Face Recognition for Identification and Verification in Attendance System: A Systematic Review

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Face Recognition for Identification and Verification in Attendance System: A Systematic Review

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***Abstract*— Attendance is an important concept to be implemented in order to enhance organizational performance. Measuring attendance may be a concern issue for many organizations, especially with the rapid changes that have occurred in this era of digitalisation. Face recognition is one of many approaches to support long distance attendance, unfortunately, there are some issues that need to be overcome regarding face recognition, for example, its verification. The purpose of this systematic literature review is to provide either academics and practitioner with insight and knowledge related to face recognition implementation, how to verify it, and what is its critical success factors towards an attendance system. Therefore, the results of this study hopes to give both practitioners and academics knowledge on how to build a relevant attendance system based on the findings of this study. The review was conducted through a systematic literature review stages that was adopted from Kitchenham. It began with declaring protocol review and ended with an analysis of the prior studies that was obtained from five relevant sources. There were 22 of 516 studies that met the criteria after several filtering stages. It is found that academic reasons are mostly used on verifying face recognition. Moreover, based on the findings, information security has been considered the most utilized security methods regarding face recognition in attendance system. Furthermore, 78% of the analysed papers stated that security issues is the most critical factors towards implementing a successful attendance system.**

Keywords — SLR, attendance system, face recognition, identification, verification.

I. INTRODUCTION

Attendance system could be a framework for handling participation that is one of the foremost commonly utilized innovation system in businesses. Human Resource Department (HRD) received a variety of attendance, overtime, and leave information [1]. Managing and observing the execution time and nearness of a huge number of laborers within the office would be extremely inconvenient for HRD. For this reason, the existence of a digital attendance system is needed by HRD to monitor and manage employee attendance more effectively. Other than that, many of the related research found that most of the attendance system is conducted in an academical realm for the absence of their students. According to Prangchumpol, checking students class attendance has an influence so the teachers style of teaching in order know students intentions towards their academic needs [2]. Many have implemented an attendance system using various different techniques. Face recognition, fingerprint scan, radio frequency identification (RFID) card are some technique examples to help support the attendance system rather than doing it manually by roll calls. RFID based attendance systems may be used to take attendance in schools, colleges, universities or workplaces [3].

As a result of the advent of covid19, most organisations must devise an attendance scheme that complies with government rules and regulations in order to avoid the spread of the disease. Face recognition is one of the ways to promote long-distance attendance. Recognizing face pattern and size is a powerful technique by using face recognition [4]. The advantage of using face recognition is that it could record many faces at a time and recognize it directly then store it in the attendance system database [5]. In order to implement face recognition, three steps must be in considered, face detection, face alignment and face identification. Face pattern, face size, and even camera resolution influences the face identification, face detection and face alignment of the face recognition proses respectively [6]. However, there are some problems with face recognition, such as its authentication, that must be addressed. Many organizations that have implemented face recognition have to deal with problems regarding its verification. In order to implement a reliable face recognition for an attendance system, security issues must be an obligation to address [7] [8].

To solve this problem, this study will conduct a systematic literature review on what face recognition verification and identification have been utilized in prior research and how it has impacted on organizational managers or educational teachers to support the discipline of his employees/students.

The result of this study is based on the analysis of the prior relevant studies regarding the implementation of face recognition. The main objective of this study is to analyse what organizational realm has implemented face recognition as its attendance system, how to secure it, and what are the success/failure factors in implementing an effective and efficient attendance system using face recognition through prior studies review or systematic literature review (SLR).

This systematic literature review is based on the Kitchenham method. SLR using Kitchenham method has been used in many prior studies for example identification problems of Peer to Peer (P2P) Lending [9]. Besides that, Kitchenham method has also been used in research on Knowledge Management System (KMS) Development and Implementation [10], Review of Issue and Solution for Security E-Commerce [11] and review on Challenges and Recommended Solutions for Change Management in Indonesian E-Commerce [12]. Kitchenham has three steps, planning, implementation, and reporting [13]. For that, the research question that this study will deliver is:

1) Who has utilized this Face Recognition technology for attendance systems?

