

Virtual Training in the Police Domain

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Abstract

Dubai Police has employed cutting-edge video game technologies to create innovative virtual incidents ranging from crime scenes to traffic accidents to hostage scenarios in an engaging way that mimics real-life situations to allow the trainee to learn-by-doing to harness his skills in a safe and practical environment. The importance of such an innovative approach has been realized early on to enhance and support the traditional methods employed for learning and awareness. Over many years, Dubai Police researched and developed many virtual environment prototypes with a large portfolio of virtual environment products to reach the current state. These products have been replicated in different fields and are shaping up a technological transformation for the methods used in learning and awareness in the Police domain and beyond. Additionally, these products have been used and recommended nationally, regionally, and internationally. It is essential to highlight that all of these products have been developed in-house using Dubai Police personnel within the Virtual Technology Centre in Dubai Police and cover the four strategic goals of Dubai Police.

Keywords: Virtual; Simulation; Law Enforcement; Video Games.

1. Introduction

Dubai Police has employed cutting-edge video game technologies to create virtual incidents ranging from crime scenes to traffic accidents to hostage scenarios that require SWAT planning and intervention in an engaging way that mimics real-life situations to allow the trainee to learn by doing to harness his skills in a safe and practical environment. Dubai Police realized early on the need for solutions to enhance and support the traditional methods employed for learning and awareness. Over many years, it researched and developed many virtual environment prototypes with a large portfolio of virtual environment products to reach the current state. These products have been replicated in many different fields and are shaping up a technological transformation for the methods used in learning and awareness in the Police domain and beyond.

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The technological development in general and the evolution of video game technologies and applications led to a noticeable gap between two generations, a generation that grew up with technology and is called the generation of "digital natives" and a generation that grew up before the advent of technology and is called the generation of "digital immigrants". Each generation has its own characteristics and its favorite ways of learning. Prensky [1] said that digital natives are those born after 1974. He summarizes the differences between them and digital immigrants. He also noted that the average college student spends less than 5,000 hours of their life reading, compared with 10,000 hours spent on video games and 20,000 hours watching television. This surge in game utilization is a disruptive technology since it challenges the existing expertise and practice, requires new skill sets, and demands organizational change [2]. The change in the characteristics of the digital natives is evidence of this disruption which has increased the pressure on the dominant educational delivery mechanism: the lecture. The disruption also affects the teacher by changing the learning from teacher-centered to player-centered [3]. This changes the role of the teacher when using games from being an agent transmitting knowledge to becoming a promoter who enables learning [4].

The use of serious games dates back to the 1980s when Battlezone was used for military training. However, the interest in serious games has only lately been accelerated by the increased interest shown by the U.S. Department of Defense (DOD) in video games technology [5] and initiatives with more than a military focus such as the Serious Games initiative, International Simulation & Gaming Association, North American Simulation, and Gaming Association. Definitely, computer games companies today see serious games as an additional activity that is commercially viable and makes use of their present expertise. Though, this connection with games companies is conceptually too limited, although most definitions do agree that serious games involve the use of gaming technology for purposes more than entertainment. In the military domain, the technology was used to train different skills such as rifle range and obstacle courses [6], leadership, and tactical experience [7]. It is also used in health domains such as therapy and training procedural skills. Moreover, serious games were used in teaching physics, mathematics, and history.

The Police domain is still far behind in the use of virtual technology in training. Most of the examples found use video-based simulations, and there is a lack of empirical study, as was shown by a report conducted by Bennell and Jones [8]. Despite an exhaustive search and two decades of video-based simulations, the report found that the documentation of their effectiveness was scarce. The report only managed to find four studies that used simulations for police training. This shortage can be explained by the high cost of using the video in training because it requires representation staff, photography staff, and others, and the difficulty of changing the scenario, which usually involves re-filming of the scene and there is no complete freedom for the trainee to explore what he wants due to limited scenes [9].

The use of serious games represent a feasible option that not only appeals to the new generation of police recruits, but has shown its ability to address a number of issues facing current training methods at the Dubai police force. The current traditional training methods within the organization are non-interactive learning (Passive learning). Interactive learning depends on learning by doing and forcing the learner to employ several senses compared to passive learning, which depends on a single sensory channel (hearing) that assumes learners' perceptual and intellectual uniformity. The shortcomings of passive learning can be summarized in five points

(see Figure 1): the first point is that the ideal learning situation must be customized to the very specific needs of the learners, but in the case of lectures, it is a one-size-fits-all approach which ignores the individual's learning style. The second shortcoming is the lack of immediate feedback. The third is that it fails to allow active discovery and the development of new kinds of comprehension. The fourth is the lack of motivation which undermines engagement. The final shortcoming is linked to its failure to ensure that the concepts and procedures are committed to long-term memory, which makes them available thereafter for the analysis and interpretation of real-world experiences. All of these factors have made it essential to search for more suitable learning methods that provide a safe and practical environment for the trainees.

