

Investigation of 3D Modelling and Virtual Reality Systems in Malaysian Automotive Industry

Maryam Mousavi*, Faieza Abdul Aziz and Napsiah Ismail

Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

*mousavi.maryam@gmail.com

Abstract - Automotive industry uses virtual reality (VR) and three-dimensional (3D) modelling at different stages like many other industries in the world. To choose the right technology for the right purpose, it is crucial to identify the existing technology used, their benefits as well as barriers. Six automotive manufacturing companies in Malaysia were selected as case studies for this work. Investigation was performed on 3D and VR technologies used. A total number of 240 questionnaires were distributed between selected automotive industry and 153 people responded to the questionnaires. Frequency analysis was conducted followed by t-test on the respondents' answers. Based on the questionnaires, this research identified and analyzed the opportunities of 3D and VR in the industry and their constraints. The results showed that 70.6% of the respondents used 3D modeling and 38% of respondents used VR in their organization at present. It was also found that 'reducing rework' and 'improving quality of manufacturing' are the two most common advantages of using VR technology. 'Lack of knowledge', 'lack of trained people' and 'time to get proficient' are three major barriers for adopting with new technology such as VR. It is concluded that the benefits of using 3D modelling and VR outperformed the existing barriers.

Index Terms - 3D modeling, analyze, virtual reality, opportunity, constraint, benefit, barrier, Malaysia, automotive industry, manufacturing

1. Introduction

Production of automotive in Malaysia earns so many benefits for Malaysian economic. Compared with other industries in the manufacturing sector in Malaysia, the automotive industry has been assigned to boost the industrialization process so that Malaysia can be a developed nation by 2020[1].

Many researches have been carried out regarding the use of 3D models and VR in automotive industry. Dani et al. [2] in their research have shown the advantages of real-time interaction, stereo visualisation, and a specific 3D interface in the early stages of design. Choi and Cheung [3] proved that VR system is an easy-to-use and cost-effective tool for visualization and digital fabrication of multi-material prototypes to facilitate product design review and improvement. It is important to conduct the research on VR and 3D used in industry to have a complete overview of the technology for the industrialists, researchers and developers. For deciding about using technologies, first should analyse the existing technologies, then it can be easier to decide regarding the improvement of the existing technology or not. This research is focused to give a clear picture about the use of VR and 3D in automotive manufacturing industry and analyse the

existing 3D and VR systems, also identify the opportunities of 3D and VR and its constraints.

2. Materials and Methods

Subjects. Six automotive companies in Malaysia were selected for this study. Field data were collected by: (1) Survey interviews, and (2) Focus group interviews. Survey interviews were performed by questionnaire. Forty questionnaires were randomly distributed among the employers of each company. This (number forty) was selected based on normal distribution purposes [4]. As focus group interview considered as purposive sampling [5], four groups consist of five people considered for focus group interview [6, 7]. Secondary data were also used in this research, which were gathered from different sources such as databases, books, websites, and the monthly, quarterly, and yearly industry reports.

Questionnaire design. A structured questionnaire has been designed to cover the objectives of the research [8]. Section A in the questionnaire was meant to obtain the Primary information of respondents, Section B concentrated on the existing 3D and VR. Reasons, barriers and benefits of using 3D and VR in the company were also evaluated [7]. Pilot study was performed where two statisticians from UPM and Boobalishina University of Iran had reviewed it before it was distributed among the industry practitioners.

3. Results and Discussion

In this study, t-Test [9] is used to test the association between the average use of 3D and VR technology. After analyzing the demographic part of the questionnaire, it was found that 70% of respondents were male and 30% were female. 92% were university graduates and the rest were diploma/college graduates. The highest number of respondents (30.1%) was having 5 to 10 years working experience. Respondents were executive, engineering management officer, manufacturing designer, software engineer and others.

Existing 3D Modelling. This section reviews many aspects of 3D modelling application in the industry like different existing software, barriers and opportunities of 3D modelling etc. Respondents of five companies out of six have stated the use of 3D modelling in their company. One company declared that they are not using 3D modeling because of not being involved with R & D in their branch at all and other branches located in overseas used 3D modelling.

