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Technology Management Adaptation in Resolving Public Bus Drivers Fatigue Challenge

(Case Study of Fatigue Monitoring System Technology FMST in Dubai)

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***Abstract:* - After several years of knowing and understanding the technology, several professionals have recognized its capability to function in the world of business, which led to the development of the concept of technology management. In this paper, a comprehensive analysis of the collection of literature about technology management has been conducted. The results have shown how several studies, since technology management and its definition and purpose have been developed, were successful in providing a coherent and relevant understanding of technology management in the operations of businesses. The concept of adapting and managing demonstrated in the case study of Dubai, by developing and implementing the fatigue monitoring system for public bus drivers to reduce the accidents and enhance operation performance.**

Key words—Technology Management, Technology Adaptation, Technology Process Fatigue, Transportation.

INTRODUCTION

With the increasing influence of technology, management of technology (MoT) is recognized to play a vital role in organizations to enhance the performance. The way it functions for strategizing and continuously providing an effective and productive workflow in organizations has been the goal of several technical experts. However, there are still some instances that technology management has been lacking in the field where it tends to provide its best performance. This paper provides a comprehensive analysis of how technology management has performed its role in organizations.

The resolution of introducing new technology to the industry is to improve its performance. Ever since technology existed, it aims to enhance the operations and improve the individual performance in terms of efficiency and effectiveness. In specific, new technologies were able to establish exceptional opportunities for Transportation Modernization that have resulted in improving the drives skills and preventing the accidents and lead to attractive public transport.

LITERATURE REVIEW IN TECHNOLOGY MANAGEMENT:

Technology management is a process that consists of directing, planning, implementing, monitoring, evaluating, staffing, controlling, coordination and implementation of technology in order to accomplish the operational objectives within the organization. Technological capability is the collection of activities that improve the production process, existing technology and it is used to generate new skills and knowledge. The framework of technology management considers technology as an important resource and the activities of technological management are linked with the three business processes such as innovation, strategy and operational processes (Cetindamar, Phaal and Probert, 2016; pp2).

According to Kocaoglu and Jetter (2008), technology management is defined as engineering management because it has linked with engineering, management, science in order to plan, maintain, and implementation the capabilities of the technology to accomplish the goals. Technology management is widely used in industrial sector. Technology management encompasses activities such as innovation process and the integration of strategies (Kocaoglu and Jetter, 2008; pp1). According to Kurtulan, technology management also utilizes economic science for studies about technological infrastructure and innovation, technological prediction and planning and execution which take place in economic production factors and more generally a country's economic structure (Kurtulan, M.) "Establishment of Technology

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Development Units in Organizations and Technology Management in the Environment Global Competitiveness", Karamanoğlu Mehmetbey University, Institute of Social Sciences, Department of Business, Master Thesis, Karaman 2009)

Technology is becoming the major determinant of the competition so more management tools are required to develop and applied for its effective and efficient. Technology management is important for the parameters of development within the organization. Parameters include complexity of a good and the accessibility and distribution of the knowledge of technology (Brockhoff, 1996; pp175). In general, the management of technology is used to manage the use of technology in a systematic order within an organization, it is further used to innovate and enhance the practices of technology to get competitive advantages.

Technology Management Process, Activities, and Tools:

Technology management can be understood better if explained in detail. Those details will be illustrated, covering the technology management frame exploring its process, activities, and challenges.

1. *Technology Management Process*

Technology Management education rests on knowledge developed over many years (Van Wyk and Gaynor, 2014; Yanez et al., 2010) that covers the comprehensive body of knowledge for TM in four groups:

- Knowledge of technology;
- Knowledge of technology-linked management topics;
- Knowledge of general management topics;
- Knowledge of supporting disciplines.

Technology Management education is mainly found in mastering this body of knowledge. Technology capabilities and skills can be achieved by understanding the ongoing dynamic changes of some core business processes, namely innovation, operational processes, and strategy.

2. *Technology Management Activities*

Technology Management activities process are a very powerful tool. In order to understand the technology process, Manager need to know about the classifications of the five main activities: Identification, selection, acquisition, exploitation and protection. Those stages are shown in figure 1. [Technology Management Process and Encountered Problems in Organizations].