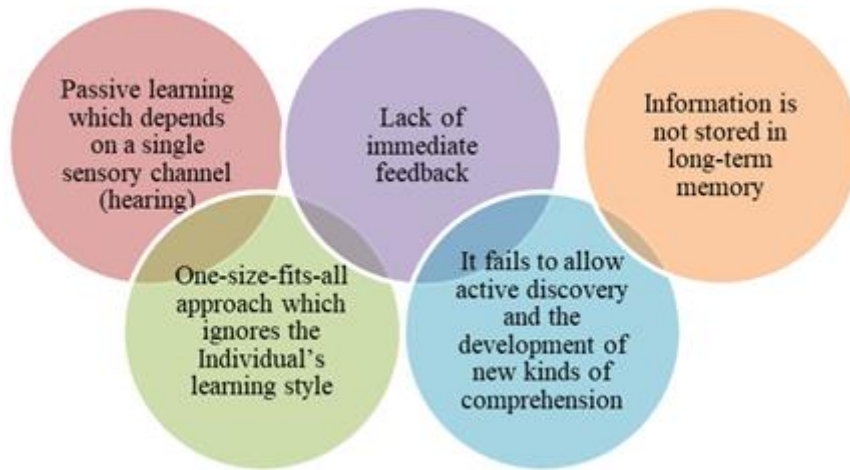


Figure 1: Theoretical Education Problems.

2. The infrastructure

A feasibility study, which included a 52-page report of the study, five years plan, and a detailed breakdown of HR, IT (software & hardware), and budget requirements, were submitted to the commander of Dubai Police. The commander-in-chief of Dubai police ordered the establishment of the Virtual Technology Center. The first implemented project was Traffic Accident Investigation (TAI) and then replicated to other fields such as crime scenes, SWAT, body language, and many others fields.

We use the latest game engines available in the market, such as Unity3D and CryEngine. Some of our serious games are created using CryEngine. CryEngine is the same engine used in creating most of the top games globally, such as the Crysis game and the design of the AVATAR movie. This movie is characterized by the possibility of producing the highest quality in the design of three-dimensional models. Using the Unity3D game engine allowed us to target different operating systems such as Android, iOS, and Windows devices. We equipped our training halls with the top gaming PCs to support our high-end games. We are also using motion capture and Render farm to speed up the development process. We use the latest smart devices to test our developed games to ensure they work on different devices. We are also using the latest virtual glasses such as Oculus Rift and HTC Vive to add a better feeling for the trainees.

Our virtual training products have been developed in-house using Dubai Police personnel (25 personnel including admins, project managers, programmers, scenario writers, analysts, artists, and animators). Dubai Police has also managed to build a human resources capital that has gained a wealth of expertise for using video game technologies to produce serious games that effectively solve many different needs.

3. The challenges

You cannot always place trainees at the scene because of safety issues, environmental concerns, or security reasons, so we are making the police force learn how to deal with potential crime scene situations with virtual technology testing officers in the virtual world helps them overcome routine mistakes. These games help trainees to make the transition to reality. Gaming also lets trainees make mistakes, which can otherwise be costly in the real world. Besides their own instincts, players can use many tools. They can use a measuring tape to size up car skid marks; snap pictures of impact points; collect samples like glass pieces for lab tests; use flashlights and even call a police operations room. Their performance is tracked. More importantly, the progress of individual cadets can be tracked from initial intake to graduation, meaning cadets who fall short in one area can brush up on their policing skills before they receive their first real-world call.

The practice has been validated through a rigorous approach during two phases: first during the research and development phase with 19 refereed publications (in many counties: UK, USA, Spain, France, Jordan, Poland & Belgium) and many practical prototyping experiments over five years. The second phase was during deployment with many quantitative and qualitative training results validation. Implementing the virtual training technology in Dubai Police started with TAI and then replicated in other fields such as crime scenes, SWAT, body language, and many other fields.

