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Future Role of Sustainable Innovative Technologies in Crisis Management

Mohammed Ali

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Mission

The successful use of digital technologies (including social media and mobile technologies) to provide public services and foster economic development has become an objective for governments around the world. The development towards electronic government (or e-government) not only affects the efficiency and effectiveness of public services, but also has the potential to transform the nature of government interactions with its citizens. Current research and practice on the adoption of electronic/ digital government and the implementation in organizations around the world aims to emphasize the extensiveness of this growing field.

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- Case Studies and Practical Approaches to E-Government and E-Governance
- E-Government in Developing Countries and Technology Adoption
- Knowledge Divide, Digital Divide
- Frameworks and Methodologies for E-Government Development
- Urban Development, Urban Economy
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Detailed Table of Contents

The COVID-19 crisis has engulfed several countries, leaving policymakers perplexed and unprepared to deal with the situation. Choosing the most appropriate course of action has become more challenging as a result of the infection and its effects on the body. While dealing with the coronavirus crisis and the stress that goes with it, new information technologies are critical in addressing and alleviating that stress. As a result, new information technology capabilities are required to address the challenges confronting policymakers when dealing with pandemic diseases such as COVID-19 in the past. As a result of the systematic review process used in this study, the best available evidence is synthesised from text and opinion to provide actionable advice to policymakers. The findings indicate that the challenges fall into two categories: battling the disease and mitigating its effects. Furthermore, the internet of things, cloud computing, machine learning, and social networking all contribute significantly to resolving these issues.

Disaster management's objective is to minimise the potential damage caused by disasters, to provide victims with immediate and appropriate assistance, and to ensure an effective and rapid recovery. To accomplish these goals in the aftermath of a disaster, a coordinated and efficient rescue effort is required. As a result, breadth of information about the disaster's impact is required in order to plan an immediate and effective response. The internet of things (IoT) is poised to save lives in the event of a natural disaster. This chapter proposes an IoT-based solution for planning rescue operations in the aftermath of natural disasters. This chapter is further validated through an analysis of IoT technology adoption for disaster management using the task-technology fit (TTF) approach.

Natural disasters have the potential to cause catastrophic damage and massive economic losses. Actual damages and losses have been increasing in recent years. As a result, disaster managers bear a greater responsibility to safeguard their communities in advance by developing effective management strategies. Numerous studies have been conducted on the processing of disaster-related data using artificial intelligence (AI) techniques, all with the goal of developing more effective disaster management strategies. This chapter summarises current AI applications in the four phases of disaster management: mitigation, preparation, response, and recovery. Numerous AI techniques can be applied to various stages of disaster management, and several practical AI-based decision support tools are demonstrated. It seems that the vast majority of artificial intelligence applications are focused on disaster preparedness and response.

The regulatory and cyber risk landscapes are reshaping the role of human resources. As a result, information security/information technology (InfoSec/IT) professionals are increasingly being asked to assist organisations in determining and enforcing employee data permissions, training employees on cybersecurity policies, and assisting with employee-related cyber incidents in order to be prepared for any kind of cyber attack. This chapter delves into the role of HR in managing cyber risk and provides recommendations on how organisations can manage cyber risk effectively to support their HR departments.

As an occurrence that jeopardises vital national interests or the basic needs of the populace, a crisis necessitates rapid decision-making and coordination between various departments and agencies in order to resolve it effectively. As a result, crisis and disaster management systems are necessary and critical. Crisis and disaster response systems are intricate, requiring numerous phases, techniques, and resources. These systems require useful and necessary data that can be used to make future decisions more effectively, such as historical and current data on crises. The use of machine learning and big data technologies to process data from crises and disasters has the potential to yield significant results in this area. The first section of this document discusses crisis management systems and available tools, such as big data and machine learning. Additionally, a machine learning and big data approach to crisis management systems were developed, which included a description and experiments, as well as a discussion of the findings and the field's future directions.

Recent events have emphasised the critical nature of making key decisions with the support of innovative technologies to manage crises. This chapter will review pertinent literature on crisis management and existing categorizations or typologies before delving into crisis decision-making. Two distinct modes of decision-making are discussed: rational and intuitive decision-making. The following subsection conducts a review of articles in the literature on artificial intelligence and data-driven approaches, categorising them as rational and intuitive decision-making.

The recent coronavirus pandemic has wreaked havoc on global economies, heightening interest in crisis management. As a result, it is critical to provide decision-makers with some assistance in improving their decision-making. As a research field, artificial intelligence (AI) has permeated nearly every facet of human endeavour, gradually displacing humans in tasks with promising outcomes. By combining these two fields of research, this chapter proposes ADDS: an artificial intelligence-based decision-making framework for crisis management. It proposes a decision-support framework. The development of such a framework can be beneficial for two reasons: (1) it can aid in advanced crisis preparedness, and (2) it can result in effective and productive communication during a crisis. It is worth noting that a thorough understanding of this can aid in planning, controlling, and managing the situation.

Demand for the implementation of innovative technologies in accounting continues to grow in lockstep with the advancement of technology innovation. The objectives of this chapter are to familiarise readers with current and potential innovative accounting technologies for obtaining high-quality data and to identify success factors for enterprises implementing these technologies. This chapter expects to provide businesses with practical approaches and recommendations for successfully implementing innovative accounting technologies through a thorough presentation and critical evaluation of the aforementioned key topics. In terms of business success, an effective application can help businesses gain a competitive edge by providing more relevant and reliable accounting and management information necessary to navigate today's difficult economic conditions and volatile business environment.

The Lebanese economy has been experiencing dramatic changes marking political and financial waves of reform and turmoil over the last decade, and specifically after the latest consecutive recessions. All sectors of the local economy had been substantially affected by the economic recession. The accounting system

diverse and reflects a globalised version of contemporary higher education. Globalization, high-quality education, and increased competition for HE degrees have re-energized student migration, resulting in the formation of cross-cultural student environments at educational institutions worldwide. In essence, this culturally diverse higher education sector in the United Kingdom was expected to experience a range of effects from the COVID-19 pandemic crisis on students with asymmetric cultural backgrounds. This chapter provides a multidimensional experience of remote online education during the COVID-19 crisis.

Businesses today face more intense competition than in the past as a result of advancements in information and communication technologies. Supporting employees and developing positive relationships with their managers are critical for the organization's and employees' performance. Mobbing behaviour, which is prevalent in the workplace, has a detrimental effect on employees' performance and motivation. The purpose of this chapter was to assess an organization's mobbing behaviour from a management and marketing perspective and within the context of crisis management. The chapter also aimed to determine whether employee exposure to mobbing results in a significant difference in word-of-mouth communication (WOM). The research concluded that employee exposure to mobbing resulted in a significant difference in WOM.

The agri-food industry is in the midst of a massive crisis due to low economic growth and production. Recently, the adoption of several AI technologies has aided farmers in producing thousands, thereby reducing human intervention in food production. The components of artificial intelligence, which include learning, perception, problem solving, and reasoning, have aided the agri-food business industry in identifying sustainable models for crisis management. In this chapter, the author proposes a four-stage strategic roadmap for addressing the challenges associated with implementing artificial intelligence to manage crises in the agri-food business.

Citizens' health is a barometer of society's health, and thus healthcare is a primary focus of all governments/societies. Precaution is preferable to cure. It is critical to monitor patients on a regular basis and to treat them proactively. Despite being proactive, there is a possibility that patients will require reactive treatment. Over the last century, the healthcare industry has made tremendous strides. Technology has been critical to these advancements. This has aided doctors in diagnosing patients more accurately, resulting in more effective treatment. Healthcare costs have increased, as has the incidence of chronic lifestyle diseases and the ageing population. These factors are compelling healthcare stakeholders worldwide to pursue round-the-clock activity tracking and continuous monitoring of health parameters. Hospitals are critical for monitoring and treating patients. The purpose of this chapter is to discuss how hospitals are implementing newer technologies to monitor and treat their patients through the development of next generation affordable healthcare systems.

Foreword

Information Communication Technology (ICT) is critical to the development of global business because they have transformed how businesses conduct their operations and transactions. This has enabled global businesses to leverage ICT that facilitate crisis management, and which many organisations have been utilising to sustain their operations. This requires agreement on a brand of ICT that is geared toward the long-term viability of global businesses. This book defines ICTs as innovations or tools that enable organisations to rethink their global business and information technology strategies in the face of a global crisis, resulting in a better understanding of how they can adapt to such crises and other disaster scenarios.