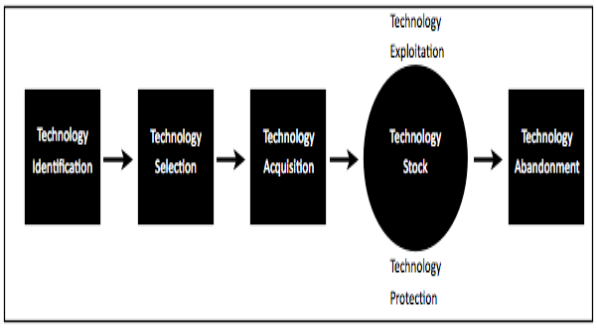

Figure 1. Stages of Technology Management Process

The activities of the technology management process, as explained by Yıldırım (2000) are discussed briefly below:

a. Technology Identification:

Identification of technology is mainly about technological intelligence operations. This operation identify the organization with their own technology that certainly unique in certain measures. It also act as a warning system against newly developing technology that may treat the organization as well.

b. Technology Selection

Selection of technology is the resolution of technology from a variables of choices to be supported by the organization. The decision of the technology has great impact on everything that will be handled in the present and the future of the organization and it is considered as input for the acquisition of technology process. Selection of technology have four components; technological strategy, production and marketing properties, organization substructure and environment factors.

c. Technology Exploitation

Institution develop or purchase a technology with special requests that are mainly designed to meet their organizational needs to achieve uniqueness.

d. Technology Protection

The most important priority in every technology is achieving ultimate protection to the organization information and the right of technology use along with the commercial advantage.

e. Technology Abandonment

The final stage of technology management is the dissolution of technology. Dissolution of technology aims to keep the technology always up to date to avoid loss that may force the organization to replace with another new developed

technology. Contextually, technological advancements may cause the dissolution of technology.

3. ***Tools***

Over centuries, it was quite hard to classify technology management tools. Categorizing depends on various tasks and elements. The most useful way was to classify the technology management tools according to the type of work the tools are supposed to assist.

The three most useful factors to decide tools are:

- **Positioning,** those tools which help to classify a company's relation to a sector, other organizations or a new technologies; the mostly can be used to find answers to strategic questions to help senior management decide to which markets they should contribute and what technologies be used.
- **Diagnostic,** those tools for evaluation assessments on how well the company performs meeting the chosen goals and to identify areas whereas they need more attention.
- **Intervention or improvement**, tools which are used to perform activities with a specific target in mind. They mostly includes the tools which help investigate the nature and causes of specific problems and how they might be solved along with the tools that helps in planning, monitoring and performing.

Most of information concerning the dispersal of tools are unreliable. The degree of complexity of use are believed to be a major determinant in their application. Simple benefit measuring techniques such as checklists and scoring models are widely used (Liberatore and Stylianou, 1994). In the past few years, A large number of tools have been developed by managers, consultants and academics to simplify the practical and conceptual matters associated with the management of technology. However, more complex models have been ignored by technology industry, according to Schmidt and Freeland (1992).

Technology Management Challenges

New interchangeable challenges are continuously appearing in the technology management arena despite all of its growth and recognition in industry. It is believed that it may change and transform technology management in fundamental ways. According to the Yale School of Management, ‘‘Today, the most significant and important managerial problems are not defined by a single function or industry. Financial markets, globalization, climate change, corporate governance, healthcare, education, development, entrepreneurial activity, all of these critical concerns in today’s world economy require a broader perspective and a deeper sensitivity to the ways in which market forces can be brought to bear not just to create and sustain wealth, but also to address and alleviate some of the most vexing societal problems’’ (Yale, 2010).

Technology management is a complex subject that may cause a lot of conceptual confusion. As an interdisciplinary branch of science, it is quite hard to establish a lifetime guidance about its boundaries as it is continually changeable. Some problems appears in technology management process as well as in all management processes.

