this thesis work is to study the implementation of P-Y technique in the Indian manufacturing companies and the evaluation of its result. There are various manufacturing industries in which the technique is used. If I consider the case here, then the front-end machine used for productivity implements the concept of P-Y Techniques and there is a manifold increase in the productivity. With the help of the Poka-Yoke activities performed, in this case by the team and equipment effectiveness enhancement there was an improvement in overall productivity. The

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intangible benefits resulted from the change of organizational culture, change of paradigm for production people in realising the importance of Poka-Yoke activities and the relationship between Poka-Yoke, productivity and quality.

## 5.1 Implications of the study:

This case study employed P-Y techniques methodology to improve equipment effectiveness as well as the technical skills, morale of members participated in P-Y implementation. This was not the first attempt that the company in this study implemented P-Y techniques but, ultimately, the company succeeded to do so in the front-end process. It is foreseeable that once a particular process P-Y techniques adapts to the new philosophy, others processes can also be reengineered to achieve the aims of P-Y techniques. When all the labour force or employees or work force learn and P-Y techniques are implemented, then there is a lesser need for a Poka-Yoke team.

## 6. FUTURE SCOPE OF POKA-YOKE (P-Y) TECHNIQUES

1. The methodology of implementing P-Y Techniques is flexible and industries have to use some decision factors or guidelines in the development of a Poka-Yoke Techniques implementation methodology best suited for their industries as per their specific requirements.
2. It will be to learn more in a professional manner about P-Y Techniques initiatives and finally provide consultancy in implementing P-Y Techniques in the small/medium type industry.
3. Poka-Yoke Techniques has been proven to be a program that works. It can be adapted to work in industrial plants. The suitability of P-Y Techniques in this area can also be the part of future research.
4. It may develop modeling using appropriate techniques like Interpretive Structural Modeling and Structural Equation Modeling (SEM).

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