2) What types of security methods are used in Face Recognition?

3) What are the success or failure factors of Face Recognition implementation?

To provide a substantial outcome, this systematic literature review is taken through a structured methodological steps and three stages in respect to the Kitchenham method that has been expressed above. Furthermore, the result of this systematic literature review will give both academics and practitioners a comprehensive knowledge of the finest face recognition for identification and verification to support an attendance system. This study is structured as follows: abstract, background study, research method, results and analysis, and conclusion. The research method is structured through review protocol, search process, inclusion and exclusion criteria, quality assessment and data extraction.

II. BACKGROUND STUDY

A. Attendance System

Attendance system is a system utilized to oversee one's participation in an action. To guarantee this nearness, many methods are utilized, including counting manual marks to require advantage of biometric innovation. The vital thing within the participation framework is the capacity to recognize a person's nearness and record the time of his nearness [14]. Attendance system is crucial for any organization. It permits to track how customary the employees/students are, and additionally to know around the employees/students taking take off without any reason [15]. Attendance of understudies has a vital part of execution and performance, normality towards considers, less reprobate, or having dangerous behavior [16]. In this study, we investigate the success and failure factors of an attendance system when it is integrated to specific technique, and how it will derive the organizational goals and strategy.

B. Face Recognition

Face recognition is defined to as a process of recognizing facial object using a Closed-circuit Television (CCTV) or a camera and sparing it naturally into the systems database [17]. Face detection and face identification is the phases of face recognition process that is generally being used [18]. A face recognition system is a future high quality recognizing system that is able to coordinate facial object from a picture or video which the data is integrated with the systems database, it is done by calculating facial pattern and size from a given picture or video [19]. In this study, we aim to analyze what kind of organizational realm has implemented face recognition in their system and what tools they utilize in order to detect facial images.

C. Identification And Verification

Identification is an activity that aims to analyze and examine specific things. With the rise of facial recognizable proof in versatile frameworks, specialists figure that yearly facial acknowledgment gadgets licenses and gadgets will increment from $28m in 2015 to more than $122.8m around the world by 2024 [20]. Besides cost issues, other problems that need to be overcome regarding identification is the security issue. Several security problems are concerning the current biometrical techniques even though personal identification has a high-quality result regarding this technique [21]. Face identification is one of the most frequently used in biometric technologies [22]. Therefore, the identified face is needed to be verified in order to determine whether the identified face is the same as the one stored in the database [23]. Hence, face verification is a critical strategy in an overall face recognition process in order to minimalize fraud activity within the system.

In this study, we investigate the use of security tools in prior research and compare it to the cost of each in order to present a comprehensive view of a reliable security system.

III. RESEARCH METHOD

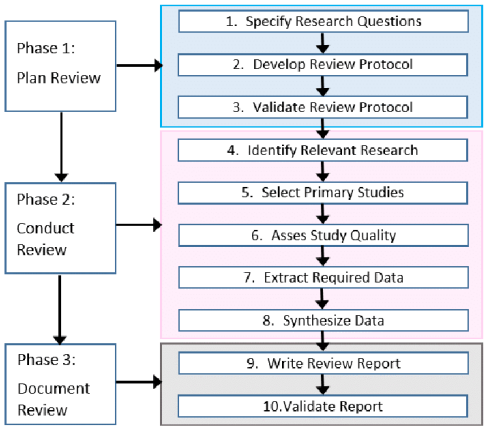

Fig. 1. Research Methodology

To find out and identify how facial recognition is a technique for identifying and verifying the attendance system, a literature review is carried out. In conducting this literature review, several stages were carried out, namely searching for article data from several journal database sources using certain keywords, then selecting with predetermined inclusion and exclusion criteria and extracting the results to answer research questions. We structured our research by applying several stages, the stages that this study conducted can be seen in figure 1 as shown above.