Most common problems faced by organizations can be summarized as follows:

- Starting lots of projects with no sufficient resources.
- Allocating critical resources for multiple projects,
- Lacking of discipline,
- Avoiding tough decisions by managers,
- Lacking of significant knowledge of evaluating the organizations technology management process,
- Experiencing Difficulties in maintaining participation to organizations,
- Facing problems in team works such as cultural and personal differences, incompatibility of people.
- Conflicting of opinions
- Communicating and understanding problems,
- Experiencing problems in technology acquisition process, on supplying some technologies.

The Future of Technology Management

Technology management, as one that is continuously developing, still has a lot of limitations or lacking capabilities when it comes to playing the role of the definition attached to it. The way technology has been associated with management already gives this feature an important role especially that technology is a massive and complex world to deal with and can easily give a person or an organization a problem such as those that is linked to ethics and professionalism (Pfano, 2016). On the other hand, its missing parts of its role allows it to be recognized in the future as promising. Technology management plays its role in the different business industries, thus understanding how it has still a great potential in improving itself (MIT, 2019).

In a study, Brockhoff (2007) highlighted how understanding a dynamic model of technological change

would help in devising an ideal technology policy and how it could provide explanations for changes in observed behavior of organizations. This study also highlighted that technological developments should also not just be categorized by its originating disciplines, but that the roles that it play in molding competitive positions has to be deliberated. This will then require a much more distinguished approach to the management of technology than the one that has been consumed today in most organizations.

In another study, Gates (2010) highlighted the understanding that the key to a technology management strategy is to how it explains how information technology will support and align the overall business strategy of an organization and how it can reflect a global level of thinking regarding information technology and its incorporation with the organization. In view of this, organizational situations can then be used to explore the options found in information technology and may also result into a productive development of IT-specific situations, in configuration with organizational situations.

There are other areas in society that technology management already plays its role effectively. For instance, Tas & Yeloglu (2018) were able to highlight how technology management education is becoming more significant when it comes to solving problems within organizations, specifically in colleges and universities. Accordingly, there is a need for the institutions of higher education to lead the way in developing curriculums, programs, departments, and actions that would result into addressing and meeting the needs of industries and organizations. In this study, Tas & Yeloglu (2018) were able to comprehend the significance of technology management in both academic and industrial contexts and how vital it is to have a collaboration and interaction between the industry universities and organizations. Unfortunately, there is still a lacking existence of technology education on undergraduate level at the university curriculums observed today. Accordingly, there are several graduate programs focused on technology management in universities globally, however, there are practitioners and scholars that are paying less attention to undergraduate programs, thus requiring future researchers, professionals and policymakers to highly consider this issue as to how it can help on improving the understanding and implementation of technology management in the different areas of society.

The Research Case Study "Public Bus Drivers Fatigue challenge in Dubai"

The Fatigue Monitoring System Technology (FMST)

Setting the Context:

Dubai is one of the seven emirates making up the United Arab Emirates with an area of 4,114 square kilometers and with more than 3.19 million inhabitants and expected to reach 5.2 million in 2030. Majority of personal trips in Dubai done by private vehicles, which will contribute to the challenge of traffic congestion and increasing the level of carbon dioxide, which affects the environment and increase the city climate.

These challenges addressed by developing Dubai Transportation Master Plan, which aims to reduce the dependencies on private vehicles and promote using Public Transport. Reducing private transport use and improving public transport use two critical but challenging tasks for dealing with the problem of urban transportation (Lai, Chen 2011). The central pillar of that direction is to provide a public transport system with zero fatalities. Public buses are one of the public transport systems where drivers play a fundamental role in making the journey safe. The main objective of this research is to address and analyze the fatigue issue among public bus drivers using the technology management adaptation process.

