Designing Interactive Walkways of Smart Cities in Saudi Arabia

Amr Jadi
a.jadi@uoh.edu.sa
Department of Computer Science and Information
College of Computer Science and Engineering,
University of Ha'il, Ha'il, Saudi Arabia

Abstract – In this work, a noble walkway approach suitable for Saudi Arabia (SA) towards its aim to develop a wide range of smart cities is considered scientifically. This work intends to minimize the errors at each level by testing the events that take place in the walkway environment. similarly, the minimum requirements to develop a walkway to the additional features to be considered while designing a walkway are discussed in this paper with sensitive areas such as environmental factors, healthcare issues, patients visiting the walkways, etc. The applications of different monitoring devices such as CCTV's, global positioning systems (GPS), etc. are carefully addressed to help the proposed method for improving the monitoring activities of a variety of events that possibly cause problems to a common man. The ultimate goal of this work to ensure a safe and satisfied journey of pedestrians while they come for a walk with all suitable safety measures. The safety measures included in this work are for pollution, noise, temperature, humidity and traffic jams on the roads. To improve the accuracy and to test the proposed approach some polices are defined and will be tested for the consistency of the proposed system. The obtained accuracy of the proposed system is proved to be far better with an accuracy of 93% improvement in the results.

Keywords: *Walkway, GPS, Healthcare, Patients, Saudi Arabia*

I. Introduction

The changing trends, advanced technologies, increased competition, impact of globalization, etc. have impacted the lifestyle of human beings [1]. Human beings are on their toes all the time to reach their destinations and most of them are adopting easy and faster means of travelling resources by which they feel comfortable and luxurious. In this process, most of them forgot that there is something called physical fitness, which is more precious and needed to be maintained regularly with constant practice and consistent effort. Due to the lack of fitness, people are suffering from a variety of health issues and spending most of their earnings on medical bills [2]. After spoiling their health condition, they start different types of fitness courses as per the doctor's suggestion. Most of the common and popular suggestion was given by a doctor would be to have a daily walk for a minimum of 30 minutes to one hour based on the patient's health condition. Therefore, it is very much essential to have some of the activities included walking in our daily life. However, most of the cities do not have a proper walkway facility for pedestrians and they are not designed well at the time of designing at the definition level. With the increasing number of patients with diabetes, sugar, blood pressure, etc. across the Kingdom of Saudi Arabia (KSA), the government is working to improve the health condition of its citizens by introducing the smart interactive walkways. This initiation aims to make a greater number of people to adopt walking as part of their daily routine and to become healthier.

Generally, the sidewalks must be an integral part of a city and need to be the topmost priority component for any type of people-oriented urban design. According to EMBARQ Network, there are eight important principles to be considered while building an active city that is friendly with walkway context [3]: proper sizing, surface quality, efficient drainage, universal accessibility, secure connections, attractive spaces, permanent security, and clear signage. The people walking on the walkways need to have proper street furniture such as benches to rest, drainage systems for rainwater and clear information signage for easy access to local destination points.

The introduction of various electronic and electrical devices to design the walkways made a positive impact on the people and some of these applications are guiding the people for following some of the important instructions while reaching a particular destination. Additionally, some mobile-based applications are trying to guide the people with their total defined tasks, the number of steps they walked or supposed to walk per day, identifying the total calories they burnt for that single day, etc. A reconfigurable pressure sensing floor was presented by Srinivasan *et al.* is capable of studying the movement of human on a particular floor and is capable enough to provide the real-time information from the floor, such as location and the force that has been exerted over the floor [4]. Similar attempt was made by Gazdzinski by designing a moving walkway with a touch panel, flat panel display, and speech recognition system along with a synthesis system [5]. Of course, the work presented in this research was carried out for elevator cars, but can be used for moving walkways with more advanced features/facilities. Day-by-day people are liking to have a more interactive atmosphere during their walk or the time that they spend on a walkway. Some kind of useful announcements, alert or a piece of beautiful music playing on the streets always make

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people get attract to continue more and more. For example, visually impaired people need some kind of smart technology that helps them to get needful information. In this context, Liu *et al.* developed an integrated service using sensor-based technology to support the impaired people towards an independent living [6]. In this work authors claimed to integrate the web-based information with the inputs obtained from the sensor-based data to guide the impaired people.