The study adopted the process of structuring a systematic literature review (SLR) based on Kitchenham [13]. We began the study by reviewing the protocol that is relevant towards our research questions. Furthermore, the study searched for relevant researches based on our subject from five different online databases. In order to obtain primary studies, we carried out an inclusion and exclusion criteria process, then eliminating studies that is not relevant towards our research. The study then assessed the quality of the obtained studies by performing three phases of quality assessment from the authors. Once the obtained papers have been assessed and scored a high ranking of relevancy towards our study, we then start to extract data from the relevant studies in order to write a review report.

A. Review Protocol

The review protocol specifically defines the use of systematic literature review methods in this study, that includes background, background study, inclusion and exclusion of search process and research questions. The review protocol section will determine the keywords from this study in order to acquire a relevant outcome based on the research questions. This systematic literature review used Population, intervention, comparison, outcome, and context (PICOC) criteria that has also been adopted by study about Knowledge Management System (KMS) Development and Implementation [10]. The review protocol of this study can be seen in Table I. The population is the main area of study. In the meantime, the intervention as a setting to be examined. Comparison is recognizing each intervention between related studies. The context is the general field of study regarding face recognition implementation.

TABLE I. PICOC CRITERIA

Population	Face Recognition, Attendance System
Intervention	Verification, Identification, Information System Development
Comparison	Identificated security tools for Face Recognition, Identificated critical success for Face Recognition
Outcome	Comparison of security methods for face recognition, A better knowledge for Attendance System
Context	Education, Social, Finance, Construction, Property, Tourism

B. Search Process

To answer research questions, it is necessary to build information by processing article data using the SLR approach from various digital libraries or online databases. The sources used are as follows:

a) Science Direct (https://www.sciencedirect.com)

b) Association for Computing Machinery Digital Library (https://dl.acm.org/)

c) ProQuest (https://www.proquest.com)

d) IEEE Xplore (https://ieeexplore.ieee.org)

e) SpringerLink (https://link.springer.com)

The authors searched for relevant studies within these five online databases due to the fact that many papers regarding information and communication technologies (ICT) can be found there. For example, IEEE Xplore, IEEE Xplore is an online database that has published many papers regarding advance technologies. Besides IEEE Xplore, Association for Computing Machinery (ACM) is also an online database that focuses on the development of information and communication technologies. Furthermore, Science Direct, SpringerLink and ProQuest is an online database that has published many highly ranked papers according to Scimago Journal & Country Rank.

This article was searched by publication year boundary between 2016 and 2021 using the keywords "facial recognition" AND verification AND (identify OR identification) AND "attendant system". Table II below shows the results of the studies boolean search for each credible source that has been mentioned above. It was found that every online database source has various of results number and we have chosen five sources above as our main sources due to its paper relevance regarding our SLR research.

TABLE II. BOOLEAN SEARCH

Format ScienceDirect: Find items with these terms: "face recognition" AND (verification) AND (identification OR identify) AND "attendance system"
Format ACM: [All: face recognition] AND [All: identification OR identify] AND [All: verification] AND [All: attendance system]
Format ProQuest: "face recognition" AND (verification) AND (identification OR identify) AND "attendance system"
Format IEEE Xplore: (("All Metadata": face recognition) AND ("All Metadata": verification) AND ("All Metadata": identification) AND ("All Metadata": attendance system))
Format SpringerLink: All: (“face recognition” AND (verification) AND (identification OR identify) AND (“attendance system”)

As a result, there are 16 papers in ScienceDirect, 21 in Association for Computing Machinery Digital Library, 217 in ProQuest, 20 papers in IEEE Xplore and 242 Papers in

SpringerLink database, for a total of 516 papers. After sorting out the duplications, 491 papers were obtained.

C. Inclusion and Exclusion Criteria

The Inclusion and exclusion criteria is used to filter the papers that was searched. This section is divided into three stages; Initiation stage; Title and Abstract stage; and Full-text Selection stage. The inclusion and exclusion criteria can be seen in Table III.