Fatigue Issues Among Bus Drivers:

There is no universally accepted definition of fatigue.For example, Brown (1993) defined fatigue as a subjectively experienced disinclination to continue performing the task at hand because of perceived reductions in personal efficiency (p. 240). And the argument of the definition is (Brown 1993) did not differ if the fatigue is a motivational state or describes a physical or mental state. Williamson et al. (2011) defined fatigue as a biological drive for recuperative rest. The advantage of this definition cover both physical and mental state. The definition of fatigue in the transport context typically refers to a combination of following symptoms and contributory factors including:

- **Symptoms:** Impaired performance (loss of attentiveness, slower reaction times, impaired judgment, poorer performance on skilled control tasks, and subjective feelings of drowsiness or tiredness.
- **Contributory factor:** Long periods awake, inadequate amount or quality of sleep over an extended period, sustained mental or physical effort, disruption of circadian rhythms (the normal cycles of daytime activity and night sleep), short rest breaks and environmental stresses (such as heat, noise, and vibration).

As known that drivers may attempt to compensate for slower reactions and impaired visual scanning by slowing down or being less willing to overtake. When the driver is more fatigued, the driver has little awareness of his/her

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behavior, and steering responses are slower. The driver tends to zigzag within the lane, sometimes cross the centerline or run off to the side of the road. Finally,the driver may fall asleep at the wheel resulting in a major bus accident.

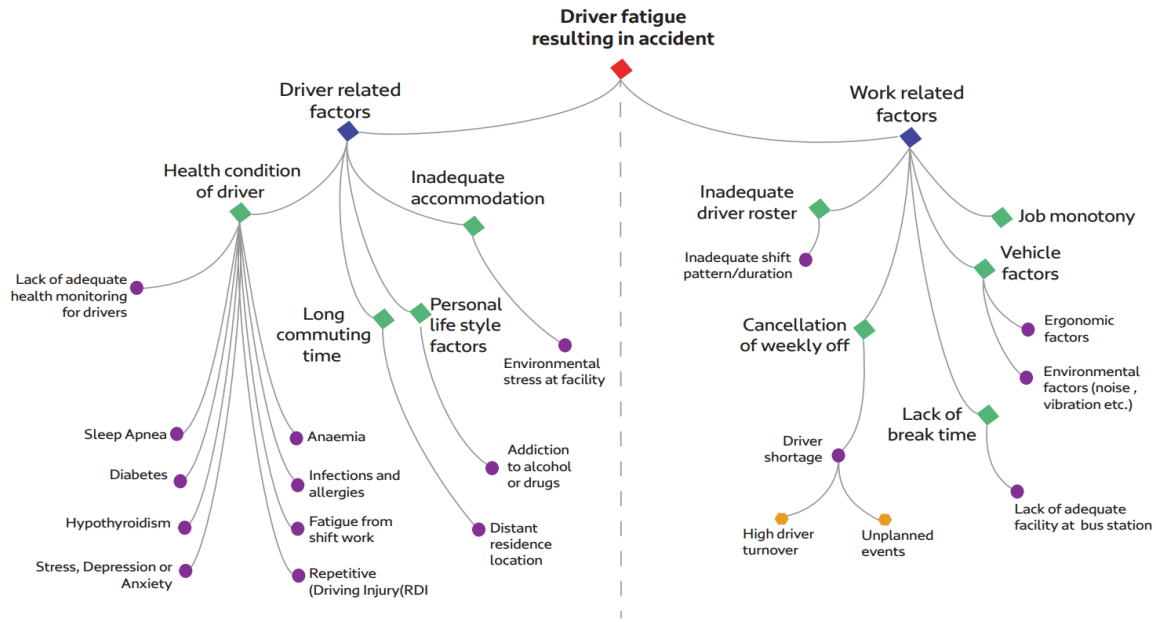
Following are the warning signs of fatigue:

- Wandering in the lane or over lane lines.
- Changes in speed, especially slowing down without reason.
- Heavy eyelids, and difficulty keeping eyes open.
- Poor concentration.
- Boredom, Restlessness, Yawning, and Drowsiness.
- Head nodding and Micro-sleeps (brief sleep episodes that can be as brief as a few seconds).