The book delves into the social and technical implications of ICTs, as well as the viability of global business in the face of a global crisis. The lack of coverage on the use of ICT and innovative technology by global businesses during a time of global crisis underscores the importance of educating about the potential of such technologies to effectively manage crises or disaster scenarios. Finally, the book is motivated by the desire to advance theory in order to increase global business awareness of ICT that can aid them in adapting their business strategy in the face of a global crisis, thereby shedding some light on how technologies can promote business sustainability.

Dr. Mohammed Ali introduces a series of chapters on technologies related to crisis management and disaster scenarios, and written by dedicated and knowledgeable authors. It identifies several novel and previously unexplored issues, including the use of innovations powered by cloud computing, the internet of things (IoT), artificial intelligence, and big data among others to provide intelligent shared computing in order to increase simplicity, scalability, and efficiency.

Future Role of Sustainable Innovative Technologies in Crisis Management provide a unique perspective on the current and future role of technological advancements in global business adaptation during a global crisis. These concepts herald the emergence of new ICT and innovative technologies and future models and frameworks that integrate established crisis management strategies with cutting-edge technological advancements. Additionally, the book draws academics and practitioners' attention to the concept of developing business strategy and communication in a global business context through the use of technological paradigms such as cloud computing, the Internet of Things, artificial intelligence, and Big Data. Additionally, the book is inspired by a variety of engaging and insightful frameworks and models, including systematic literature analyses, sociotechnical theory, and case study analysis. Additionally, the book discusses recent global crises situations such as the COVID-19 pandemic and its effect on the use of ICT, which has gained popularity in the aftermath of the pandemic. The book's central thesis is the application of these technological paradigms in global business settings and the various ways in which they facilitate crises or disaster scenarios. As a result, a principled approach to managing crises via ICT is critical for global businesses to promote strategic adaptability and sustainability. This book fills a critical gap in the literature by being both conceptually elegant and operationally useful.

Dr. Mohammed Ali weaves the phenomena in this book with the zeal of an artist intent on creating a beautiful and intricate work of art that the public can appreciate. This can represent the editor's commitment to and goal of knowledge sharing in their domain, as well as anticipating future issues, much like a skilled researcher who needs to better allocate knowledge as a public good. The book combines the conceptual depth of a novel method for diagnosing existing industry gaps through ICT or innovative technologies with a practical perspective on how to connect this to business development and sustainability, as well as strategic adaptability in the face of a global crisis. The book identifies archetypes of emerging technology trends that aid in the diagnosis and discovery of global business issues, while also establishing a direct link between them and technological interventions.

Finally, the book accomplishes something that I believe will become increasingly critical in the coming years: it establishes the foundation for global business strategy and sustainability via current and future ICT and innovative technologies. As the technological landscape continues to evolve at a breakneck pace, organisations' business strategies will need to adapt to meet these technological demands in order to remain viable in the future. Dr. Mohammed's book demonstrates the path to crisis management and long-term change that global business must take in the future. I am both honoured and humbled to have been asked to write the foreword to this extremely useful and innovative book.

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Preface

OVERVIEW

Due to recent pandemic, multinational corporations have accelerated their adoption of digital technologies in order to continue their operations and manage any obstacles they may potentially face. The origin and evolution of new technologies in the face of environmental threats is a major focus of technology analysis and innovation management. When confronted with unexpected and harmful consequences of crises that necessitate an immediate and effective response, we look to emerging innovative solutions for resolution. New crisis scenarios are always emerging, particularly with the recent coronavirus disease (COVID-19), which is being studied for patterns of critical innovation. Our narrative approach to crisis management, grounded in the theory of technological exaptation, examines critical innovative technologies that are ultimately used to manage crisis situations. In light of global crises such as the pandemic threat and the opportunities for global business sustainability provided by innovative technologies, it is necessary to investigate the role of such technologies to manage crisis situations.

CONTEXTUAL FIT

On a global scale, crisis management is critical for long-term business development opportunities. Crisis situations or disaster scenarios that require businesses to adapt to new routines in order to confront and overcome crises necessitate the use of rapidly expanding information and communication technologies (ICTs) and innovations. This book discusses and illustrates the use of a variety of information and communication technologies (ICTs) and innovative technologies in crisis management, including cloud computing, artificial intelligence, virtual reality, blockchain, the Internet of Things, and big data (Ali, 2019, 2020; M. Ali, 2019; Ali M et al., 2018; Ali & Abdel-Haq, 2021; Ali & Edghiem, 2021; Ali et al., 2017; Ali, 2021; Ali et al., 2020a, 2020b). For a long time, these technologies were overlooked as a result of the global economic crisis and businesses' subsequent need to adapt to the new global landscape. As a result, determining the extent to which these innovative technologies contribute to the long-term value and sustainability of the business requires an examination of the crisis management context. Additional research is required to ascertain the extent to which innovative technologies can be used to develop long-term crisis management solutions. The purpose of this book is to educate readers about the potential for information and communication technologies (ICT) and innovative technologies to assist organisations in times of crisis. Organisations must acquire critical knowledge about how to use ICT effectively in order to adapt their business models to current crisis or disaster scenarios.

TARGET AUDIENCE

Crisis management, disaster scenarios, sustainability, information systems, information technology management, business studies, and emerging technologies are all discussed in this book. The book covers a range of topics, including cloud computing, ubiquitous computing, and emerging online technologies like artificial intelligence, virtual reality, and cloud computing systems. Crisis managers, for example, will be interested in the book's findings because they plan and advise businesses on how to respond to a global crisis situations. Anyone with a professional interest in the subject may refer to the information in Table 1:

Table 1. Reading guide for practitioners

Reader Interests	Chapter(s)	Section(s)
Background of technologies and rationale	2-10, 12-15	Introductions
Key Concepts	All	Discussions
Digital/Innovative technologies	2-10, 12-15	Main bodies
Crisis Management/Disaster scenarios	All	Main bodies
Systematic studies of innovations in crisis management	1, 11	Main bodies
Global crisis business cases	8, 9, 12, 13, 14, 15	Cases and main bodies
Conclusions	All	Conclusion

ORGANISATION OF THE BOOK

The book is organised into 15 chapters with a summary of each as follows:

Chapter 1

The COVID-19 crisis has engulfed several countries, leaving policymakers perplexed and unprepared to deal with the situation. Choosing the most appropriate course of action has become more challenging as a result of the infection and its effects on the body. While dealing with the coronavirus crisis and the stress that goes with it, new information technologies are critical in addressing and alleviating that stress. As a result, new information technology capabilities are required to address the challenges confronting policymakers when dealing with pandemic diseases such as COVID-19 in the past. As a result of the systematic review process used in this study, the best available evidence is synthesised from text and opinion to provide actionable advice to policymakers. The findings indicate that the challenges fall into two categories: battling the disease and mitigating its effects. Furthermore, the Internet of Things, cloud computing, machine learning, and social networking all contribute significantly to resolving these issues.

Chapter 2

Disaster management's objective is to minimise the potential damage caused by disasters, to provide victims with immediate and appropriate assistance, and to ensure an effective and rapid recovery. To accomplish these goals in the aftermath of a disaster, a coordinated and efficient rescue effort is required. As a result, breadth of information about the disaster's impact is required in order to plan an immediate and effective response. The Internet of Things (IoT) is poised to save lives in the event of a natural disaster. This chapter proposes an IoT-based solution for planning rescue operations in the aftermath of natural disasters. This chapter is further validated through an analysis of IoT technology adoption for disaster management using the task-technology fit (TTF) approach.

Chapter 3

Natural disasters have the potential to cause catastrophic damage and massive economic losses. Actual damages and losses have been increasing in recent years. As a result, disaster managers bear a greater responsibility to safeguard their communities in advance by developing effective management strategies. Numerous studies have been conducted on the processing of disaster-related data using artificial intelligence (AI) techniques, all with the goal of developing more effective disaster management strategies. This chapter summarises current AI applications in the four phases of disaster management: mitigation, preparation, response, and recovery. Numerous AI techniques can be applied to various stages of disaster management, and several practical AI-based decision support tools are demonstrated. It seems that the vast majority of artificial intelligence applications are focused on disaster preparedness and response.

Chapter 4

The regulatory and cyber risk landscapes are reshaping the role of human resources. As a result, information security/information technology (InfoSec/IT) professionals are increasingly being asked to assist organisations in determining and enforcing employee data permissions, training employees on cybersecurity policies, and assisting with employee-related cyber incidents in order to be prepared for any kind of cyber-attack. This chapter delves into the role of HR in managing cyber risk and provides recommendations on how organisations can manage cyber risk effectively to support their HR departments.