TABLE III. INCLUSION AND EXCLUSION CRITERIA

Stage	Inclusion Criteria	Exclusion Criteria
Initiation Stage	- According to the keyword search - English Language - Publication Year 2016-2021	- Paper with non-English language - Publication year outside 2016-2021
Stage 1 (Title and Abstract Selection)	- Face Recognition - Identification OR Identify - Verification	- Component except Face Recognition - Non-Identification OR verification section - duplicate paper - review paper
Stage 2 (Full-Text Selection)	- Security, Success Factor, Failed Factor - Open access paper - Q1, Q2, Q3 tier journal	- Non Security, Success Factor, Failed Factor in Face Recognition - Non accessible full text paper - Except Q1, Q2, Q3 tier journal

D. Quality Assessment

Quality Assessment is a process to measure each selected paper relevancy regarding this study in order to produce a quality systematic literature review paper [13]. Several quality criteria were used to guide prior studies analysis, as follow:

1. Has the paper stated its research objective clearly?
2. Has the paper stated its related work clearly?
3. Has the paper depict the application of the participation framework utilizing confront acknowledgment clearly?
4. Has the paper stated a conclusion that is relevant regarding its main goal research and questions?
5. Has the paper stated a recommendation of improvements regarding its foundlings?
6. Has the paper been indexed by ScimagoJr?

A number of 22 papers from 491 were selected after the filtration that is based on full text search, the studies were then assessed by six quality questions from the Quality Assessment above. The score of each question is as follows: “not at all” (0), “very little” (0.25), “a little” (0.5), “yes, but not the most relevant” (0.75), and “the most relevant” (1). The number of papers from each credible source that were selected are as follows: 5 ScienceDirect, 2 ACM Library, 4 ProQuest, 8 IEEE Xplore and 3 SpringerLink. The result of QA from numerous selected studies received an evaluation score of 4 in average. In order to fairly score the quality of each obtained papers, the quality assessment process is carried out by three authors of this study respectively. Mendeley were utilized in this study in order to search for the duplication papers that were obtain from different sources automatically.

E. Data Extraction

The data extraction in this study were done by fast reading of every selected paper that were obtained from QA process using MS Excel. The study used MS Excel table in order to categorize each data as follows: organizational field, tools type, security type, success factors, failure factors, purpose, contribution, limitation, and supplementary notes. This study also included the references citation and its publication year in order to fulfill the initiation stage from inclusion and exclusion criteria. The researcher conducts a process of full-text screening to seek for the relevancy of selected papers data and information regarding this study.

IV. Result and Analysis

The results of the literature review will be discussed below and answer the three research questions that has been stated above earlier.

A. Systematic Literature Review Results

The overall process of selecting primary studies can be seen in the figure below.

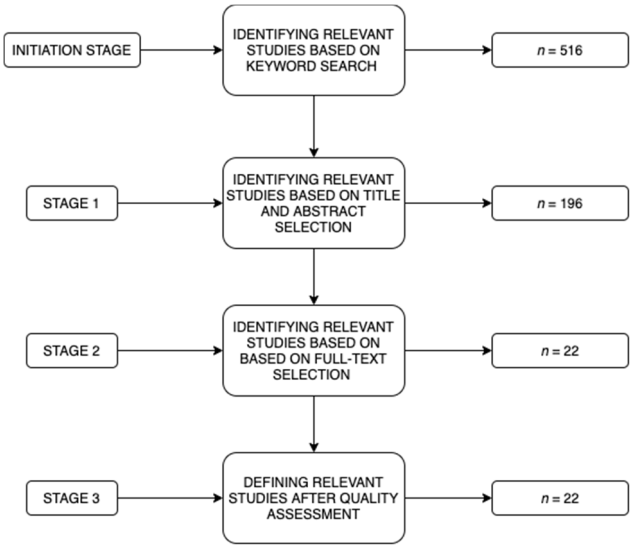

Fig. 2. Primary Studies Selection Process

Before the researcher discuss the results of the research questions based on the selected relevant papers, below is an overview of the selected papers source, types and its publication year.

a) Publication Source Overview

The results of the selected database extraction were obtained as many as 22 articles that met the criteria, as shown

in Table IV. From these results, the article will be reviewed further.