Driver fatigue and distraction is one of the leading contributory cause of an accident. The primary cause of the accident is poor lane discipline, insufficient distance, and inattentiveness. 1% of own fault accidents are confirmed fatigue cases based on driver statements and based on CCTV video. As per the Traffic and Transport Psychology: Proceedings of the ICTTP 2000, Drivers who had less than 6 hours of sleep were at three times the risk of a fatigue crash, and drivers with less than 5 hours of sleep were at five times the risk of a crash due to fatigue. Rosa (1991) found long work shifts degraded subjective and objective performance tasks, while Dahlgren et al. (2006) found 12-h day shifts were linked with greater exhaustion, increased sleepiness, and reduced sleep (evaluated via actigraphy).

The majority of accidents due to driver fatigue will lead to significant casualties and damages. Severity is mainly affected by vehicle speed and driver reaction time. The following aspects primarily influence driver reaction time:

1. Mental Processing Time: Time is taken to sense and act in the event of an emergency. It's mainly affected by sensation, perception, response selection, etc. Driver fatigue affects sensation, perception, and response selection. Hence the driver will require more time to react, and it will increase the casualty and damages.
2. Movement Time: Time needed to move in the event of an emergency. Its mainly affected by obesity and ergonomics. We have now included maximum body mass index as one criterion for recruiting new bus drivers.
3. Device Response Time: Time required for the vehicle to stop upon applying the brake. Response time is affected by the brake efficiency of the vehicle.



Fatigue Monitoring System Technology

To address the fatigue challenge among bus drivers. The Fatigue Monitoring system technology (FMST) initiated, whichinitially used in the mining and trucking industry. The system platform combined of three central systems: First, Seeing Machines to monitor the distractions and fatigue using detectives cameras. Second, Mobileye – Intel which used to identify the lane departure, over speeding, headway

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monitoring, and forward-collision, and pedestrian collision warning. Third, Internationally Fatigue Monitoring system (Telematics Devices), which used to monitor harsh braking, harsh acceleration, Idling, and aggressive left or right turn.

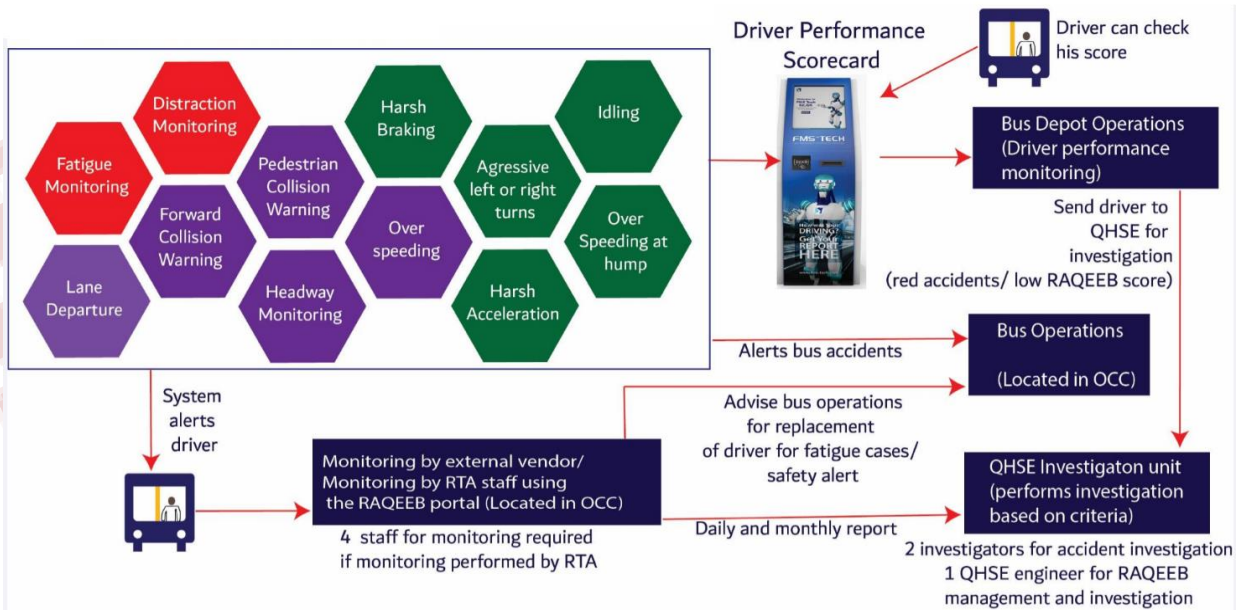
The Development of (FMST) initiated by providing the following resources:

- Budget, around 0.78% of the bus price.
- Technical Resources such as IT infrastructure, Telecommunication, and Project management office.
- Human resources to develop and run the system, such as Operation Control Center (OCC) staff, support, safety, technical, contracts, and IT governance teams.
- Materials and Equipment such as Artificial Intelligent engine, Telematics devices, Face detection camera, and GPS antenna.