The developments are done by cooperating with specialists in the fields. For example, we coordinated with specialized people in crime scene investigation to develop a Crime Scenes Investigation 3D virtual application. Clients are engaged through the whole development process, and many focus groups are held during the development process. For example, to develop the first virtual training program, a field study was conducted to better understand the traffic investigation field. The field study was divided into two phases: knowledge acquisition and preliminary experimentation. The main objectives of the knowledge acquisition phase were to understand the investigation process better and identify the instructional problems facing current training in the Dubai police force, which consists mainly of lectures and on-the-job training. The objective of the preliminary experiment was to examine the suitability of using serious games to teach traffic investigation. The preliminary experiment compared the use of a multiplayer serious game against the use of tabletop training. The results helped in identifying what the virtual training program must focus on and in getting a feel for the acceptance of such technology in the Dubai police force. An experiment was conducted to measure the effectiveness of TAI as a training tool and to analyze its suitability to address the issues facing the Dubai police force. Fifty-six participants were selected randomly from traffic investigators in the Dubai police force (see Figure 2). Analyzing the performance in Table 1 shows that both trained groups (novices-B and experienced-B) have managed to improve their performances by 36.17 and 23.54, respectively. These results confirm that the training condition managed to improve performance significantly. The results helped in identifying what TAI must focus

on and in getting a feel for the acceptance of such technology in the Dubai police force. Therefore, TAI was developed in response to the needs and has learning objectives to provide an environment that resembles a real traffic accident investigation that is practical in nature and varies in complexity.



Figure 2: The experimentation part of the field study.

Table 1: Average performance score and improvement.

Group A (Control)	Pre-test			Post Test	Change
Beginners A	37.25	Without Training		39.07	1.82
Experienced A	49.33			47.34	-1.99
Group B (Training)	Pre-Test	Training Session 1	Training Session 2	Post Test	Change
Beginners B	40.04	30.97	76.11	76.21	36.17
Experienced B	51.86	36.01	67.38	75.4	23.54
Average	45.95	33.49	71.75	75.81	29.86
Difference	11.82	5.04	8.73	0.81	12.63

One of the limitations of this experiment is not verifying that training transfer would be carried out to real accidents.

The study conducted has shown the amount of transfer but will that be maintained and, more importantly, will it be applied in a real accident? The subjective comments from the participants in the experiment and the narratives from people used in testing TAI provided a strong sign that this may be the case. However, that has not been proven.

As all developments are done internally, all costs are controlled and planned. Each project has its whole executing plan, and the plan is beaked down to sprints. Each sprint is a two-week task.

The Scrum process Methodology is used, which ensures continuous improvements through small changes. Scrum helped with repeatability & quality by allowing us to maintain focus through set guidelines and processes and improving staff productivity efficiency.

4. How the initiative was received by the users or participants

Our serious games are available on PCs in the training halls, provided to trainees on smart devices, and Dubai Police App Store. These allow the trainees to have training at any time and at their convenient time. Let us take, for example, TAI and Crime Scene Investigation (CSI). TAI Trains police personnel on how to investigate various types of traffic accidents by giving the trainee the ability to carry out the investigation procedures in which they play the role of the investigating officer. The trainee has to deal with injured people, secure the scene, question witnesses, divert traffic on roads, and deal with evidence. TAI has been implemented in many courses provided by the traffic institute in the General Department of Traffic. It has been adopted as a way of training for the fourth-year cadets at the Dubai Police Academy.

Crime Scene Investigation (CSI) (see Figure 3) provides a virtual training environment to simulate a crime scene to help the trainee experience investigations by carrying out various tasks similar to real crime scenes. He accomplishes that by carrying out different tasks such as traveling to the crime scene, securing the crime scene, searching for evidence, communicating with the dispatcher, and requesting forensic experts and additional support units. CSI has been implemented in many courses and has been adopted as a way of training for the fourth-year cadets and the criminal investigation diploma "Detective Program" adopted by the Dubai Police Academy.



Figure 3: Crime Scene Investigation (CSI).

5. The learning outcomes

Our products cover all four strategic goals of Dubai Police and range across ten different security & awareness topics servicing most of the 20 general departments and, all ten police stations, and more than seven other organizations.