TABLE IV. ARTICLE IN SELECTED

Source	Articles Found	Candidate Articles	Selected Articles
Science Direct	16	11	5
ACM Digital Library	21	15	2
ProQuest	217	125	4
IEEE Xplore	20	8	8
SpringerLink	242	37	3

Results of inclusion and exclusion, 22 papers will be reviewed literature. 8 studies were obtained from IEEE Xplore as the credible literature sources. In addition, 5 studies were obtained from ScienceDirect and 4 from ProQuest, meanwhile SpringerLink publish 3 related papers and ACM Library publish 2 related studies about face recognition in regards to the attendance system. Based on Table IV, it is found that although SpringerLink has the highest number in article found, the selected papers remain only 3, that is due to the irrelevant content on most articles found towards our main research.

b) Publication Type

This systematic literature study searched for relevant papers regarding face recognition from journal, conference papers/proceedings, books, book section and trade publication. Amongst these five publication types, only two publication types fulfill the study criteria. The researcher obtains (65%) of conference papers and the rest of (35 %) are from journal papers. We found that conference papers dominated our relevant sources due to its newness research on face recognition as a tool that supports attendance system.

c) Publication Year

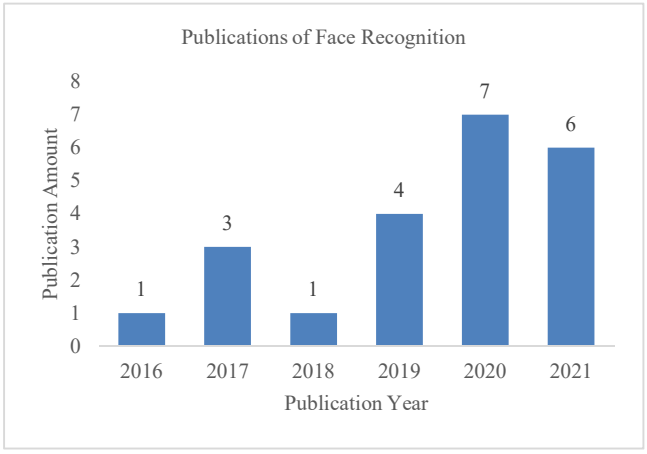

Fig. 3. Publications of Face Recognition

Regarding the selected relevant studies that this research obtained, the primary studies filled dominantly with year 2021 (28%), 2020 (32%), 2019 (18%), 2018 (4.5%). 2017 (13%) and 2016 (4.5%). Year 2020 dominated with 32%. The publication year can be seen in Fig. 3 as shown above.

According to Fig. 3, researches on face recognition increases by the year. It is showed that year 2019 began the increase due to the covid pandemic that has structed worldwide. From this graph, we could see that since the beginning of this pandemic, many researchers are motivated to study about face recognition as a replacement of manual attendance system. Yet, year 2021 has fewer research than year 2020 regarding face recognition due to the ongoing year as this study is conducted.

B. *Research Questions*

As we have discussed earlier, the main objective of this study is to seek for information regarding its research questions based on the selected prior studies about face recognition implementation in an attendance system. Below is a detailed analyses of the study's research questions and the data that the researcher has found in order to answer these research questions respectively.

a) RQ1. Who has utilized this Face Recognition technology for attendance systems?