In recent times most of the smart cities focusing to adopt interactive walkways. According to a Swedish Architect firm Anders Berensson, the complete Stockholm is planned to have a weaving aerial walkway to reduce the overcrowding in the city [7]. Most of the amusement and theme parks are intended for entertainment and to attract people. Sometimes these parks consist of huge buildings and rooms with some exiting shows running around. For such scenarios, Frolov proposed a transport system within buildings and rooms by using roller-coster trains, ride vehicles, moving walkways, etc. for the visitors [8]. Most of the times these kinds of arrangements are observed in underground structures, airports, etc. to use human motion and project them on LED screens, sound systems and announcements [9].

Therefore, in the following sections, a basic needs and requirements of walkways are discussed in Section II, with needful measures and guidelines to be followed while designing a walkway. As an extension, the Section II will help to understand the improvements that can be adopted for building a walkway in a smart city and the needful facilities that are supposed to be added on the walkways that are suitable for the requirements of smart cities is discussed. In Section III, this work proposed a walkway scenario suitable for the SA environment with appropriate measures to be considered and implemented. In Section IV, the policy rules and design implementation methods and testing the suggested techniques are discussed in detail. Finally, the work is summarized in conclusions as Section V.

II. Features an Interactive Walkway

There are a few important basic principle characteristics of walkways that needs to be considered seriously while discussing the interactive walkways. They include walking directions, passage limitations, traffic awareness and special provisions for disabled people. Apart from these to establish an interactive environment, the walkways in smart cities need further improvements added with audiovisual equipment's for clear indications, LED displays, smart announcement systems, smart human density calculators, sensing devices for live notifications, etc.

A. Basic Principle Characteristics of a Walkway

Some of the important principle characteristics are discussed for a walkway:

a) Walking Directions: A pedestrian can walk in any direction on a walkway and the direction of the walk may change anytime based on the mood [10, 11]. Therefore, the walkways need to be designed carefully with a proper definition for different zones and direction in which way one can move forward, take rest, and can wait for someone with huge luggage.

Fig. 1. Some of the key principle parameters of a walkway

b) Zonal-wise Division of Walkways: This zonal wise division (see **Fig. 1(a)**) is a very important design policy for a walkway to ensure essential requirements such as sitting tables, dust bins, and attractive trees are available for the pedestrians. Three zones are shown in the **Fig. 1** as ***free zone*** (where the public needs to make an easy way for the walk), ***transition zone*** (where the public can enter to a shopping mall or can wait for someone/something without disturbing the pedestrians [13]), and finally the ***service zone*** (where the resting tables, chairs, trees, and beautification of streets using different types of plants is made[14]) [3]. The quality of surface and the material used must be consistent, slip-resistant and stable so that any kind of inconvenience for older people and visually impaired people is not appropriate.

c) Appropriate Drainage System: On the roads frequently, it is seen that the waterlogging is going to be the biggest problem, due to which most of the pedestrians feel unsafe to walk on the streets due to overflowing water and also with a fear of getting mud on to their dress. Therefore, it is essential to manage rainwater to get diverted towards appropriate drainage systems to avoid any kind of issues for pedestrians as shown in **Fig. 1(b)**.

d) Attractive Spaces: In most of the urban cities the pollution levels are high and excess temperatures are registered on the streets. In Saudi Arabia, even the normal temperatures seem to be very high and it is very difficult to imagine the type of humid conditions the pedestrians feel while walking on the walkways. Therefore, having appropriate plantation of trees on both sides on roads, to control the temperatures to the reasonable levels for pedestrians is very important. The urban heat island effect can be avoided by maintaining the shaded sidewalks as shown in **Fig. 1(c)**. Such facilities not only help the pedestrians but also helps to control the overall pollution levels of urban cities.