Chapter 5

As an occurrence that jeopardises vital national interests or the basic needs of the populace, a crisis necessitates rapid decision-making and coordination between various departments and agencies in order to resolve it effectively. As a result, crisis and disaster management systems are necessary and critical. Crisis and disaster response systems are intricate, requiring numerous phases, techniques, and resources. These systems require useful and necessary data that can be used to make future decisions more effectively, such as historical and current data on crises. The use of machine learning and big data technologies to process data from crises and disasters has the potential to yield significant results in this area. The first section of this document discusses crisis management systems and available tools, such as big data and machine learning. Additionally, a machine learning and big data approach to crisis management systems were developed, which included a description and experiments, as well as a discussion of the findings and the field's future directions.

Chapter 6

Recent events have emphasised the critical nature of making key decisions with the support of innovative technologies to manage crises. This chapter will review pertinent literature on crisis management and existing categorizations or typologies before delving into crisis decision-making. Two distinct modes of decision-making are discussed: rational and intuitive decision-making. The following subsection conducts a review of articles in the literature on artificial intelligence and data-driven approaches, categorising them as rational and intuitive decision-making.

Chapter 7

The recent coronavirus pandemic has wreaked havoc on global economies, heightening interest in crisis management. As a result, it is critical to provide decision-makers with some assistance in improving their decision-making. As a research field, artificial intelligence (AI) has permeated nearly every facet of human endeavour, gradually displacing humans in tasks with promising outcomes. By combining these two fields of research, this chapter proposes ADDS: an artificial intelligence-based decision-making framework for crisis management. It proposes a decision-support framework. The development of such a framework can be beneficial for two reasons: i) it can aid in advanced crisis preparedness, and (ii) it can result in effective and productive communication during a crisis. It is worth noting that a thorough understanding of this can aid in planning, controlling, and managing the situation.

Chapter 8

Demand for the implementation of innovative technologies in accounting continues to grow in lockstep with the advancement of technology innovation. The objectives of this chapter are to familiarise readers with current and potential innovative accounting technologies for obtaining high-quality data and to identify success factors for enterprises implementing these technologies. This chapter expects to provide businesses with practical approaches and recommendations for successfully implementing innovative accounting technologies through a thorough presentation and critical evaluation of the aforementioned key topics. In terms of business success, an effective application can help businesses gain a competitive edge by providing more relevant and reliable accounting and management information necessary to navigate today's difficult economic conditions and volatile business environment.

Chapter 9

The Lebanese economy has been experiencing dramatic changes marking political and financial waves of reform and turmoil over the last decade, and specifically after the latest consecutive recessions. All sectors of the local economy had been substantially affected by the economic recession. The accounting system which is directly connected with business sectors was hindered by the economic crisis developments where the compliance of business entities that are on the verge of collapse with IPSASs (International Public Sector Accounting Standards) became extremely problematic. This chapter explores robotic process automation (RPA) in the accounting domain from the perspective of the Lebanese economic crisis.

Chapter 10

Visual language communication has already gained significant traction in graphic design and marketing literature as a substantial communication approach for expressing visual designs for advertising products and services. However, VLC goes beyond the marketing arena, it has been known to support critical situations such as times of crisis or disaster. This chapter explores the role of visual language communication in managing crisis situations. The characteristics of visual communication are articulated through the lens of crisis management, together with the benefits and challenges that may impede or foster visual language communication to manage crises. The chapter concludes by recommending a typology for managing future crises using VLC innovations.

Chapter 11

The purpose of this chapter is to examine the transition from traditional teaching and learning methods that rely heavily on face-to-face interaction inside lecture rooms to online distance learning in the context of the pandemic. The existing literature is systematically reviewed using the guidelines for conducting systematic information system (IS) literature reviews, with the assistance of NVivo. Diverse experiences navigating the contingency transition to distance learning in the midst of the Covid-19 pandemic. The review's findings are presented in the form of various figures, tables, and graphs. It makes comparisons between the included studies' objectives, methodology, theory application, findings, perspective, and context. Additionally, the analysis compares the findings from prepared (in terms of infrastructure and training) and unprepared implementation cases. This chapter is expected to guide decision-makers in developing strategic action plans to enhance the online learning experience for instructors, students, and institutions as a whole during a crisis situation.

Chapter 12

The UK's higher education HE sector continues to be one of the most dynamic in the world, attracting 2,697,380 students by March 2021. The population of UK higher education students as a whole is extremely diverse and reflects a globalised version of contemporary higher education. Globalization, high-quality education, and increased competition for HE degrees have re-energized student migration, resulting in the formation of cross-cultural student environments at educational institutions worldwide. In essence, this culturally diverse higher education sector in the United Kingdom was expected to experience a range of effects from the Covid-19 pandemic crisis on students with asymmetric cultural backgrounds. This chapter provides a multidimensional experience of remote online education during the Covid-19 crisis.

Chapter 13

Businesses today face more intense competition than in the past as a result of advancements in information and communication technologies. Supporting employees and developing positive relationships with their managers are critical for the organization's and employees' performance. Mobbing behaviour, which is prevalent in the workplace, has a detrimental effect on employees' performance and motivation. The purpose of this chapter was to assess an organization's mobbing behaviour from a management and marketing perspective and within the context of crisis management. The chapter also aimed to determine whether employee exposure to mobbing results in a significant difference in word-of-mouth communication (WOM). The research concluded that employee exposure to mobbing resulted in a significant difference in WOM.

Chapter 14

The Agri-Food industry is in the midst of a massive crisis pandemic due to low economic growth and production. Recently, the adoption of several AI technologies has aided farmers in producing thousands, thereby reducing human intervention in food production. The components of Artificial Intelligence, which include learning, perception, problem solving, and reasoning, have aided the agri-food business industry in identifying sustainable models for crisis management. In this chapter, the author proposes a four-stage strategic roadmap for addressing the challenges associated with implementing artificial intelligence to manage crises in the agri-food business.

Chapter 15

Citizens' health is a barometer of society's health, and thus healthcare is a primary focus of all governments/societies. Precaution is preferable to cure. It is critical to monitor patients on a regular basis and to treat them pro-actively. Despite being proactive, there is a possibility that patients will require reactive treatment. Over the last century, the healthcare industry has made tremendous strides. Technology has been critical to these advancements. This has aided doctors in diagnosing patients more accurately, resulting in more effective treatment. Healthcare costs have increased, as has the incidence of chronic lifestyle diseases and the ageing population. These factors are compelling healthcare stakeholders worldwide to pursue round-the-clock activity tracking and continuous monitoring of health parameters. Hospitals are critical for monitoring and treating patients. The purpose of this chapter is to discuss how hospitals are implementing newer technologies to monitor and treat their patients through the development of Next Generation affordable Healthcare systems.

CONCLUSION

The book makes a contribution to the fields of ICT/IS, business management, and crisis management by examining the role of ICT or innovations in crisis management in global businesses. The theoretical implication of this book is the identification of an unusually complicated situation through an examination of crisis management culture and global business sustainability via ICT and innovative technologies in the face of global crisis or disaster scenarios. This is supplemented by methodological implications, such as the presentation of comprehensive global business scenarios in which these technologies are used to manage disasters or crises. Case studies revealed some fascinating trends regarding the current state of technology use and the propositions of ICT and innovative technologies that facilitate crisis management in global business settings, even during the most trying times, such as the Covid-19 pandemic. While these technologies provide an alternative business environment to the traditional business environment in the event of a pandemic, it is still unknown whether they can fully manage disasters or crises or whether the technology itself can produce the sustainable outcomes necessary to support a crisis management business model. Due to the exploration of ICT's potential to manage global crises, the themes of crisis management and sustainable innovative technologies have a significant impact on this book.

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Chapter 1
A Systematic Review of Information Technologies to Assist Policymaking in Crisis Management

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ABSTRACT

The COVID-19 crisis has engulfed several countries, leaving policymakers perplexed and unprepared to deal with the situation. Choosing the most appropriate course of action has become more challenging as a result of the infection and its effects on the body. While dealing with the coronavirus crisis and the stress that goes with it, new information technologies are critical in addressing and alleviating that stress. As a result, new information technology capabilities are required to address the challenges confronting policymakers when dealing with pandemic diseases such as COVID-19 in the past. As a result of the systematic review process used in this study, the best available evidence is synthesised from text and opinion to provide actionable advice to policymakers. The findings indicate that the challenges fall into two categories: battling the disease and mitigating its effects. Furthermore, the internet of things, cloud computing, machine learning, and social networking all contribute significantly to resolving these issues.