FMST Development Stages:

Four primary stages identified forthe successful development of FMST.

- ***Stage 1: Design Review and Validation***. By communicating with stakeholders internally, such as driver training center, OCC, and ITS department. Externally with vendors, telecommunication companies, and tracking devices and software development companies. The main subtask was to develop, design, validate, and approve the specifications and features of the system. Conduct risk assessment and legal compliance review.
- ***Stage 2: Installation and Commissioning of the front end.*** By establishing an installing plan for each type of bus and installation and testing by the procedures approved in stage 1.
- ***Stage 3: Backend system implementation and integration.*** By developing a backend system with required application controls and securities features. Designing of a unified platform for monitoring and reporting.
- ***Stage 4: Training.*** By delivering training materials for both bus drivers and trainers.



FMST Development Challenges:

Like any systems and technology need to be deployed, particular challenges need to addressed to have smooth deployment. Four main obstacles identified and registered for the continuous implementation of FMST. First availability of the budget where the development of the system can cost around 0.78% of the bus price, which usually requires approximately 1.5 million AED/bus. Second Bus driver's acceptance to the new system, which monitors their driving behaviors and their response to system alerts. Third Bus design constraints since the new system should integrate with bus systems. Fourth, the technological challenges of availability and integrations in one platform.

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The following challenges and risks mitigation action took:

No	Risk/Challenge	Degree of Risk	Mitigation actions
1	Weak adaptation by a driver to FMST Alerts	Medium risk	Training delivered to the driver and audible alerts were included in the training material
2	Driver dissatisfaction	High risk	Communicated the benefits of system implementation • Incentive scheme to award good performers.
3	Bus design constraints	High risk	Design modification to suit custom bus design requirement
4	Quality of retrofit equipment's	High risk	Reviewed and validated product conformity certification. Compliance to quality test designed in coordination with bus manufacturers
5	Lack of equipment compatibility	High risk	A developed technical solution to overcome the compatibility issues
6	Lack of fraud prevention controls	Medium risk	Design improvement to prevent tampering of the system. System level controls applied to alert operations in the event of tampering.
7	Budget availability and Cost reductions	Medium Risk	Cost reduction by awarding to consortium who provide three systems together. Agreements with the insurance companies to share profit upon reduction in claim ratio.

FINDINGS & RESULTS OF THE SYSTEM:

The FMSTcan detect fatigue/ distraction and alert both driver and operation control center (OCC). Two tests conducted to verify the capability of the system. The first test, events were captured without alerting drivers or OCC. In second test, driver and OCC alerted, and thereby the system was able to reduce the fatigue events by 88% and distraction events by 76%.

Results of Test 1:

- 983 fatigue events: driving with eyes closed for 1.5 seconds or longer.
- 196 Perceived Risk events: An event where the driver has closed their eyes for a reason other than fatigue such as yawning or praying.
- 659 Distraction events: driving while looking away from the road for 4 seconds or longer.

Results of Test 2:

- 88% reduction in fatigue events over 1.5 sec in duration.
- 90% reduction in fatigue events reported at a speed more than 50 km per hour.
- 93% reduction in fatigue events over 2 sec in duration.
- 76% reduction in distraction events.
- 64% reduction in average number of perceived risk events per day.