d) Clear and Informative Signage: The pedestrians need a clear and independent orientation of the city to understand different guidelines, rules, and regulations of the walkways. Such information is generally provided at the key entry/exit positions of a city to help the pedestrians avoid long walks and tiring experiences on the roads as shown in **Fig. 1(d)**. For any city, such type of arrangement is essential to help people to self-navigate from different places in the city.

e) Passing Limitation: Most of the highways, connecting roads, and trunk roads are having certain limitations and barriers related to speed, timings, traffic regulations, traffic jams, etc. Such hurdles can be avoided by using over bridges, under bridges, and pedestrian crosswalks [10].

Apart from these, the sidewalks need to be user friendly for people with disabilities who are using the wheelchairs, crutches, etc. Uneven designs and any kind of step-type designs must be avoided on sidewalks and must be a passage for an easy walk for all kinds of pedestrians. Similarly, they must be connected with other modes of transportation safely to access the bus stations, cab parking areas, railway stations, etc. Finally, it is very important to consider the security of pedestrians on the streets by adopting appropriate gaps between the public and private spaces. Most of the complications are seen on the streets due to the lack of friendly eyes [3]. Rich lighting on the streets is key for the safety and security of pedestrians during the night times.

B. Essential Characteristics needed for Interactive Walkway

In an interactive walkway environment, to fulfill the needs of a smart city some of the following are key to fulfill: free wi-fi zones, digital signage systems, smart sensing devices, moving walkways, information centers, etc. (see **Fig. 2**).

Fig. 2. Shows the Essential Characteristic parameters of an Interactive Walkway

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a) Free Wi-Fi Zone: In the modern lifestyle people are dependent on electronic accessories with internet facilities for all kinds of communication with the rest of the world. Quick access and sharing of the information are considered to be an important objective of human life in the present-day lifestyle. Right from a kid to an old man the daily activities, office work status, important meetings, schemes, latest news, health advice, and whereabouts are observed by the people using their mobile phones, *i*-pad's, etc. All these activities are possible with free wi-fi zones for the pedestrians in modern society as shown in **Fig. 2(a)**. These free wi-fi zones, somehow attracting the people to get on to the streets for a walk with a free mood of mind and helping to relax as well from all family/work tensions.

b) Digital Signage System: The smart cities are known for faster developments and improvements as compared to other cities. These development activities are involved with road blockages, construction activities, and sometimes included with emergency services too. Such information needed to be communicated by the city administration to the people so that the pedestrians on the walkway need to check for an alternate route for their pleasant walk. Such activities including faster communication are possible with the digital signage systems (DSS) (see **Fig. 2(b)**), which are in general operated with an automated computer program. Recently, the introduction of artificial intelligence (AI) based automated systems are helping the administration and people to get faster communication on their electronic gadgets.

c) Smart Sensing Walkways: The usage of sensors with piezoelectric films for tiles along with light embedded LEDs making the floors more attractive and smarter enough to guide people. These sensor-based tiles are integrated with a variety of computer applications, which in turn can guide the people on the walkways with different lighting-based directions. The tiles with sensors are available for a different types of colors and some pressure-sensitive floors change the intensity of lights based on the applied pressure while walking on the walkways.

