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**Department of Computer Science**

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| Q.1 |  |  |  |
|  |  | Study some Case Studies for software maintenance and maintenance costs and write summaries of these case studies  Answer  (Reference of Case Studies are given at the end of document)  **Summary of Case studies of Software Maintenance**  **Summary of Case Study[1]**  Importance of maintenance Software maintenance has become one of the most important concerns of the software industry. The maintenance of software has a significant importance to keep software operational and fulfils the needs of its user. We can consider the importance of software maintenance by the following example; Airbags are used in auto vehicles as a safety instrument which works under highly sensitive software which put it into action. But with very minor software negligence in detecting the input parameters can cause severe loss of precious lives. Basically the system should be deployed within well time as the vehicle bump with any external object to save the rider being injured. Reliability Understandability Testability Modularity Expandability S/W Quality Attributes Maintainability Volvo had to recall 65,000 cars due to airbag’s software problem. Euro NCAP is a European automotive testing authority which found that problem in Volvo products and then Volvo had to re-examine the robustness of the airbag’s software and release the cars after maintenance [1].  . From the above example we can realize the importance of software maintenance; it would be a massive loss for Volvo if there were no software maintenance.  **Summary of Case Study[2]**  In order to avoid early death software system should have the ability to evolve. Software can be considered as a moving target as the environmental requirements are continuously changing so “maintenance” should be performed continuously. The impulse behind software maintenance has numerous reasons which are necessary to keep a system in a working condition and updated according to the user requirements. The first major aim of it is to endow with stability of services which can only be carried out with the help of maintenance. Maintenance might be done to fix the bugs, to prevent it from the risk of failure and to make changes in it if hardware is changed. Maintenance is required whenever a change is needed to update the software for government rules and to accommodate competitor products. Sometimes the requirements of user changes and there is a need to update the software to accommodate the software accordingly. There could be several reasons behind these requirements i.e. improvement in the functionality, improved performance and to make it according to operational model. Updation in the documentation, change in the code and databases is needed sometime so maintenance should be done to handle these problems [2].  **Summary of Case Study[3]**  Maintenance is classified into four major categories, which are given below. The purpose of categorizing maintenance is to answer why the maintenance is must require. As the different diseases have different cures and without a proper diagnosis of a disease the doctor is not able to write the proper prescription. Similarly before heading towards the process of maintenance proper understanding of each type make the maintenance easier and appropriate. Hence, we should have to know in which criteria the system lies. Then we can follow what kind of maintenance should be performed on the system. There are different classifications of the maintenance activities in the literature. According to IEEE standards, maintenance activities can be categorized into four major classes (corrective, adaptive, perfective and emergency maintenance) depending upon the nature of four types of maintenance are (corrective, adaptive, perfective and preventive maintenance.   * **Corrective maintenance**   It is a correction of the faults and errors in the software after the delivery that has not previously been exposed. The reason of the defects might be design errors, logic errors and coding errors.   * **Adaptive maintenance**   Adaptive maintenance is done when the requirements or the environment of a program has changed i.e. operating system or hardware. The term environment refers to all the circumstances which act on the system from outside.   * **Perfective maintenance**   This kind of maintenance deals with rapidly changing user requirements. As the name shows it makes system more perfect both from functional (performance) as well as well as nonfunctional requirements (user interface). Success of a software system is not based on the success of its first release but the users just for experiment try to extend the system’sfunctionality along the direction for which it was not initially designed so in result they identify the new requirements for the system. The maintenance activities that are used for this purpose are known as perfective maintenance.   * **Preventive maintenance**   This type of maintenance activities are performed to mitigate the future potential threat of malfunction and to enhance the maintainability of the system by updating documentation, adding comments, and improving the modular structure of the system. Studies show that corrective, adaptive and perfective maintenance activities increase the system’s complexity. As the understandability and complexity are inversely proportional to each other so there should be some way to sort it out, so this work is known as preventive maintenance. It should be noted that for the three types of maintenance to be done correctly, both the documentation (e.g. requirements specifications, design specifications, test plans) and the code must be changed so that the code and documentation remain consistent with one another [3].  **Summary of Case Studies of Maintenance Cost**  **Summary of Case Study[4]**  Software has become more expensive as compared to the hardware due to the growing demand of the former as compared to the latter [4]. Software maintenance is a time consuming act i.e. there are many steps involve to perform reliable maintenance as understandability of the structure, comprehension of code, behavior and functionality of existing software are very time taking actions. Time and cost are highly related to each other because; as much time software takes to be operational the level of cost will obviously go up.  **Summary of Case Study[5]**  Many researches has been done and many well-known method of software engineering has been explored, one might anticipate that the cost of maintenance would be decreasing but unfortunately they could not bring an efficient decrease in the maintenance cost . Software maintenance was considered to be ‘iceberg’ as there are large numbers of potential problem and cost dwells beneath the plane. Many researches has been done to find out maintenance cost though the results show a discrepancy but almost 60 to 80 % of the total SDLC’s cost is consume for maintenance [5].  **Summary of Case Study[6]**  As maintenance is a time consuming act and employment of Cost for different types of maintenance is different. 20% of the total cost is used to do corrective maintenance, adaptive maintenance takes almost same time as corrective does i.e. 25 % and the most cost consuming type of maintenance is perfective one which takes 50% of the cost. The ratio of timing given above differ with different software depending upon some factors i.e. proficiency of maintenance workforce, environment and nature of associated documentation. There are number of reasons that are always there to make the process of software maintenance more expensive. They are as follows:   * Software Development team stability * Contractual responsibility * Maintenance Staff Skills * Program age and Structure   According to him the long term solution is to accept the universal truth that software has rarely defined lifetime. Schneidewind also highlighted that myopic view that maintenance is a post delivery activity is also a source to make maintenance harder [6].  **References**  [1] M. Krigsman. 16 November). Volvo recall due to airbag software problems.  Available: <http://blogs.zdnet.com/projectfailures/?p=727>  [2] P. A. G. Armstrong A.Takang Software Maintenance Concepts and  Practice. London: International Thomson Computer Press, 2003.  [3] IEEE, "IEEE Standard for Software Maintenance," ed: Software  Engineering Standards Committee of the IEEE Computer Society, 1998.  [4] A. Bryant and J. A. Kirkham, "B. W. Boehm software engineering  economics: a review essay," SIGSOFT Softw. Eng. Notes, vol. 8, pp. 44-  60, 1983.  [5] G. C. a. A. Cimitile, " Software Maintenance," Faculty of  Engineering at Benevento, University of Sannio, Benevento Italy.  [6] N. F. Schneidewind, "“The State of Software Maintenance”," in IEEE  Transactions on Software Engineering,, pp. 303-310. |  |

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