System Benefits:

Tangible benefits of using the fatigue monitoring system

- 88% reduction in fatigue events.
- 76% reduction in distraction events.
- 70% of driver improved behavior.
- Reduction in congestion which is costing ~AED 700,000 per KM to the economy.
- Reduction in accident claims will facilitate in reduction of insurance cost.
- Estimated 25% reduction in loss ratio, resulting in potential ~1.5-2 million drop in insurance cost.
- The returned of investment over 5 years has been calculated by 18 million AED net saving.

Intangible benefits of using fatigue monitoring system

- Reduction in reputational impact.
- Improved people happiness.
- Improved utilization of asset and better cost recovery.
- Minimal disruption in public transportation.
- Improvement in performance KPI such as accident rate, customer satisfaction etc.
- Increase in patronage owing to improved safety performance.

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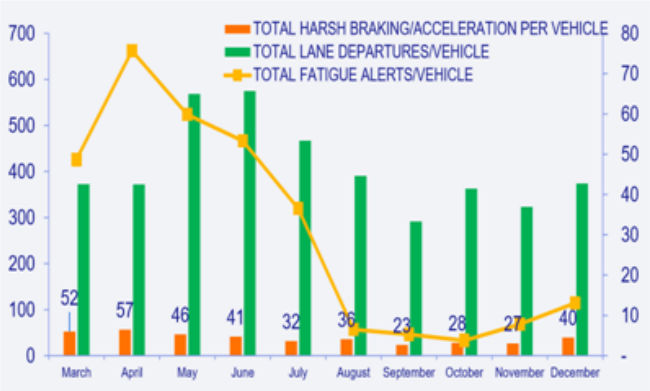
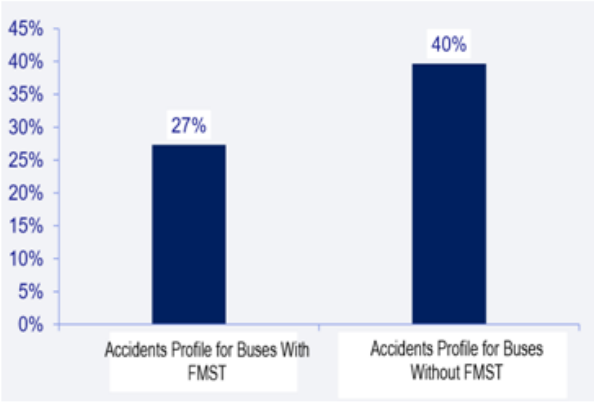


Reduction in Fatigue Events demonstrated improved drivers behavior
Data for 2018



32% reduction in own fault accidents in buses installed with FMST

Potential Case Studies for Using FMST:

The data generated from the system could be usual for enhancing and improving the performance both for drivers and the bus operation. Following potential case studies proposed to make use of data generated from the system.

No	Case Studies	Expected Benefit
1	Advance Driver Profiling and Training	Develop an advance training material and field experiment program.
2	Predictive Maintenance	Identify the benefit of FMST data to enhance the schedule of predictive maintenance and optimize the resources.
3	Improve Customer Happiness and Comfort	Identify the relationship between reduction of accidents and harsh driving on customer satisfaction in buses with FMST.
4	Eco-Driving Programs	Develop Eco programs based on data received from the system
5	Driver Recruitmentusing FMST buses	Identify the characteristics required for the drivers with less fatigue event and enhance the recruitment criteria.
6	Route & Location Risk Assessment	Identify the high risk corridors and provide the mitigation actions such as reroute the buses line and provide calming measures in the roads.
7	Insurance Impact Assessment	Using the data to support the argument of reducing insurance claim due to the reduction of the accidents.
8	Driver Skill Evaluation using FMST buses	Using the data from the system for drivers' rewarding scheme.

CONCLUSION:

From the process of developing the FMST, it has been noticed that any technology management adaptation and implementation should go through stages common by any technology project. It is crucial to identify the exact requirements and the purpose of developing any technology in order to reduce risk and challenges during the implementation stages. It is also enhancing the acceptance level of adopting the technology,which should be taken intoconsideration in the early stages. Technology is getting updated very fast, and organizations should become more flexible to the change of technology and getting the maximum benefit from the technology in different case studies where can enhance another aspect of organization performance from the planning stage, organizing, process, and monitoring and controlling.