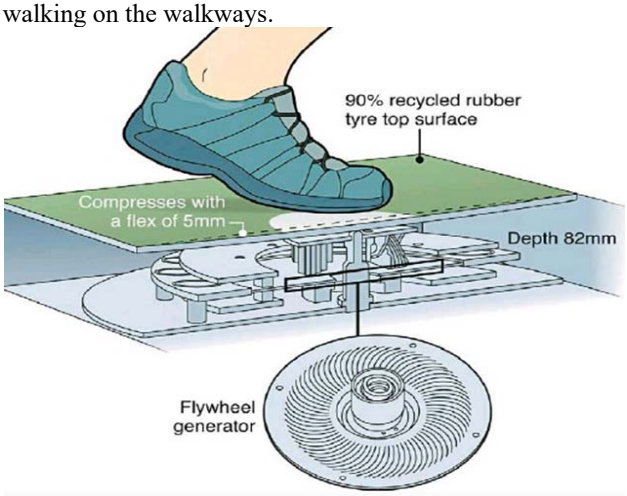

Fig. 3. The tile technology of Laurence Kemball-Cook generating 7W energy when pedestrians walk over the tiles

For example, the pedestrians can be motivated in SA for the morning walk using the tile techniques introduced by Laurence Kemball-Cook of Loughborough University, which generates the energy of 7W when someone walks on a tile as shown in **Fig. 3** [12]. The same idea was discussed by Durand and Durudean [15] for the interactive features of a passenger. Of course, this technology was introduced as a substitute for solar/wind energy in the weather conditions of the UK, where the sun is not shining or wind is not blowing. The flow of people walking in Victoria Station, London gave birth to this idea started generating huge amounts of energy, when the people are walking for their trains and subways. Initially, piezoelectric crystals were assumed to use, but based on the weight of a footstep over the tiles make an in-built horizontal fly-wheel to rotate, which is converted into energy at later stages. So, the generation of energy is directly proportional to the number of steps when people walk on the tiles. Similarly, some of the interactive floor tiles help to direct the pedestrians with the right time to walk/cross the roads, ride a bicycle, etc. as shown in **Fig. 4**. Such kind of initiations helps the people to get attracted when these methods are introduced with some kind of competition or recognition certification.

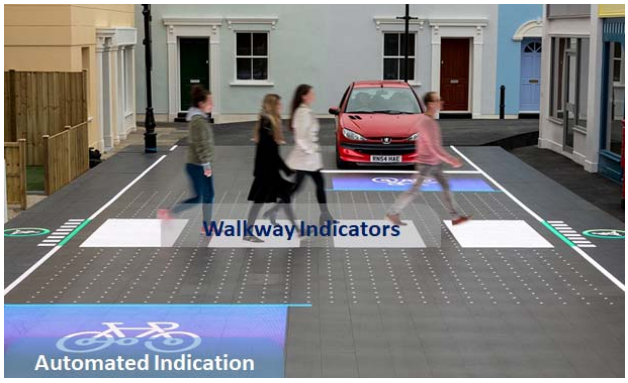

Fig. 4. Interactive floor tile directing the pedestrians over the walkways

d) Moving Walkways: The moving walkways are the part of most of the smart cities in the world, for helping the pedestrians with heavy luggage, and to travel for a longer distance in a single lane. They help old people, disabled, pregnant women and kids to reach longer distances at one stretch in a defined path as shown in **Fig. 2(d)**.

e) Information Centers: Most of the time people travelling on walkways will be in a hurry to reach their destinations. In this process, they miss some of the crucial information happening around the city. The information centers as shown in **Fig. 2(e)** plays a key role to display the latest news from the city and keeps the pedestrians updated with different events such as road blockages, accidents, traffic jams, etc. Some times the promotional offers within the shops near

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those roads will help the people to get the best experience of shopping and spending time at different hotels and restaurants.

So far, the importance of walkways and different characteristic parameters of an interactive walkway have been addressed. However, the purpose of this paper to address the key challenges of KSA towards encouraging different types of patients to walk for better health from different types of medical issues. The proposed method to tackle different problem scenarios is explained in the next section with appropriate conceptual models.