We use Kirkpatrick's model to evaluate training. Kirkpatrick's model consists of four levels: Reaction, Learning, Behavior, and Results. Reaction measures the participant's satisfaction with the training program. Kirkpatrick notes that if their responses are not positive, they will not be motivated to learn. But if their responses are positive, It is not certain that they have benefited, but this increases learning opportunities only [10]. The

learning level measures the extent of knowledge and skills development and is measured in the scope of the training session. The behavior level is measured in the scope of work after completion of the training and measures the level of knowledge and skills transferred to the workplace.

The results level measures training from the organization's perspective to see the return on investment in training. Results include increased productivity, improved quality of knowledge and performance, reduced cost, etc.

We use Kirkpatrick's model as the following:

- Level 1 Reaction is evaluated through interviews and questionnaires, and it is a measure of customer satisfaction. We provide forms for the people to fill out at the end of a class or workshop, and this is used as an instrument for measuring Level 1.
- Level 2 Learning is evaluated through pre and post-tests, and this is used to measure learning and the increase in knowledge as the result of attending a program.
- Level 3 Behavior is evaluated through Observations (transfer of knowledge, skills, and/or attitudes from training to on the job). This is used to measure the extent to which a change in behavior has occurred as the result of attending a virtual training program.
- Level 4 Results: Performance-based KPI (On-the-job evaluation using control groups). This involves measuring the final results that occurred as a result of attending a virtual training course.

The solution has a reasonable learning impact that has been proven in the classroom and in the field (see Figure 4). For example, in the field of crime scene investigators, crime scene investigators who trained using virtual environments performed better in real cases than those who didn't by an average of 57.2% (evaluated on 17 tasks on real crime cases). Moreover, for crime scene investigation, the group's performance who trained using Crime Scene Investigation virtual program increased by 32.8%.

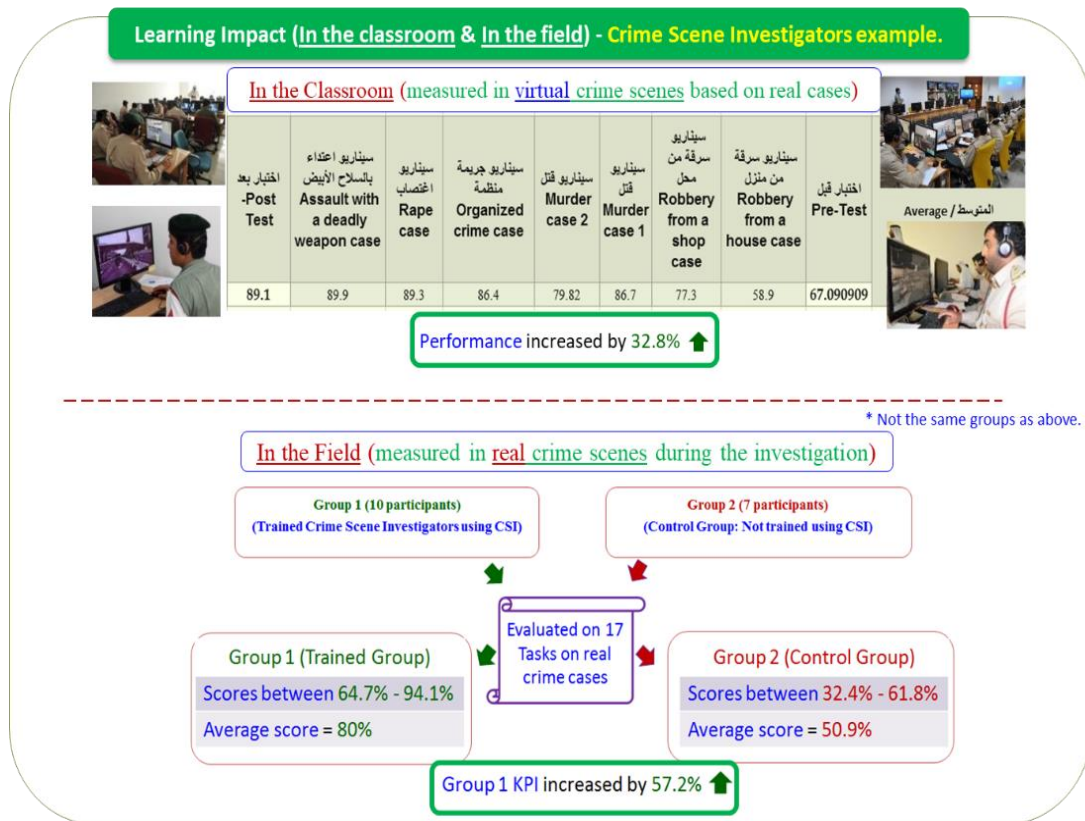
The Mann-Whitney test was used to compare two independent samples.