REFERENCES:

[1] Jetter, A., 2016. Defining the Research Agenda: Technology Management as a Contributor to Service Sciences, Management, and Engineering. International Journal of Business Management, 18(2), pp.33-44. Retrieved from <https://www.researchgate.net/publication/226789723_Defining_the_Research_Agenda_Technology_Management_as_a_Contributor_to_Service_Sciences_Management_and_Engineering>

[2] Unsal. E & Cetindamar. D. (2015). Technology Management Capability: Definitons and its Measurement. European International Journal of Science and Technology. 4(2). pp.181-185, Retrieved from <https://pdfs.semanticscholar.org/f07f/a2c1d3039b8285dee8977e6cee2d8f7bffb9.pdf>

[3] Brockhoff, K. (1996). Technology Management in the Company of the Future. Technology Analysis & Strategic Management, 8(2), 175-190.

[4] Kocaoglu, D. F., Daim, T. U., & Jetter, A. J. (2008). Defining the research agenda: Technology management as a contributor to service sciences, management and engineering. In Service Science, Management and Engineering Education for the 21st Century (pp. 55-60). Springer, Boston, MA.

[5] CALP, M. Hanefi & Doğan, Ahmet. (2015). Technology Management Process and Encountered Problems in Organizations.

[6] Yildiz, E. (2007) "Technology Management", Kahramanmaras Sütcü Imam University, Institute of Social Sciences, the Department of Business, Master Thesis Project.

[7] Yildirim, U. (2000) "Technology Processes Management Capability Profiles of Machine Manufacturers in Turkey", Unpublished Master Thesis.

[8] Van Wyk, R.J., Gaynor, G., 2014. An academic template for graduate programs in engineering and technology management. IEEE Eng. Manage. Rev. 42 (4), 119–124.

[9] Mel Horwitch,Edward A. Stohr, 2012.Transforming technology management education: Value creation-learning in the early twenty-first century.

[10] Cetindamar, Dilek & Phaal, Robert & Probert, David. (2016). Technology management as a profession and the challenges ahead. Journal of Engineering and Technology Management. 41. 10.1016/j.jengtecman.2016.05.001.

[11] Brady, Tim & Rush, Howard & Hobday, M. & Davies, Andrew & Probert, D. & Banerjee, S.. (1997). Tools for technology management: An academic perspective. Technovation. 17. 417-426. 10.1016/S0166-4972(97)00017-5.

[12] Liberatore, Matthew & Stylianou, Anthony. (1995). Toward a framework for developing knowledge-based decision support systems for customer satisfaction assessment: An application in new product development. Expert Systems with Applications. 8. 213-228. 10.1016/0957-4174(94)E0011-I.

[13] Schmidt, R.L. and Freeland, J.R. 1992. Recent progress in modeling R&D project selection processes. IEEE Transactions in Engineering Management, 39:189-201

[14] Brown, I.D., 1993. Driver fatigue and road safety. Alcohol Drugs Driving 9, 239–252.

[15] Williamson, A., Lombardi, D., Folkard, S., Stutts, J., Courtney, T., Connor, J., 2011. The links between fatigue, safety and performance. Accid. Anal. Prev. 43, 498–515.

[16] Bloom, N. et al. (2016). Management as a Technology? Harvard Business School. Retrieved from https://www.hbs.edu/faculty/Publication%20Files/16-133_64fd57c1-5f76-415a-9567-f1c0d310aff3.pdf

[17] MIT. (2019). The Work of the Future: Shaping Technology and Institutions. Retrieved from https://workofthefuture.mit.edu/sites/default/files/2019-09/WorkoftheFuture_Report_Shaping_Technology_and_Institutions.pdf

[18] Chanaron, J., & Grange, T. (2007). Towards a Re-Definition of Technology Management. Retrieved from https://halshs.archives-ouvertes.fr/halshs-00137074/document

[19] Brockhoff, K. (2015). Technology Analysis & Strategic Management. Chanaron, J., & Jolly, D. (1999). Technological Management: Expanding the Perspective of Management of Technology.