II. Proposed Scenario of Walkways for KSA

In Saudi Arabia (SA) the roads are well structured and organized with appropriate technical aspects. The number of vehicles travelling on these roads is very high as compared to many other neighboring and European countries due to the massive flow of pilgrims from different parts of the globe. Therefore, the pollution levels are always a concern to address while defining the walkway zones in any area. Moreover, these walkways are intended to make the patients (suffering from diabetes, blood pressure, heart-related issues, etc.) get motivated to spend a good amount of time to improve their health conditions. Not only the patients but the total citizens of KSA are expected to use these walkways and keep themselves fit and healthy. Therefore, designing smart cities with interactive walkways in SA needs to consider the following aspects for sure:

- The areas with low vehicle movement density to ensure low pollution.
- The places with a higher possibility of having better greenery and plantation with good water supply.
- The place's with good connectivity to shopping malls, business stores, food courts, restaurants, and libraries.
- The surroundings must be connected with better wi-fi internet connectivity.
- Emergency services providers such as police, fire, and healthcare services.
- Pleasant environment with playgrounds, gardens, etc.
- Good signage systems, emergency alerting mechanism, quick response teams, and support staff at reachable positions.
- With good mobile network facilities such as global positioning systems (GPS); and
- Finally, pedestrian navigation systems at each corner of the walkway for the complete stretch.

A. *Proposed Technique for Walkways in Saudi Arabia*

In the proposed method the database is going to play a crucial role in terms of providing a large set of information to patients and the administrators. Different parameters included in the database are shown in **Fig. 5**, includes pedestrian details, changes in the environment, and different records of monitoring devices and checker components.

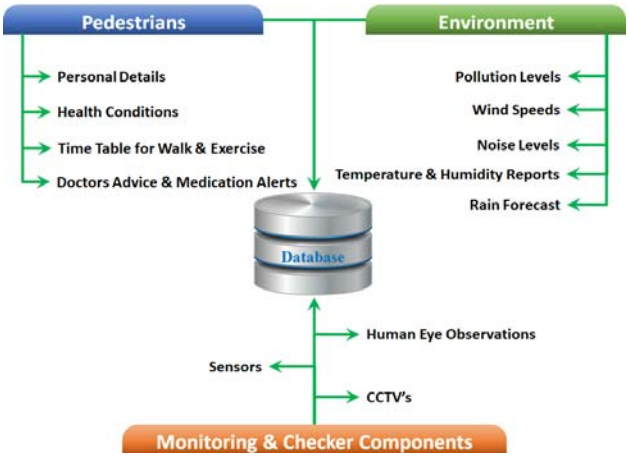

Fig. 5. Different Parameters of Database in the proposed approach

B. *Proposed Runtime Monitoring Component*

The runtime monitoring and checker component for the proposed walkway environment in Saudi Arabia are shown in **Fig. 6**. For the smooth functioning of a pedestrian on the walkways, the proposed method considered some of the important parameters that influence the pedestrians in a smart city environment.