There was a significant difference between the degree of task knowledge between the group attending the virtual training session and the group that did not attend the virtual training course with 99% confidence.

The degree of familiarity with the tasks in the group attending the session was much higher than the group that did not attend the session (as shown in Table 2).

Table 2: Average performance score and improvement.

Degree of achievement	The degree of task knowledge varies for all individuals varies between 64.7% - 94.1%	The degree of task knowledge varies for all individuals varies between 32% - 61.8%
Average scores	The average score of individuals trained using virtual training = 80.0	The average score of the individuals didn't train using virtual training = 50.9
% Increase in efficiency resulting from virtual training	Virtual training led to an increase in the degree of knowledge of tasks by 57.2%	
Mann-Whitney Test	The level of significance = 0.00, and since it is less than 0.01, we reject the zero hypothesis with a confidence level of 99%	
	Shows the value of $Z = 3.428$ and where it is greater than 2.57, if we reject the zero hypothesis with a confidence level of 99%	
	There was a statistically significant difference between the degree of task knowledge between the group attending a virtual training course and the group that did not attend the virtual training course with 99%. The degree of familiarity with the tasks in the group attending the course was much higher than the group that did not attend the course	

**Figure 4:** Learning impact in the classroom & in the field.

Locally: The Dubai Police Academy has accepted the virtual learning environments in 3 fields (Crime Scene Investigation, Traffic Investigation, & Body Language) to be used in their License in Law major. Also, many courses have been conducted using our virtual environments for different organizations such as the UAE Ministry of Interior (including Ajman Police, Sharjah Police, Fujairah Police, etc.), UAE Armed Forces, and Community Development Authority. Regionally: Our products have been used to train Crime Scene

Investigators from Regional Police. The total number of trainees passed 5000 trainees (locally and regionally). Internationally: The United Nations (UN) has officially requested collaboration with the Virtual Applications Development Center. Moreover, National Tactical Officers Association has used our specialized products such as Sniper. Additionally, The International Civil Aviation Organization (ICAO) recommended the use of our virtual environments.

"Dubai presented their newly developed and innovative computer-based learning tool, known as the Virtual Reality Training System (see Figure 5). The system received recognition for providing a rich, interactive, and engaging educational context, thus supporting experiential learning-by-doing. ..."



Figure 5: Passengers screening virtual training.

The performance of our innovative approach can be split into intangible and tangible benefits. The intangible benefits include software capital and human resources capital. Also, since all the Development is made in-house, Dubai Police has built a strong team of experts in the virtual environments field. The tangible benefits include research capital, intellectual property capital, innovation capital, and revenue. In the process of building its portfolio, Dubai Police has managed to publish 15 publications in journals and conferences.

Furthermore, it has secured 59 Copyrighted virtual environments registered with the Ministry of Economy. Also, income is made from selling current applications to other organizations. Moreover, Dubai Police is viewed as a pioneer in the region. It houses the first specialized in-house games development center in a police organization that focuses on developing serious games. In doing so, Dubai Police not only managed to build a capital of intellectual property software assets registered in the Ministry of Economy, but it has also managed to build a human resources capital who have gained a wealth of expertise for using video games technologies to produce serious games that are effective in solving many different needs. Additionally, Dubai Police was the first police force in the world to build a simulation for traffic accidents investigators. Regarding the cost of training, The cost of virtual training is much less than the cost of field training; for example, the virtual training cost of having 2010 trainees on crime scene investigation and traffic accident investigation is around 2.1 million dirhams whereas the field training cost for the same trainees on the same programs is approximately 95.9 million dirhams. This means there is a saving of around 93.7 million dirhams (25 million dollars)

Comments from participants who were trained with our serious games indicated that it was effective and its ability to teach. In addition, many found that it was excellent and useful. Comments from trainers showed that Serious Games effectively improved performance and provided an environment that they could utilize in a classroom setting.

Besides improving performance, other indications suggest the potential suitability of serious games to address the problems with the two training methods-lectures and on-the-job training-employed by the organization. The issues facing the use of lectures are exam-focused teaching, lack of hands-on practice, class size and time constraints, and lack of motivation and engagement. The exam-focused teaching could be attributed to the fact that students are only tested using theoretical examinations, which leads them to focus on the topics that are going to be in the exams. These exams often measure the student's ability to memorize facts, but the student's ability to apply the knowledge remains questionable. Serious games can provide a platform for students to put what they have learned into practice, which can help them refocus on the whole investigation topic rather than what will be in the exam. Additionally, a game often forces students to take an active role, which provides hands-on practice.