INTRODUCTION

Numerous benefits and scenarios can be facilitated in our daily lives by new information technologies and industry 4.0 innovations, such as cloud computing, the Internet of Things (IoT), artificial intelligence (AI) and big data (Ali, 2019, 2020; M. Ali, 2019; Ali M et al., 2018; Ali & Abdel-Haq, 2021; Ali & Edghiem, 2021; Ali et al., 2017; Ali, 2021; Ali et al., 2020a, 2020b). They are not only used for routine tasks; they are also used to determine life and death. At the moment, the world is experiencing an unprecedented global health crisis as a result of COVID-19, which is putting a significant strain on our

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societies (Okereafor, 2021). As a result, policymakers have encountered a variety of difficulties. When addressing the COVID-19 crisis, it is critical to pay close attention to policymakers' challenges and concerns. Information technology can be fully utilised in crisis management in this situation. Personal, organisational, and practical capabilities necessary to address the coronavirus crisis are embedded in a variety of information technology applications. When a crisis strikes, one of the most effective tools available to policymakers is information technology. The absorptive capacity of information system theories has had a profound effect on the scope and capability of information technology use (Vishwanath et al., 2019). The capacity of a country to absorb new knowledge and innovations is viewed as one of its strengths. Two critical factors can aid a country's system in becoming more innovative: its innovation capability and its absorption capacity. Emulation capabilities for future technology-related activities will be enhanced as a result of innovative efforts and investments. Increased absorption capacity has the potential to improve innovation dynamics while increasing R&D productivity and fortifying the country's policy commitment to technology-related activities (Castellacci, 2013). Due to the COVID-19 pandemic and policymakers' confusion, policymakers face a number of difficulties when dealing with a pandemic crisis. Following that, emerging information technologies are discussed as a potential solution. Therefore, this research presented the following questions to address these concerns:

RQ1: *What are the main obstacles that policymakers face in dealing with the COVID crisis?*
RQ2: *To what extent can new information technologies help us address these problems, and what are those capabilities?*

Following the below methodology, the results and conclusion are presented.

RESEARCH METHODOLOGY

We conducted this investigation using a variety of sources, including books and online articles. Key search terms used as part of the investigation include "pandemic challenges," "pandemic management challenges," "pandemic challenges," and "Coronavirus challenges." Between October 4th and October 11th 2021, Google Scholar was used to conduct the search. The authors sifted through the results and continued until they came across insignificant findings. Additionally, experts were consulted regarding the difficulties faced by policymakers during previous pandemic crises. Individuals who have published at least one article or have managerial experience in this field are considered experts in pandemic crisis management (see Table 1). For the sake of completeness, we included all publications that addressed at least one significant challenge. These sources shaped the initial framework of policymakers' challenges during the COVID-19 pandemic. The authors developed the framework after consulting with experts, implementing best practises, and adding interpretations to previously published articles. The authors investigated new information technologies and their applications to the challenges in the second research question. A literature review was conducted to ascertain the validity and accuracy of the aforementioned claims (Moher et al., 2009).

A quality assessment of the studies were also conducted to determine the reliability and integrity of the current literature pertaining to the pandemic challenges and supportive ICTs (see Table 2). The studies were assessed based on their individual components and study type, including the introduction, methods, results, discussion and conclusion. Scores were defined on a scale of 0-3, 0 being poor and 3 being great. A total score was calculated and converted to a percentage. 0-40% meant a poor study, 41-60% meant a fair study, 61-80% meant a good study and over 80% was a great study. Most of the studies featured were either fair or good, which indicates that the literature is still in its infancy and is starting to mature. This was further indicated by the strong results the studies show (65%), and the fair conclusions (65%) they present. This indicates that while scholars are beginning to gather real empirical data about the role of modern IT in managing contemporary crisis situations such as pandemics, the conclusions are speculative given the novelty of the research based on a recent world issue.

RESULTS

In this section, we discuss the potential for each new technology to address the issues raised in our research. Ten peer-reviewed journals or reputable institutes were chosen based on their implemented strategy for addressing the challenges confronting policymakers during a pandemic crisis.

Challenges for Policymakers During a Pandemic Crisis

Numerous studies examined how policymakers dealt with pandemic crises (Arabi et al., 2020; Cook & Cohen, 2008; Galaz, 2009; Levin et al., 2007; Reissman et al., 2006; Ting et al., 2020). Table 3 illustrates a framework of policymakers' challenges in managing the COVID-19 crisis based on available literature and reports from the Tony Blair Institute (Yiu, 2020). Disease encounters (COVID-19) and pandemic impact mitigation (COVID-20) are two distinct categories of impediments.

The first challenge relates to encountering the disease. The first step is to identify the most pressing issues. The planning, detection, tracing, and treatment of infected individuals fall into five categories, as do social interaction, control, and awareness, capacity building, and resource mobilisation. Disease control planning is a significant policy challenge because it impacts everything from the number of new infections to the speed with which a pandemic can be declared over if the disease continues to spread. Thus, making informed decisions about disease control and forecasting the end of an outbreak requires comprehensive and detailed information about the disease outbreak and its resolution. Additionally, early warnings should be issued prior to the pandemic causing any deaths or burdens, regardless of whether the disease spreads or not (Cook & Cohen, 2008; Galaz, 2009; Reissman et al., 2006; Ting et al., 2020; Yiu, 2020). Identification of individuals infected with infectious diseases is also critical. Testing every single person takes a lot of time and money, but it is not impossible due to the rapid spread of pandemics within a community (Cook & Cohen, 2008; Ting et al., 2020; Yiu, 2020). To assist with the tracking challenge, we should first narrow and define the areas and people with whom the patients have come into contact in order to identify those at risk of contracting the disease (Yiu, 2020). Although the ultimate goal should not be to detect the virus in patients or suspected human cases, patients should be tested and necessary care taken even if test kits and sufficient supplies are unavailable.

Finding and distributing vaccines in the event of an epidemic would be a significant challenge. Allocating medical equipment and qualified hospital personnel to those infected with the virus is a critical concern in this situation. Additionally, quarantined areas must provide adequate housing for their occupants. The most difficult aspect of resource allocation and management will be when an entire country is affected by a pandemic (Cook & Cohen, 2008; Reissman et al., 2006; Ting et al., 2020; Yiu, 2020). On a related note, the possibility of the virus being transmitted to medical personnel or patient families

Table 1. Studies summary

Study Author/Year	Title
Alevizopoulos et al. (2021)	Intelligent machines and mental health in the era of COVID-19
Arabi et al. (2020)	COVID-19: a novel coronavirus and a novel challenge for critical care
Azizy et al. (2020)	Do not forget Afghanistan in times of COVID-19: telemedicine and the internet of things to strengthen planetary health systems
Bai et al. (2020)	Chinese experts' consensus on the Internet of Things-aided diagnosis and treatment of coronavirus disease 2019 (COVID-19)
Cook & Cohen (2008)	Pandemic disease: a past and future challenge to governance in the United States
Galaz (2009)	Pandemic 2.0: can information technology help save the planet?
Javaid et al. (2020)	Industry 4.0 technologies and their applications in fighting COVID-19 pandemic.
Javaid & Kahn (2021)	Internet of Things (IoT) enabled healthcare helps to take the challenges of COVID-19 Pandemic
Menon (2012)	Challenges in disaster management
Oden et al. (2012)	Four Key Challenges in Disaster Response
Okereafor (2021)	Cybersecurity in the COVID-19 Pandemic
Reissman et al. (2006)	Pandemic influenza preparedness: adaptive responses to an evolving challenge
Singh et al (2020b)	Internet of Medical Things (IoMT) for orthopaedic in COVID-19 pan-demic: roles, challenges, and applications
Singh et al (2020a)	Internet of things (IoT) applications to fight against COVID-19 pandemic.
Singh et al (2020c)	Significant applications of virtual reality for COVID-19 pandemic
Shu et al. (2017)	Fake news detection on social media: a data mining perspective
Ting et al. (2020)	Digital technology and COVID-19.
Vishwanath et al. (2019)	Cyber hygiene: The concept, its measure, and its initial tests.
Wu et al. (2020)	Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV out-break originating in Wuhan, China: a modelling study

makes providing care to those who are infected extremely difficult. Additionally, as the patient population grows, hospitals will be unable to accommodate them all (Ting et al., 2020; Yiu, 2020). Additionally, the disease's treatment options raise a number of ethical concerns. Numerous people will perish if we do not have access to adequate medical equipment. Providing resources to a larger population than we currently have is fraught with ethical dilemmas (Levin et al., 2007). The primary goal of these social and control challenges is to avert pandemics among healthy people. A complete prohibition of all activities is used to reduce the virus's infection rate during all pandemics. Self-quarantine is also a significant challenge, as is persuading the public to do so. Additionally, monitoring individuals who have been quarantined is a difficult consideration (Cook & Cohen, 2008; Reissman et al., 2006; Yiu, 2020).