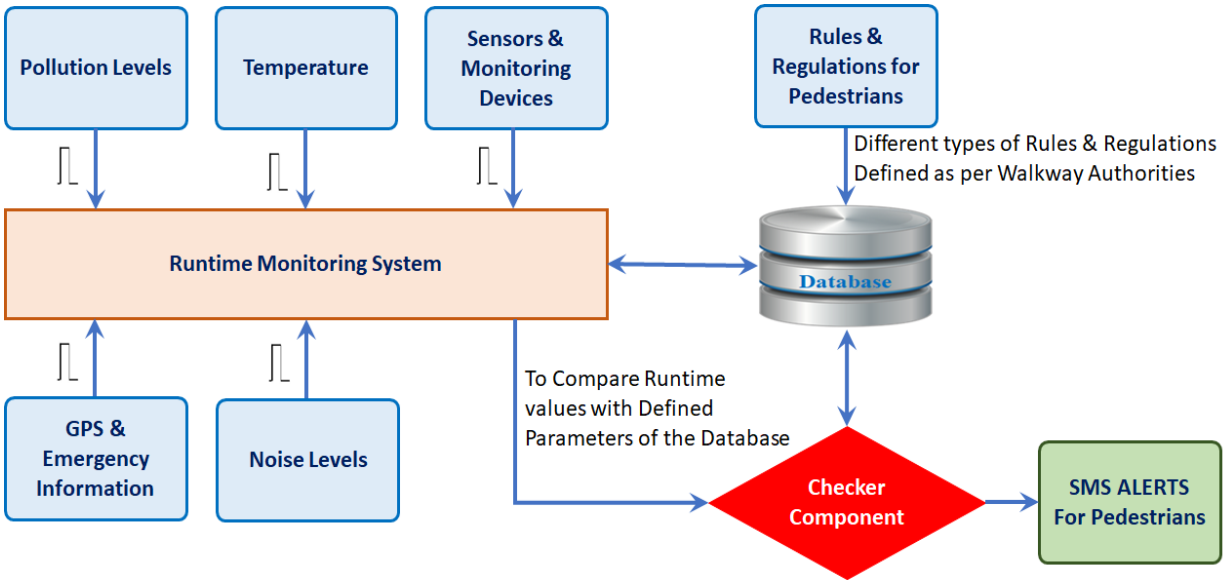

Fig. 6. Runtime Monitoring System for the Proposed Walkway in Saudi Arabia

- ✓ *Pollution Levels:* The pollution levels of different cities are monitored by the metrological departments of individual cities and the updates are collected on a regular and consistent basis to analyze the pollution levels. The pedestrians are informed if any kind of abnormality is observed after comparing it with the ideal values.
- ✓ *Temperature Levels:* The temperature levels are extreme in Saudi Arabia in day times and night times as well. The people cannot come out of their homes in extreme conditions as they can harm the people instead of making any good for them. Therefore, the abnormal temperature levels will be informed to the pedestrians regularly.
- ✓ *Sensors and Monitoring Device:* The sensors are going to play a vital role to identify or predict any kind of accidents in the walkway zones. These sensors will predict any kind of fire accident, excess water flows, etc in the walkway zones. Especially the possibility of such accidents is more in the shopping malls, book stores, etc. due to any kind of short circuits, mishandling of fire equipment, etc. Similarly, the monitoring devices are included with CCTV's, Speedometers, etc. to observe various abnormal activities by the people.
- ✓ *GPS and Emergency Information:* The role of GPS is critical in the proposed method to ensure that the pedestrians are having full awareness of the path they are selecting for their pleasant walk. All possible blockages of roads, traffic jams, repair works, etc. will be communicated to the pedestrians in advance. Similarly, all kinds of emergency alerts will be communicated from the police, fire, water, etc. departments to avoid any kind of risk of life on the walkways.
- ✓ *Noise Levels:* The noise levels must be monitored based on the information from the local agencies monitoring the noise levels at different cities of SA. This information must be updated with the database for further assessment for the suitability of noise levels for the peaceful environment at the walkways.
- ✓ *Runtime Monitoring System:* This component plays an important role to observe the latest updates from different components and sensory devices and provides the same to the database and also to the checker component to predict the differences in different parameters as compared with the ideal conditions.
- ✓ *Rules and Regulations:* These are defined by local bodies and concerning the Government rules and regulations to be followed by the pedestrians during their stay at walkways. These are also provided to the people through the storage of the database.
- ✓ *SMS Alerts for Pedestrians:* The pedestrians will get the latest updates and alerts of different events, promotions, and emergencies on their mobile phones in advance. Similarly, this module helps the people to get their individual information such as milestones they defined for themselves, targets they planned, etc. on their mobile as alerts and keep the people to be alert with their own goals.

The Checker component plays a vital role to ensure that all the rules and regulations laid out by government agencies are followed strictly by the people using the walkways by testing each activity with the ideal conditions in the proposed method. the functioning of this component can be extended and made more accurate and faster by using artificial intelligence (AI) based techniques, which are not discussed in this paper and can be proposed for the future work.

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III. Policy Rules for the Proposed Method

Some of the policies are defined to test the activities of walkways in the smart cities and to understand the role of each entity defined in these policies to ensure that the errors in dealing with mistakes are avoided.