6. Conclusion

Due to the presence of some difficulties and challenges in the ways of traditional education, which includes theoretical and practical education (in the field and workplace). Given the importance of qualifying human resources in all general departments of Dubai Police, in order to achieve and meet the strategic goals of Dubai Police, and to fulfill the guidance of the top leadership of Dubai Police and their determination to create specialized professional teams that work as one team and equipped physically and mentally. Virtual training is considered an addition to work that relies on strength and fitness through the preparation and Development using electronic software and technologies. It is considered the basis of police officers developing training plans on different scenarios and accidents using modern electronic technologies and software. Mental training is a vital stage. If training and physical effort are combined with mental training, this will create a team integrated mentally and physically, which means the success of any operation by 100%. Dubai Police's virtual training has been proven by implementing different virtual training programs in many training courses and their contribution to raising the efficiency of trainees who have undergone the virtual training courses. The use of virtual reality technology proved to support education and training in various areas because of its characteristics such as practical application and its ability to attract and hold the trainee's attention for long periods. These are essential factors in the delivery and consolidation of information according to theories of learning. The results of the experiments and application showed an improvement in the performance of the participants, whether beginners or experienced both in the classroom or in the field. The recommendations are summarized as follows:

- The importance of paying attention to human resources is the cornerstone of strategic success by adding the virtual training aspect, which is an attractive way to simulate real situations.
- To continue to develop additional scenarios in virtual criminal investigation and virtual traffic investigation to cover the largest number of different scenarios dealing with various issues and incidents, which serve the core of police work, which aims to support the achievement of the Ministry

of Interior's strategic objectives in enhancing safety and security.

- Completing the training cycle by adding the virtual training side provides an electronic, practical, and safe training environment that will give the trainee the full opportunity to cope with crimes, accidents, and scenarios similar to what he can actually face. This will enable him to improve his skills and improve performance. A virtual environment allows the trainee to make mistakes, which may be expensive in the real world, and provides the impression of the real world. In addition to the possibility of tracking the trainee's performance at all stages and all the procedures performed where they are self-evaluated and recorded in a database.
- To develop the virtual training programs to suit the needs of the requesting parties and to include the specialists in all phases of the Development of the virtual project by informing them of what has been developed and holding focus groups.
- Spreading the concept of virtual training in the various security areas after the success of the idea in many fields such as criminal investigation and traffic investigation, which can be used in many areas, such as the Development of virtual programs for special teams and rapid intervention, inspectors of various checkpoints, and many areas, and many areas with training procedures related to the strategic goals of the ministry on the interior in the fields of road security control, enhancing safety and security and ensuring readiness and preparedness in crises and disasters.
- Using virtual gaming technology and serious games to provide a virtual environment for various purposes, including documentation and awareness, where the game technology can be used in the field of community awareness about security, behavioral, social, national, and other issues.

Dubai Police is viewed as a pioneer in the region. It houses the first specialized in-house games development center in a police organization that focuses on developing serious games. In doing so, Dubai Police not only has managed to build a capital of intellectual property software assets, but it has also managed to build a human resources capital who have gained a wealth of expertise for using video games technologies to produce serious games that are effective in solving many different needs. Additionally, Dubai Police was the first police force in the world to build a simulation for traffic accident investigators.

Many things other organizations can learn from this practice:

- To keep updated with the latest development the different fields, especially technological developments.
- Higher education as a human capital investment yields great returns on the organization.
- Build the idea, test it, do experiments in one field, and then after it approves it is successful, and then replicate it in other fields.
- Teamwork
- Research & Development is essential for any organization.
- Top Management support is very important for the success of any practice.
- Let the stakeholders be part of every step within the project to succeed.

The Success Factors in Implementing the Virtual Training are:

- Motivate staff through leaders.
- Explain to employees the importance of creativity and its impact on the workflow and employee excellence.
- The involvement of staff in positive thinking
- Empowerment
- Availability of resources
- Training institutions for virtual training

The Virtual Technology center will continue in the field of developing Virtual Training & awareness applications and cover more fields in Dubai Police and other organizations.

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