Descriptive statistics showed that every respondent is using at least one software in their daily works. CATIA and XVL software were used mostly amongst five studied companies. A few of respondents also have mentioned six other software(s) which are AUTOCAD, CAELUM, ‘Generative shape design’, freestyle’, Hyperworks, and Star ccmt.

Many options have been stated as a reason for using a 3D software in the questionnaire including ‘user friendliness’, ‘project management capability’, maintenance, lifecycle related issues, marketing and client request. Among these options, two of them were more pleasant to the industry respondents, which are ‘user friendliness’ and ‘project management capability’. These two are highlighted to be the main reasons in the application of 3D software(s). The descriptive analysis of the questionnaire simply shows that any part of design section (‘preliminary design’, design, and ‘advanced design’) are more important sections than other stages among the all surveyed car companies for 3D modelling application. Due to the importance of the designing section in automotive industry, it was anticipated that the industry responses might highlight the application of 3D modelling in any part of designing phase and it was found to be a true expectation according to the previously mentioned results. Highest percentage of employing 3D modelling at different activities of projects goes to ‘engineering and manufacturing’, ‘design and manufacturing layout’, and ‘car style modelling’ activities.

Existing VR Systems. A general overview of the car companies based on the survey results showed that five out of six companies use VR in their organisation. The company which does not use VR is the same company that does not use 3D with the same reason. After analysing all questionnaires, it was found that XVL, CATIA and ALIAS Studio software are the most used software by the companies and a few of respondents also mentioned they use other software such as Polywork, 3D Magic and OPUS Realiser. The most important reasons behind using above mentioned software are “user friendliness” and “Project management capability”. The case study companies used VR systems in various stages. It is necessary to find the stage where VR systems need to be employed. This questionnaire found that VR is utilised at various sections of manufacturing such as design, ‘advanced design’, and ‘simulation’. This can show the importance of these processes at manufacturing system (refer to Figure 1).

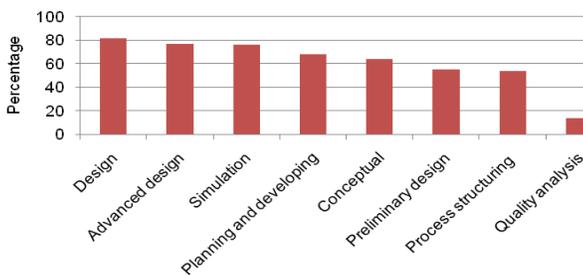


Figure 1: Percentage of Using VR in Different Stages of Projects in Automotive Industry

Car companies’ respondents’ answers regarding the VR application in different project activities reveal that ‘car style modelling’ and ‘interior and exterior design’ activities are most common activities of a project, which use VR in the companies. It is illustrated that various project activities are using VR but it differs among different companies (refer to Figure 2).

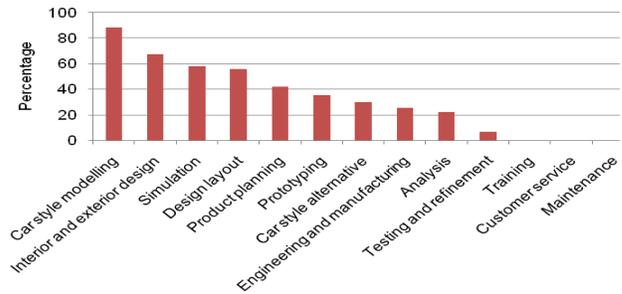


Figure 2: Percentage of Using VR in Activities of Projects in Automotive Industry

Comparison between 3D and VR Technology. The descriptive analysis of the questionnaires showed that 70.6% of the respondents mentioned that they use 3D modelling. On the other hand, 38% of respondents replied that they use VR at present. This result in accordance with research findings conducted by [10] demonstrated that virtual reality application is still in its infancy in industrial context. The studied companies utilize different technologies, some employ 3D and some VR but the application of both technologies is also reported in the responses. Based on the previous descriptive statistics, the average use of 3D and VR technology is tabulated in Table 1.