The walkway (W) addresses the rules (*R*) and regulations (*R1*) defined by the local government of Saudi authorities need to be addressed first by formalizing as follows:

$$Policy1 \triangleq \left(\begin{array}{c} fin(Walkway) \wedge \\ Facilities(R,\ Module) \wedge \\ Technology(R1, Module) \wedge \\ \\ \wedge_{i=Environment}^{t=Rules\ \&\ Reg.} done\ (R, R1, Submit) \end{array} \right) \mapsto (Authorize^{+}(R, R1, Approve\ for\ W))$$

The Walkway (*W*) needs to alert the Pollution levels (*P*), Temperature levels (*T*) and Noise levels (*N*) for the pedestrians are formalized as follows:

$$Policy2 \triangleq \left(\begin{array}{c} fin(Walkway) \wedge \\ Pollution\ (P,\ Module) \wedge \\ Temparature\ (T, Module) \wedge \\ Noise\ Levels\ (N, Module) \wedge \\ \\ \wedge_{i=Environment}^{t=Polution,Temp,Noise} done\ (P, T, N\ Submit) \end{array} \right) \mapsto (Authorize^{+}(P, T, N, Approve\ for\ W))$$

Walkway needs to provide full information of the Facilities (*F*) and Promotional Offers (*PO*) must be communicated to the people based on the acceptance conditions from the authorities based on the defined standards. These standards need to verify by the walkway management, local governments, and subject overall terms and conditions.

$$Policy3 \triangleq \left(\begin{array}{c} fin(Facilities: Promotional\ Offers) \wedge \\ Facilities\ (F,\ Module) \wedge \\ PromotionalOfers\ (PO, Module) \wedge \\ \\ \wedge_{i=0}^{i=Fulfilled} done\ (F, PO, SubmitReports) \end{array} \right) \mapsto (Authorize^{+}(P, PO, Communicated))$$

Walkways need to maintain the Signage boards (*S*) and Information centers (*I*) up to date with the latest informaiton from all perspectives. The old data may mislead the pedestrians and may cause serious damage to their schedules and daily routines. Therefore, to ensure smooth functioning of the walkway with proper guidance people must be able to see the correct information happening across the walkway zones. Monitoring and maintaining the signage boards and information centers regularly is important.

$$Policy4 \triangleq \left(\begin{array}{c} fin(Signage, InformationCenter: Essential) \wedge \\ SinageBoard\ (S,\ Module) \wedge \\ InformationCenters\ (I, Module) \wedge \\ \\ \wedge_{i=0}^{i=Matching} done\ (S, I, SuccessfulReview) \end{array} \right) \mapsto (Authorize^{+}(S, I, Maintained))$$

Here the alerts for various unauthorized events (*UE*), Activities (*A*) and Road Accidents (*RA*) must be communicated by initiating the SMS alerts for the pedestrians and to the interested people who show enthusiasm to use walkways in the smart cities. This policy will ensure to grade the overall performance of the students in their academics and their behavioral aspects with other students.

$$Policy5 \triangleq \left(\begin{array}{c} fin(SMSAlerts) \wedge \\ UnauthorizedEvents(UE,\ Module) \wedge \\ Activities\ (A,\ Module) \wedge \\ RoadAccidents(RA, Module) \wedge \\ \\ \wedge_{i=Environment}^{t=Events,Activities,acc} done\ (UE, A, RA,\ Submit) \end{array} \right) \mapsto (Authorize^{+}(P, B, InitiateAlerts))$$

These policies defined for smooth processing of the walkways in different scenarios to ensure smooth functioning and to achieve the objectives of smart cities to see their citizens happy and comfortable while using the facilities.