TABLE V. FACE RECOGNITION IMPLEMENTATION BASED ON ORGANIZATIONAL FIELD

No	Organization Field	Frequent	References
1	Company	5	[1][8][14][21][23][27][29]
2	Education	11	[2][3][4][5][6][7][15][16] [17][18][19][28][30]
3	Government	2	[20][24]

According to Table V. face recognition technology has been implemented for companies five times in the prior relevant studies. Amongst these studies, Seal utilize CCTV to facilitate face recognition activities [1]. Studies from Bah and Isa optimize the use of digital cameras to support face recognition in their companies [8]. Whilst two other studies implement face recognition in the company realm by using the help of webcams which are located on top of all computers that are located in the company [14][23].

Eleven relevant studies exploit face recognition as an attendance system in the academic realm. Most of the studies use the help of smartphones in order to recognize students' facial image. Sunaryono propose an android based course attendance system using face recognition, which the activities has to be accessed via third party application [7]. One relevant

study uses the help of CCTV in order to detect faces from their students [5], and Srivignesh claims that face recognition by webcam can increase the accuracy of face recognition in academic sections [6].

Another organizational field that we found from the relevant studies is that government organizations have also implemented face recognition for an attendance system [20][24]. Francisco utilizes digital cameras in order to mark employees' attendance within the government organization [18]. Whilst another study that has been implemented in government conduct surveillance cameras to support face recognition in public areas [24]. The face recognition tools can be seen in the table below.

TABLE VI. FACE RECOGNITION SUPPORT TOOLS

No	Tools Type	Frequent	References
1	CCTV	2	[1][5]
2	Smartphone	6	[2][3][4][7][15][19]
3	Webcam	6	[6][14][16][17][18][23] [28]
4	Digital Camera	3	[8][20][21][27][29][30]
5	Surveillance Camera	1	[24]

b) RQ2. What types of security methods are used in Face Recognition?

As we have discussed earlier, the main problem of implementing face recognition as an attendance system is its security. We come up with the research question of what type of security will make a reliable attendance system. The result of our analysis can be seen in the table below.

TABLE VII. SECURITY TYPE

No	Security Type	Frequent	References
1	Database Security	7	[1][2][4][14][16][18][20][27] [30]
2	Information Security	11	[3][5][7][8][15][16][19][20][21] [23][24][29]
3	Network Security	3	[6][16][17][28]

We found that this section is very important to be discussed due to most of our relevant sources claimed that security is a fatal to be noticed. Many studies about face recognition tools that are implemented until now faces many security problems that lead to the unreliable system and many practitioners are uninterested in using this type of attendance system.

According to Table. VII, nine relevant studies ensure that the best way to conduct a reliable attendance system is to secure the databases [1][2][4][14][16][18][20][27][30]. Research from Prangchumpol suggests that database security is an obligation to support the security of face recognition student manipulation and fraud [2]. Whilst twelve studies show that information security is the best way to overcome security issues that until now has not been solved by many organizations that have implemented face recognition to support an attendance system. And study from Elias claims that without securing the network, data's from face recognition could be insecure [17]. As we can see in Table VII. from all the relevant studies, information security claimed to be a crucial thing to implement in order to overcome the issues that we have stated above.

c) RQ3. What are the success factors of Face Recognition implementation?

One of our main goals in this systematic literature review is to analyse comprehensively about the success factor in implementing face recognition to support an attendance system. The results can be seen in the Table below.

TABLE VIII. SUCCESS FACTOR

No	Success Factors	Frequent	References
1	Integrated Application	5	[2][4][6][15][18][29]
2	Data Disposition	4	[1][2][14][21][30]
3	Governance	3	[16][19][24][27]
4	Technology Environment	6	[1][3][5][17][19][24]
5	Reliable Security	14	[3][4][5][6][7][8][14][15][16] [19][20][21][23][24][28][30]

According to Table VIII. The most important component that should be considered as an issue in implementing face recognition for an effective and efficient attendance system is reliable security. Five papers suggest that Integrating application is the most important factor to implement an attendance system by using facial recognition [2][4][6][15][18][29]. Six papers found that the Technology Environment is an issue to motivate and ensure organization that will implement face recognition as an attendance system [1][3][5][17][19][24]. Data Disposition was only stated by four papers about the success factor of face recognition [1][2][14][21][30]. Whilst Governance has not been seen as a success factor to implement face recognition as an attendance system because only three from eighteen papers point that out as a success factor.