Healthcare stakeholders, as well as those outside the industry, require access to accurate, reliable, and relevant data and information. Establishing trust in health care services, preventing unnecessary hospitalizations, and combating the spread of false information are all made possible through the development of strong relationships with the various organisations and hospitals that comprise the health

Table 2. Quality assessment

Study	Research Type	Intro Criteria	Method Criteria	Results/Discussion Criteria	Conclusion Criteria	Overall Total
Alevizopoulos et al. (2021)	Qualitative	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	8/12 67% Good
Arabi et al. (2020)	Qualitative	Score: 1/3 Poor	Score: 2/3 Good	Score: 1/3 Poor	Score: 1/3 Poor	5/12 42% Fair
Azizy et al. (2020)	Qualitative	Score: 3/3 High	Score: 2/3 Good	Score: 3/3 High	Score: 2/3 Good	10/12 83% High
Bai et al. (2020)	Qualitative	Score: 1/3 Poor	Score: 2/3 Good	Score: 2/3 Good	Score: 1/3 Poor	6/12 50% Fair
Cook & Cohen (2008)	Qualitative	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	8/12 67% Good
Galaz (2009)	Qualitative	Score: 1/3 Poor	Score: 2/3 Good	Score: 1/3 Poor	Score: 1/3 Poor	5/12 42% Fair
Javaid et al. (2020)	Qualitative	Score: 2/3 High	Score: 3/3 Good	Score: 3/3 High	Score: 2/3 Good	10/12 83% High
Javaid & Kahn (2021)	Qualitative	Score: 2/3 High	Score: 3/3 Good	Score: 3/3 High	Score: 2/3 Good	10/12 83% High
Menon (2012)	Qualitative Secondary	Score: 1/3 Poor	Score: 2/3 Good	Score: 2/3 Good	Score: 1/3 Poor	6/12 50% Fair
Oden et al. (2012)	Qualitative	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	8/12 67% Good
Okereafor (2021)	Qualitative Secondary	Score: 1/3 Poor	Score: 2/3 Good	Score: 2/3 Good	Score: 1/3 Poor	6/12 50% Fair
Reissman et al. (2006)	Qualitative	Score: 1/3 Poor	Score: 2/3 Good	Score: 1/3 Poor	Score: 1/3 Poor	5/12 42% Fair
Singh et al (2020a)	Qualitative	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	8/12 67% Good
Singh et al (2020b)	Qualitative	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	8/12 67% Good
Singh et al (2020c)	Qualitative	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	8/12 67% Good
Shu et al. (2017)	Qualitative	Score: 1/3 Poor	Score: 2/3 Good	Score: 1/3 Poor	Score: 1/3 Poor	5/12 42% Fair
Ting et al. (2020)	Qualitative	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	8/12 67% Good
Vishwanath et al. (2019)	Qualitative	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	8/12 67% Good
Wu et al. (2020)	Quantitative	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	Score: 2/3 Good	8/12 67% Good
-	-	**Average**: 32/57 56% Fair	**Average**: 40/57 70% Good	**Average**: 37/57 65% Good	**Average**: 31/57 54% Fair	-
Total Overall: 140/228 (61% Good)						

care system, as well as the people who use them (Levin et al., 2007; Oden et al., 2021; Yiu, 2020). In the event of a pandemic, all patients infected would be left without beds, intensive care units, or medical staff to care for them. Due to the fact that the patient population is growing at an alarming rate, in-home treatment is necessary (Arabi et al., 2020; Cook & Cohen, 2008; Levin et al., 2007; Ting et al., 2020; Yiu, 2020). This is why it is critical to maintain people's health. Medical clinic staff who come into contact with patients and other uninfected patients on a regular basis are at a greater risk of infection. To prevent contamination of both the healthy and afflicted populations, appropriate policies should be implemented (Arabi et al., 2020; Ting et al., 2020). Collaboration between organisations, national and international cooperation, and resource mobilisation all aim to bring disparate areas and levels of government into harmony (Cook & Cohen, 2008; Yiu, 2020). A second area of concern is mitigating pandemic impacts, which includes taking steps to lessen the adverse effects of a pandemic. In a nutshell, it is about re-establishing normalcy, constructing infrastructure, assisting those in need, addressing psychological issues, and monitoring the evolving economic ecosystem. Pandemics have a detrimental effect on the economies of the countries affected. Numerous industries are impacted, including commerce, tourism, and transportation. The reduction of financial consequences and the imposition of financial damage is one of the most difficult obstacles for policymakers to overcome. Individuals in critical situations should receive the necessary training, and educational institutions should remain open as well. Additionally, it is critical to establish rules and policies that promote the use of digital services and make work-from-home options more accessible (Cook & Cohen, 2008; Menton, 2012; Ting et al., 2020; Yiu, 2020).

To re-establish normalcy, a country's ecosystem must be more legally sound and have improved infrastructure. Additionally, policymakers must demonstrate their willingness to alter and modify regulations quickly in order to avoid being stifled by unavoidable constraints that stifle unconventional but proven solutions to immediate problems (Yiu, 2020). Returning to a normal state without following health advice may increase the likelihood of the outbreak re-emerging. On the other hand, unsustainable businesses can amplify the negative effects of a pandemic. Policymakers should take a more sustainable path, beginning with their societies' basic needs and progressing toward a sustainable future. Another obstacle is assisting those in greatest need. The poor, the elderly, and the homeless are particularly vulnerable populations, as they are all at a greater risk of contracting diseases that are on the rise. The homeless population faces significant challenges in managing a pandemic due to their lack of access to a variety of medical facilities (Gaetz & Buccieri, 2016; Yiu, 2020). According to the Centers for Disease Control and Prevention (CDC), "the risk of severe illness increases with age among adults, with older adults being most at risk" (CDC, 2020). Pandemics can exacerbate people's mental health problems and anxieties. Individual emotions such as fear and anxiety, as well as increased emotional behaviour, have been observed during a variety of pandemics. It is not uncommon for shortages to occur as a result of people rushing to purchase items and taking unnecessary medications, resulting in a shortage of supplies. Concentrating on social and behavioural factors will always be challenging. Doctors, nurses, and other health care professionals face the same level of stress and fear of infection as the general public. Additionally, quarantine issues and people's increasing reliance on social media for social interaction contribute to a slew of psychological problems (Arabi et al., 2020; Galaz, 2009; Reissman et al., 2006; Yiu, 2020). Keeping an eye on the economic environment and estimating the impact of policy changes are also critical (Yiu, 2020).

Novel Information Technology Capabilities

It is no secret that information technology has played a significant role in society's operational and competitive environments for a long period of time. New information technologies may be able to assist policymakers in resolving a variety of issues. We can meet each challenge by leveraging the IT capabilities listed in Table 1.

The Internet of Things (IoT) has the potential to have a significant impact on addressing several of these issues. A smart object or device, such as a smartphone or Bluetooth, could be used to assist in diagnosis, reducing or eliminating the need for direct human intervention (Yiu, 2020). Infected individuals can be quickly and easily identified using these intelligent devices. Sensors placed throughout the treatment area will collect a variety of critical data, allowing medical personnel to avoid direct contact with patients while also lowering their risk of infection (Javid et al., 2020). A medical staff member's stress can be alleviated by avoiding direct contact with patients. Patients can be treated in the comfort of their own homes and monitored remotely via smart objects. This decreases the likelihood of all patients requiring hospitalisation. Doctors are expected to be able to maintain a physical distance from their patients while monitoring them remotely through the use of robots and cameras (Javid et al., 2020; Ting et al., 2020; Yiu, 2020). Chinese researchers have been examining IoT and cloud computing systems in order to diagnose suspected COVID-19 cases (Bai et al., 2020). As Azizi et al. (2020) noted, effective COVID-19 pandemic response efforts will require a strong focus on digital health and the Internet of Things. Vaishya et al. (20) discussed the use of artificial intelligence in the management of COVID-19. Singh et al. (2020a) discovered that the IoT is advantageous for detecting symptoms and administering treatment more quickly. Remotely treating patients who are not infected with other diseases is also possible with the Internet of Things (Singh et al., 2020b).

The spread of a virus can be predicted using machine learning algorithms, which can parse massive amounts of data and identify the virus's distinct pattern (Alevizopoulos et al., 2021; Yiu, 2020). The combination of big data and machine learning algorithms results in a more accurate and complete model. Additionally, machine learning algorithms can be used to conduct medical examinations for a variety of infectious diseases, including Ebola and avian flu (Javid & Kahn, 2021; Javid et al., 2020; Ting et al., 2020; Yiu, 2020). Using three databases, a framework for determining COVID-19's current and future status was developed with the assistance of Wu et al. (2020). Additionally, machine learning algorithms can be used to detect fake news and information on social media platforms. As a result, extensive research has been conducted on how to tell the difference between real and fake news on social media (Alevizopoulos et al., 2021; Shu et al., 2017; Wu et al., 2020). Training algorithms can also be applied to student evaluations. As a result, the tests are superfluous. Dashboards powered by artificial intelligence can be used to continuously monitor the economic crisis (Yiu, 2020).