V. Conclusion

The proposed work can be implemented with more accurate results for establishing an accurate and faster communication between the walkway environment and the people living in the smart cities. The accuracy of the communication using this method can be improved to a level of 93% as compared with the existing methods implemented for walkway management. Extreme conditions, unwanted scenario's, and accident-prone situations can be avoided easily by using the proposed SMS alert system for pedestrians. Most of the people walking on the walkways will under panic in serious environmental conditions and most of the times the people with different types of health problems prefer to walk daily to improve their health conditions. Therefore, this method will ensure that their time spent, activities they do and plan to do are well guided by our prediction system and communicate them in advance to avoid any kind of panic attacks. With this proposed method the establishments of smart cities in Saudi Arabia can follow certain defined standards in the above sections, to ensure a safe journey on the walkways.

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References

[1] R. J. Burke, and E. Ng. "The changing nature of work and organizations: Implications for human resource management." *Human Resource Management Review* 16, no. 2 (2006): 86-94.

[2] A. B. Schultz., C. Y. Chen, and D. W. Edington. "The cost and impact of health conditions on presenteeism to employers." *Pharmacoeconomics* 27, no. 5 (2009): 365-378.

[3] EMBARQ Network. "The Eight Principles of the Sidewalk: Building More Active Cities". [Online] Available at URL: <https://www.smartcitiesdive.com/ex/sustainablecitiescollective/eight-principles-sidewalk-building-more-active-cities/1061606/ >, (accessed on March 12, 2020].

[4] P. Srinivasan, D. Birchfield, G. Qian, and A. Kidané. "A pressure sensing floor for interactive media applications." In *Proceedings of the 2005 ACM SIGCHI International Conference on Advances in computer entertainment technology*, pp. 278-281. ACM, 2005.

[5] R. F. Gazdzinski. "Smart elevator system and method." U.S. Patent 6,988,071, issued January 17, 2006.

[6] Y. Liu, J. Bacon, and R. Wilson-Hinds. "On smart-care services: Studies of visually impaired users in living contexts." In *First International Conference on the Digital Society (ICDS'07)*, pp. 32-32. IEEE, 2007.

[7] R. Northfield. "Greening the smart city." *Engineering & Technology* 11, no. 5 (2016): 38-41.

[8] A. Frolov. "Interactive amusement attraction." U.S. Patent 9,358,473, issued June 7, 2016.

[9] S. M. Ervin. "Sensor-y Landscapes: Sensors and Sensations in Interactive Cybernetic Landscapes." *Journal of Digital Landscape Architecture* (2018): 96-106.

[10] F. Lu, and H. C. Yu. "Walkway Network Building for Multi-Modal Route Planning." In *6th International Symposium on Mobile Mapping Technology,* pp. 1-5, Brazil, 2009.

[11] X. Shan, J. Ye, and X. Chen. "Proposing a revised pedestrian walkway level of service based on characteristics of pedestrian interactive behaviours in China." *Promet-Traffic&Transportation* 28, no. 6 (2016): 583-591.

[12] D. Thomas. "One Step at a Time". [Online] available at URL: <https://www.pressreader.com>, (accessed on March 18, 2020).

[13] K. Sall, R. Briggs, and M. Weston. "Interactive Raft Ride." U.S. Patent Application 16/431,567, filed December 5, 2019.

[14] D. Liberato, V. Bernardo, P. Liberato, and E. Alén. "Visit motivation influenced by distribution channels: the case of Paiva Walkways." In *Advances in Tourism, Technology and Smart Systems*, pp. 669-680. Springer, Singapore, 2020.

[15] R. Durand, and L. Durudeau. "Interactive passenger movement device features." U.S. Patent Application 16/030,534, filed January 17, 2019.

Amr Jadi is an Associate Professor of Software Engineering at Collage of Computer Science and Engineering, University of Ha'il. Dr.Jadi received PhD degree from De Montfort University and Masters Degree from Bradford University, UK. The author is specialized in with an area interest in Software Engineering, Artifical Intellegence ,Early warning systems, Risk management and Critical Systems. Presently the author is also involved in various development activities within the University of Hail and abroad as a consultant