Governance plays a part in successfully implementing face recognition because they are the key role in making regulations amongst the organizational internal members [16][19][27]. Three relevant papers claimed as above due to their organizational research field is a company based, from here we can conclude that to implement a successful face recognition attendance system in a company, we must consider governance as a key factor.

As for the most claimed success factor in implementing face recognition in an attendance system, fourteen out of eighteen relevant papers suggest that a reliable security is a crucial component to be considered. These security consist of database security, information security and network security as we have discussed earlier in RQ2. Security is highly recommended in face recognition as its users information is very sensitive and it will led to the performance of an organization [5][14][16].

V. Discussion

The aim of this paper is to analyse the critical success factors in implementing face recognition as an attendance system to follow the current government regulations towards minimizing the spread of covid pandemic. Based on our research after studying 22 of our relevant papers, we found that by implementing a high security over face recognition, many organization would implement a successful attendance system and could cover most of nowadays problems regarding to face recognition [3][4][8][14][15][16][23][24].

We also aim to find the solution on how to secure an attendance system using face recognition in order to conduct a system that is effective and efficient. The result shows that most face recognition is conducted in the academic realm. From all the organizational fields that have implemented this system, it is revealed that in order to secure the system, there are three types of security systems that have been pointed out through all the relevant studies; database security, information security and network security. Papers from [3][5][7][8][15][16][19][20][21][23][24][29], pointed out that information security is the best way to overcome most of the issues regarding face recognition within the attendance system. Information security is implemented by defining policies, processes, procedures and instructions within the scope of the system [20].

Smartphones and webcams are widely used by educational institutions, while the government uses CCTV. For companies that use more webcams, perhaps because of its importance for company location attendance. The successful implementation of a smartphone camera correlates with security factors. Smartphones are highly recommended due to its low cost budgeting and most students/employees nowadays is using smartphones as their daily tool [2][3][4][7][15][19]. As for webcams, it is able to support face recognition whenever if the activity requires us to meet face to face but still maintaining health protocols [6][14][16][17][18][23][28].

The success factor of implementation in government is strongly influenced by the support from top management and culture. In educational institutions there are some who also depend on top management support.

VI. Conclusion

In conclusion, this study found some highlights to share. This study provides information regarding which institutions have implemented an attendant system using face recognition. In the results and analysis, it is explained that educational institutions use more of face recognition technology, which is then followed by companies and governments. This systematic literature review pointed out the most implemented face recognition in educational realm is caused by the highly demanding of cautious regarding the students attendance in an online situation. Many universities considered face recognition as their attendance support tools in order to monitor student's enhancement of their knowledge without being affected by this pandemic.

Based on this study, it can also be seen that security is the most important success factor, where the implemented security includes information system security, database security and network security. Amongst these security, we concluded that information security (INFOSEC) is the most implemented type of security in face recognition as an attendance system. Other factors that determine the success of implementation are the training and insurance factors. By knowing the success factors, it can be an important concern as a reference in managing implementation work. This study pointed out that security issues is the most important to overcome the problems in order to implement an effective and efficient attendance system using face recognition. Thus, regarding security, it is claimed that by considering information security, the problems that has been stated out by the writer in the beginning of this study can be resolved.

Although the researcher concluded a high contribution of this review, this study also has some limitations. The main reason of lack of awareness from organization and stakeholders itself to conduct such an invention of fighting against pandemic have not been pointed out by the writer. This is on a certain organizations and not been implemented evenly. Thus, this research would need to be improved and developed in order to have concrete knowledge on why attendance system using face recognition are very important to conduct. The recommendation of a future research besides above, is that there is a need to measure the assessment for each security types to seek their risk factors and the approach of critical fail factors for people, organizations, and stakeholder that utilized these tools.

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