Using social media to connect with others and share information is a great way to do so. When face-to-face communication is not possible, social networking enables global virtual communication. Additionally, social media platforms can be used to host conferences and meetings. Additionally, these networks will enable individuals to receive training in areas such as crisis management and teaching students (Yiu, 2020). In Singapore, accurate information about Covid-19 is distributed via the social networking service WhatsApp (Ting et al., 2020). Additionally, this academic social network has established a page for the exchange of COVID-19-related research and questions. Certain businesses will be able to sell their products via social media. Additionally, these systems can help alleviate some of the psychological stress caused by a lack of communication in families.

Quantum computing may be used in the drug discovery field to simulate virus behaviour against a drug because such processes are beyond the capabilities of personal computers. Cloud computing and its capacity can be used in this situation (Yiu, 2020). It is hoped that quantum processing will expedite the discovery of a drug or vaccine for COVID-19 infection. Research on COVID-19 will be aided by D-Wave Systems' unrestricted use of their quantum cloud frameworks (Castellacci & Natera, 2013).

Stress reduction can be accomplished through the use of virtual or augmented reality (Singh et al., 2020c). Collaborative work in a simulated environment has been made possible through augmented reality (Javid & Kahn, 2021; Javid et al., 2020). It is also used as a training tool. Numerous university practical courses, as well as a few health tips, such as the importance of hand washing, can be taught using this technology. Inadequate technical infrastructure preparedness for the effects of a pandemic can also be a significant impediment. Cloud computing enables businesses to operate online by hosting applications on the platform. Computing-based platforms can be used to remotely support employees in a variety of industries. Additionally, social isolation can be alleviated by utilising a cloud computing platform that supports digital life-related services (such as video playback).

Smartphones and mobile applications are critically important in the ongoing COVID-19 pandemic. Not only do the applications inform users, but they also self-evaluate an individual's recent contact with infected individuals in order to identify suspected cases of COVID-19 infection. In situations where medical facilities are scarce, clinicians can use an application to track the distribution of masks and other medical supplies to patients. A mobile GPS device can be used to track one's movements in infected areas or to keep track of one's distance from others (Ting et al., 2020; Yiu, 2020). Apart from that, businesses can leverage the internet to remain competitive.

When a vaccine is discovered, blockchain technology can be used to expedite the distribution of medication to patients (Ting et al., 2020). As a result, any institution can exchange sensitive data securely in a trusted environment, preventing the spread of fake news.

CONCLUSION

New information technology capabilities may aid in alleviating crisis stress and resolving existing crises during pandemics. While there are examples of IT being used to manage pandemics (for example, WhatsApp in Singapore, Google providing online information, and D-Wave Systems providing quantum computing), we are still a long way from fully exploiting these technologies at the moment. Even if a comprehensive system is difficult to implement, technology can significantly reduce the impact of pandemics on society. Additionally, not all countries have the resources necessary to capitalise on all of the aforementioned benefits. As a result, not all regions of a country enjoy equal access to resources. Regional disparities in resource distribution can exacerbate pre-existing inequality. All this may have an adverse effect on a society's ability to spread a pandemic.

While the role of information technology in crisis management has been discussed in the literature, it has received less attention from a stakeholder perspective (such as patients, nurses, and policymakers). Experimental field studies conducted by other researchers can also be used to validate the framework proposed in this study. As a proposed area of study, a repository of best practises for pandemic management through the use of information technology is also required. Professionals from all over the world should be able to contribute to the maintenance of this artefact and make their own suggestions for improvement. As of this writing, we have examined two distinct types of difficulties. To help prevent future

Table 3. Matrix for addressing the challenges to policymakers during a pandemic through the capabilities of IT

			Novel ICT Solutions						
Studies	**Challenges**	**Social Networking**	**Internet of things**	**Machine Learning**	**Virtual Reality**	**Cloud Computing**	**Big Data**	**Mobile Applications**	**Blockchain**
Cook & Cohen (2008); Galaz (2009); Reissman et al. (2006); Ting et al. (2020);	Control of disease		X	X			X	X	
Javid & Kahn (2021); Javid et al., 2020; Singh et al. (2020a); Singh et al. (2020b)	Treatment		X	X				X	
Cook & Cohen (2008); Galaz (2009); Reissman et al. (2006); Ting et al. (2020);	Tracing		X					X	
Cook & Cohen (2008)	Cooperation	X	X			X			X
Cook & Cohen (2008); Galaz (2009); Reissman et al. (2006); Ting et al. (2020);	Control & Awareness	X	X	X	X	X			X
Alevizopoulos et al. (2021); Arabi et al. (2020); Galaz (2009); Reissman et al., (2006); Yiu (2020)	Psychological Issues	X	X		X	X			
Javid & Kahn (2021); Javid et al. (2020)	Infrastructure Development	X				X			
Gaetz & Buccieri (2016)	Supporting Vulnerable individuals	X	X						
Cook & Cohen (2008); Menton (2012); Ting et al., (2020)	Sustaining Economic Stability			X					

pandemics, some experts believe a third category should be established to investigate the causes of the pandemic. We were not interested in those categories in this study. While these emerging technologies may aid in the fight against pandemics, they also introduce new dangers. As an IoT network, 5G may have unintended biological consequences. Prospective studies may be prompted by current concerns. It is based on the available literature, expert opinions, and the authors' interpretations. Due to the unique circumstances surrounding COVID-19, researchers were unable to connect with additional experts in all relevant fields and conduct additional appropriate research methods for this study. This could be interpreted as a study's shortcoming.

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Chapter 2
Managing Crisis Using Interconnected Devices Powered by the Internet of Things (IoT)

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ABSTRACT

Disaster management's objective is to minimise the potential damage caused by disasters, to provide victims with immediate and appropriate assistance, and to ensure an effective and rapid recovery. To accomplish these goals in the aftermath of a disaster, a coordinated and efficient rescue effort is required. As a result, breadth of information about the disaster's impact is required in order to plan an immediate and effective response. The internet of things (IoT) is poised to save lives in the event of a natural disaster. This chapter proposes an IoT-based solution for planning rescue operations in the aftermath of natural disasters. This chapter is further validated through an analysis of IoT technology adoption for disaster management using the task-technology fit (TTF) approach.

INTRODUCTION

Although crises cannot be predicted, the least that can be done is to be prepared for them. Relief operations after a crisis are vastly different and more difficult than aid distributions carried out by government agencies under normal conditions. Furthermore, due to the scale and magnitude of natural disasters, training through simulation of crisis situations is nearly impossible. Technology has its limitations, but it has the potential to help with relief operations planning, management, and after-effects analysis for long-term crisis management (Papadopoulos et al., 2017). Today's IoT technology is quite mature and has the potential to be extremely useful in crisis situations. Crisis management planning is heavily influenced by the area's topology, climatic conditions, habitat, and so on, as well as the machinery's available resources. Duhamel et al. (2016) proposed using operations research and management science heuristics to optimise resilience in relief operations while considering the impact of relief resource distribution on

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the population. Therefore, proper planning in a country-specific context involving various stakeholders is required for effective and efficient crisis management.

In the event of a natural disaster, society as a whole must be prepared to handle and assist one another (Pine, 2017; Yu et al., 2018). Government agencies are spending money to raise awareness through advertisements and other means. However, most of these are conducted without any feedback from the public, and thus there is ample room for increasing the effectiveness of government efforts if inputs from various sections of society are solicited and incorporated into proper planning of preparedness and relief operations. Inputs from society, combined with the use of IoT technology, can aid in proper crisis management planning (Dugdale et al., 2021).

Although there are some works in the literature that investigate the utility of IoT in crisis management (Botti et al., 2015; Yang et al., 2013), there is a need to identify and prioritise the information needed for effective management of relief operations in the event of natural disasters. The purpose of this chapter is to discuss the task requirements for personnel involved in crisis management operations. Furthermore, the chapter proposes an Internet of Things (IoT) solution for effective crisis management. The task-technology fit approach is used to validate the proposed solution, analysing the strategic value derived from using the proposed solution for crisis management operations. This work will lay the groundwork for technical solutions that can be implemented in the future to realise the benefits of the IoT in crisis management.

A review of the relevant literature has already been done and is presented in this section. In the aftermath of a natural disaster, the Internet of Things (IoT) can help relief workers with crisis management technology. There is a brief explanation of the task-technology fit (TTF) model in the review as well.