Table 1: Average of Using 3D and VR

Technology	Respondent (n)	Sample mean (μ)	Standard deviation
3D	97	59.38	28.05
VR	32	38.13	25.80

n = the number of respondents that have mentioned the utilisation of each variable (3D/VR),

μ = the sample mean that is equal to average use of each technology, and in the last column, the standard deviation of the samples are given.

Therefore, the hypotheses may be defined as,

H_0 : there is no significant difference between the average use of 3D and VR technology,

H_1 : there is significant difference between the average use of 3D and VR technology.

Based on Table 1 and t-Test statistic, the hypothesis is statistically examined. The analysis of t-Test revealed that the corresponding p-value is equal to 0.01, which is less than 0.05, and null hypothesis is rejected. Therefore, there is a significant difference between the samples mean, and the use of 3D is

significantly higher among the respondents of different companies than VR. The descriptive analysis of questionnaire already showed that the automotive industry use 3D more than VR technology. This is due to the novelty of VR and the fact that it takes time for the industry to adopt with new technology.

Cost Effectiveness of Using VR. One of the items in the questionnaire that have been asked from the industry practitioners is the cost effectiveness of VR technology. The responses analysis demonstrated that above 90% of users of VR have mentioned that VR application in industry is cost effective. According to the advantages of VR technology reviewed in the literature, it was expected to receive such a high agreement on the cost effectiveness of VR [11].

Opportunities and Constraints of VR adoption. Multiple responses were offered under the category of ‘barriers of using VR systems’ to the respondents. The analysis done on the industry responses showed that the ‘lack of trained people’ is one of the major barriers of adopting with new technology such as VR. The next obstacles highlighted by all companies are ‘time to get proficient’ and ‘lack of knowledge’.

The above stated explanations are general understanding about barriers of using VR. However, questionnaire responses showed that software cost and hardware cost are another notable barrier for the domestic companies, but it is not a barrier for the overseas companies. This difference can be referred to the fact that, investigated overseas companies in this research are among the largest car manufacturing companies in the world with many branches at different countries and better investment power compared with studied Malaysian domestic companies [12]. In contrary, it was stated earlier that respondents believe that using VR systems is cost effective. This statement has no contradiction with the above-discussed barrier, which is the cost in VR adoption in domestic manufacturing industry. It is clear that cost effectiveness is a long-term process and companies can be benefited from VR adoption after the investment for the initial costs such as installation, hardware, and software. Therefore, companies that cannot afford the investment cost at the first place, would find that it will become a barrier for them to adopt with new technology [11].

Plenty of advantages of using VR systems have been highlighted among the studied automotive companies. The analysis done on the industry responses demonstrated that there are some main benefits in using VR at each company but the ‘reducing rework’ and ‘improving quality of manufacturing’ are the two most common options replied by the respondents as advantages of using VR technology. Bordegoni et al. [13] with an experiment have shown that using VR is more beneficial than using typical CAD environments. Ottosson [14] has also reported that VR application has been beneficial for saving time (by reducing rework) and cost (refer to methodology).

4. Conclusions

A general view of the current usage of VR and 3D modelling in industry based on the descriptive analysis of the

questionnaires shows that 70.6% of the respondents used 3D modelling, whereas VR application is used by 38% of them. Among VR systems ‘visualisation system’ contributes the highest percentage. XVL digital manufacturing software is the most commonly used VR software. Based on the industry questionnaire, being user friendly, facilitating and improving the project management technique capabilities are among the most important reasons for the application of XVL in VR technology and 3D modelling. VR softwares have shown wide range of benefits in the sections of ‘designing’, ‘advance designing’ and ‘simulation’. Moreover, industry responses reveal that using VR is extremely useful for ‘car style modelling’, ‘interior and exterior design’ and simulation. In terms of constraints of applying VR to the industry, it is indicated that the most important obstacles are, ‘lack of trained people’, ‘time to get proficient’ and ‘not having enough information’. In addition, according to the results of the study, it can be highlighted that ‘reducing the rework’, ‘manufacturing quality improvement’, and being ‘easy to plan and making decision’ are opportunities of using VR technology in the automotive industry. In general, feedback from companies indicates that the benefits of using 3D modelling and VR outperform the existing barriers.

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