ROLE OF TECHNOLOGY IN CRISIS MANAGEMENT

There is a large body of literature devoted to field studies of crisis relief efforts (Jiang et al., 2004). Researchers used a variety of methods, including observing training exercises, interviewing participants, and iteratively refining initial prototypes based on their observations and experiences. Kyng et al. (2006) found that developing intelligent systems for immediate relief response was fraught with problems involving victims, experts, and information technology (IT). The research focused on a solution to identify and monitor patients in an emergency. The authors developed a design paradigm to deal with the identified issues and examined various prototypes to make recommendations for the implementation of such systems. For victims, medical equipment communicating over a wireless medium, such as a wireless bio-monitoring system, is required to meet the challenges. The difficulties faced by the experts prompted the creation of a real-time video model that makes use of a video camera, GPS, and digital compass to provide situational awareness. It is possible that IT-related issues will prevent experts from fully utilising the devices created for managing emergency responses (Asadzadeh et al., 2020).

Participatory design in emergency medical services was highlighted by Kristensen et al. (2006). Practitioners and researchers are both involved in the design and evaluation of a system as part of this inclusive and iterative process. As a result of this work, a set of concepts for assisting emergency medical services were developed. A wireless bio-monitor and a remote access display are both critical to our project. Remote access to sensor data and situational awareness of victims and available relief resources are the primary concerns of these paradigms. As outlined by Jiang et al. (2004), the following design issues were identified in emergency relief services: assessment of situation through multiple sources of information, resource allocation, resource accountability, as well as assistance in communicating the situation. Concerned about these design flaws, the authors came up with a conceptual prototype, and their findings include the following: first, crisis response efforts should prioritise protecting people and the environment; and second, redundancy is a critical design principle for enhancing communication reliability and ensuring efficient safety, all of which aim to improve situational awareness. More research has been done on the importance of proper situational awareness and appropriate decision-support systems for handling emergency situations during crisis (Anparasan & Lejeune, 2019). So, the development of information systems for emergency response (EIS) was pushed into focus. EIS should be able to provide first responders with adequate situational awareness so that the relief operation can be planned better.

The lack of situational awareness and intelligent decision-support systems can be blamed for human decision-making failures during the catastrophic events of Bhopal (Endsley, 1999), and 9/11 (Son et al., 2008). Computerized support systems for emergency decision-making have been examined and has shown that improving first responders' situational awareness (Rapuzzi & Repetto, 2018; Yang et al., 2013) can help them make better decisions . The ability of information support to provide an insight into the situation faced by the responders has been emphasised in important studies, which proposed technical models for emergency relief response. However, unlike an office information system, these systems do not just rely on static data. These EISs are made to operate in a highly dynamic environment, so they need up-to-the-second information on crisis impacts and the locations of the people and resources needed to carry out relief efforts.

INTERNET OF THINGS (IOT)

Kevin Ashton coined the term "Internet of Things" (IoT) in 1998 during a presentation at MIT's Auto-ID Centre (MIT) (Ashton, 2009). However, the International Telecommunication Union (ITU) officially introduced it in 2005 in the ITU Internet report (ITU, 2005). It is a semantic term used to describe an interconnected, world-wide system of objects with a unique identity and the ability to communicate via an industry-standard protocol. Humans, inanimate objects, intelligent software agents, and even virtual data are all examples of "things" that can be found on such a network. An effective data collection strategy and the ability to share collected data are prerequisites for the IoT paradigm. With the right technology, it is possible to create sophisticated decision support systems that provide more precise, organised, and intelligent services (Ali, 2021; Gubbi et al., 2013).

The Internet of Things, is an addition to the Internet that extends coverage to non-virtual objects. Fleisch (2010) on the other hand, questions whether the Internet of Things (IoT) is a service provided by the Internet, just like any other web service. The development of smart objects with sensing, communication, and actuating capabilities has grown rapidly since the conception of the Internet of Things in 2005. Numerous smart object applications are possible with these network-enabled devices, including environmental monitoring, health care, transportation and logistics, social networks, smart buildings, and more. Other examples include healthcare, transportation and logistics, and social networking (Chen et al., 2014; Gubbi et al., 2013; Islam et al., 2015; Niyato et al., 2009; Oztekin et al., 2010; Zanella et al., 2014). Distributed smart objects and communication infrastructure are critical to this new paradigm's applications because they provide a wealth of data. The Internet of Things (IoT) has the potential to become an enabling technology in crisis management. Other key use-cases include:

1. Minimizing and preventing crisis risk includes monitoring possibilities via satellite communication and geographic information systems (GIS), designing early warning systems, and using social media to raise awareness;
2. Real-time communication is essential for emergency relief and response;
3. Online systems for finding missing people and managing funds are essential for crisis recovery.

As a result of the constantly changing requirements and environment during a relief operation, quick and accurate decisions are critical. As a result of its ability to transmit real-time information updates, Internet of Things (IoT) technology can play a key role in implementing dynamic workflow adaptations. WIFA was proposed by Wang et al. (2008) as a tool for dynamically assessing and managing workflow. The research of Wang et al. (2009) improved the work by incorporating knowledge of the resource's status in terms of demand and availability. The authors proposed that using an intelligent user interface, Crisis management activities can be managed more efficiently. Similarly, the use of Radio Frequency Identification (RFID) in small and mid-sized businesses was studied by Fosso Wamba et al. (2016) using a conceptual model developed by the authors.

There has not been much research done on the impact of the Internet of Things (IoT) on crisis relief efforts. According to Yang et al. (2013), IoT technology can be used for emergency management. A lack of statistical analysis and qualitative hypothesis testing, however, plagues the work. To better understand the workflow of rescue operations following a natural disaster, we are focusing on how IoT can meet these task requirements and what long-term strategic value it can provide. The paper discusses how crisis relief operations can benefit from the use of Internet of Things (IoT) technology.

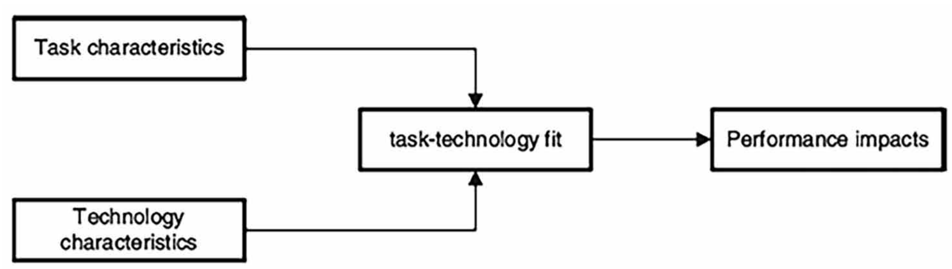
TASK-TECHNOLOGY FIT (TTF)

Individual performance and information systems collaborate in a variety of ways, as Goodhue and Thompson (1995) discovered. TTF is depicted in Figure 1 as a simplified model. Task characteristics refer to the things people do, while technology characteristics refer to the things people use to do the things they need to do. It is thus possible to define task-technology fit in terms of how much a technology catalyses an individual's activities to carry out the required tasks. TTF has put a lot of emphasis on helping people evaluate and explain the success of information systems and how they affect their own performance. To date, TTF has primarily been used to evaluate the success of information systems and to examine the impact on individual performance that this has had on them. Impacts on performance refer to a person's ability to complete a specific set of tasks. Greater efficiency, effectiveness, and quality are all components of better performance. In this way, TTF can assist in the development of a technology that can meet the task requirements. Through user performance estimation and technology utilisation, TTF examines the connection between tasks and technology fit.

CRISIS MANAGEMENT SCENARIO

When it comes to Crisis management, developing countries does things a little differently than other countries around the world. Local communities, government officials, and Crisis management organisations must work together effectively to conduct the rescue operation, as is well-known. Developing

Figure 1. Task-technology fit model



countries' community dynamics are quite complicated. The online Crisis management manuals clearly show how difficult it is in Developing countries to coordinate the efforts of rescue workers at various levels. Figure 1 shows how different levels of response coordination work together.

When developing countries' governments passed the Crisis Management Act in December 2005, they envisioned the creation of the National Crisis Management Authority (NDMA) and State Crisis Management Authorities (SDMAs) to lead and implement an all-inclusive approach to crisis management in the country as well. MAIT, an IT industry association that works closely with the government of developing countries on digital developing countries strategies, submitted a whitepaper in 2016 (Digital Developing Countries Action Group 2016) with the goal of raising awareness about the potential uses of IoT in crisis management in developing countries and covering some of the requirements, issues, and challenges associated with crisis management IoT applications. MAIT is an IT industry association. It also discusses several crisis management initiatives taken by the federal and state governments, which are detailed in the whitepaper. The Ministry of Home Affairs has developed a national crisis management framework. Everything from the institutional mechanism to prevention and early warning systems to crisis preparedness and human resource development is covered comprehensively in this plan. With the help of the government of developing countries and the United Nations Development Program (UNDP), the crisis risk management (DRM) programme is being implemented in 169 of developing countries' most vulnerable districts across 17 states. Figure 2 depicts developing countries' institutional crisis management framework.

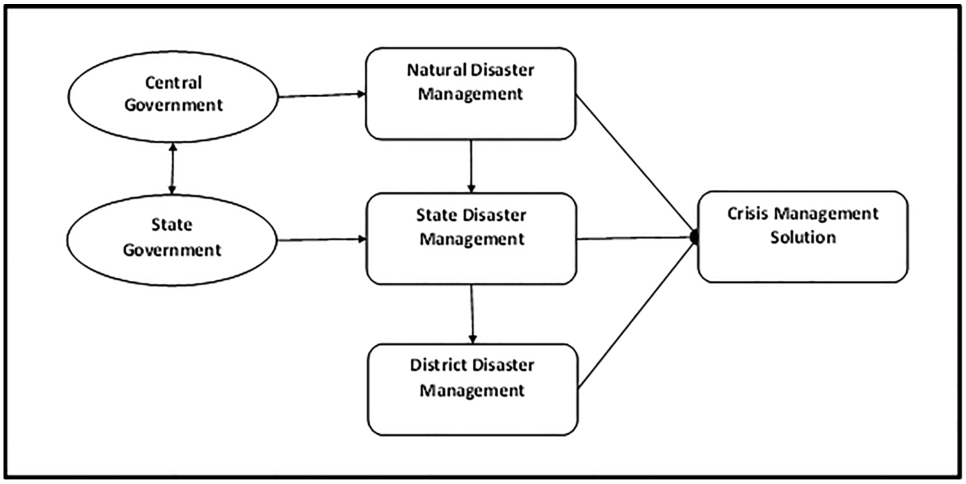
The whitepaper's framework, on the other hand, excludes feedback from those who have been affected, the crisis management team, and the public. For its effectiveness to be maximised, it must be implemented with input from various stakeholders, since visualising the actual crisis scenario by technical experts alone may not suffice. As a result, this work is critical to the success of any technical solution when implemented on the ground.

CRISIS MANAGEMENT PHASES

The following stages make up this investigation:

- Phase 1
    - Identify the information needed to begin relief efforts in the crisis area.
    - Define the main challenges that relief organisations and individuals are confronted with.

Figure 2. Crisis management framework



- Phase 2
    - Examine how and where Internet of Things (IoT) technology can be used to address the necessary problems.

Put forward an IoT-based technical solution to improve relief efforts following a natural disaster.

- Phase 3
- It is important to confirm whether the proposed solution will help to optimise relief operations using the Task-Technology Fit approach, which involves conducting a survey with those who are involved in relief operations.

Phase I

The following summarises the NDRF personnel, information, and crisis-area deployment requirements:

1. The crisis's date and time
2. Information about the affected region's location
3. Familiarity with the affected areas' topography
4. Number of people who have been harmed (dead, injured, and missing)
5. The crisis's impact on the local wildlife population
6. Affected area's contribution to global climate change
7. Property loss or damage
8. Future developments and new risks are forecasted

The land party may not be able to determine the relief operation's route solely based on knowledge of the crisis scene's location. The best route to the crisis site can be determined with the help of location information and topographical information. It will also aid in estimating the crisis's true size.

According to Wang et al. (2016), effective relief efforts necessitate combining proactive response methods with logistic expertise. Knowing how many people have died is critical for allocating the necessary relief resources for the rescue effort. Considering the impact of relief resource distribution on the population, Duhamel et al. (2016) proposed using operations research and management science heuristics to maximise resilience in relief operations. However, gathering data from the source is only part of the equation; incident commanders also need access to this data so that a successful relief operation can be planned. In a country like India, where crisis management organisations are frequently left in the dark when vital information is delayed,

Either a lack of appropriate technology infrastructure or the organisational structure's complicated hierarchy is to blame. As a result, the incident commander may not have access to complete or accurate data. Therefore, developing a proper technology infrastructure that can be used to obtain accurate and reliable information in real time is a pressing need.

Phase II

Three key functions are included in the IoT-based solution for effective crisis management:

1. Collecting of Information
2. Transmission of Information
3. Processing of Information

Collecting of Information

This entails gathering data on the crisis-affected area to make relief efforts more efficient. As discussed in Phase I, the Crisis Management Unit (DMU) needs a wide range of information to plan for early rescue operations. The knowledge of the current chemical composition of water in a flood-hit region can help determine what kind of disease is likely to spread because of contaminated water, as an example. Various data collection techniques are incorporated into the model, which can be used to analyse crisis site conditions in real time.

During rescue operations, emergency logistic planning is critical because crisis management relies heavily on the effectiveness of relief distribution networks, as Anaya-Arenas et al. (2014) demonstrated. It is important to plan logistics ahead of time by deciding on the supply source, quantity, and location of distribution centres, as well as how many people will need to be deployed. A location-routing model developed by Burkart et al. (2017) can help determine the best locations for relief resource distribution centres. A lot of these decisions must be made without knowing where the crisis has occurred. This information, along with the crisis site's location and topography, can be used to plan an effective evacuation route. Satellites have been keeping tabs on the crisis area's physical conditions. This information can be obtained. This information can be used to get a first-hand look at the damage and make decisions about things like the number and nature of rescue teams, equipment, travel routes, modes of transportation, and whether relief camps can be set up in the crisis area.

In addition to topological data, knowing the atmospheric conditions is also necessary for determining the resources needed for relief operations like air filter types, medicines, mosquito repellents, etc. For example, knowing the current chemical composition of the water in a flood-hit area can help determine the type of disease that could spread due to contaminated water. Sensors, satellites, and other devices can gather environmental data. To collect specific data from the environment, sensors must be small, low-power, and resource-constrained devices. As many sensors as possible are arranged in clusters to save on power consumption. To transmit the data collected by the cluster's sensors to either the base station or another cluster-head, there is a cluster-head on each node (Kumari et al., 2013). It is possible to use these sensors to keep tabs on the atmosphere's chemical composition as well as its air quality (particle matter, temperature, humidity, and atmospheric pressure) (percentage of CO, CO2, NO2, O2, O3, SO2, etc.).

It is critical for first responders to be involved in relief efforts, and they frequently use existing technology like web portals, message boards, and social networking portals to make an important contribution. Internet technology has been used successfully in the past to gather critical information about crises. The information was published on blogs, which are online diaries maintained by individuals. Images, videos, and first-person accounts of the crisis's impact could all be found on the blogs. Message boards have been used to share missing person information, shelter locations, and the whereabouts of family members. Shelter Finder and People Finder are useful tools for finding out about people in need of immediate shelter and for locating missing family members. In the event of a crisis, these are the first steps people take to help their neighbours.

Due to the proliferation of message boards, web portals, and blogs, socio-technological networks are now unofficial and informal. Increased use of online information sharing builds the cyber-community, which links people from all over the world. It is the goal of these resources to provide timely, accurate information, and real-time communications can occur occasionally. Like in Internet GIS applications, this spatial information is implied rather than explicit (Asadzadeh et al., 2020; Huang, 2017). Questionnaires are used to gather spatial data, such as victims' last known locations, addresses, and shelters. As a result of this information, crisis experts are better able to estimate its full scope.

Communication of Information

In crisis management, one of the most difficult challenges is keeping people in the crisis area in touch. DMU must be informed of sensor and satellite data collected on site so that immediate action can be taken. An Internet-connected gateway is required to send the data to the DMU. Sensor data will be sent to a local coordinator stationed to keep an eye on those sensors (Kumar et al., 2012). It will be possible for the gateway to receive satellite data as well as input from the local community. The gateway oversees managing the regional coordinators, collecting the received data, and sending it to the DMU's central database via the Internet. Either the GIS maps on the GIS server can be enhanced with this data, or the DMU's online portal can be used to collect first-hand information about the crisis site. Because of the crisis, it is possible that Internet access will be down. Anytime that scenario arises, the DMU will make preliminary decisions based on the most recent data received. Until connectivity is restored, the gateway will keep collecting and storing data. The data can then be sent to the DMU using the communication channel that was established. Even if connectivity cannot be restored, personnel visiting the crisis site will be provided with a solution (i.e., software or hardware) to pull the data from the gateway. The personnel will be the ones to transmit this information to the DMU. This will ensure that the DMU receives as much information as possible about the crisis site.

Processing of Information

The DMU will be able to regulate relief operations once it receives the aforementioned information. Short-term immediate relief decisions will be aided by preliminary data. This information will be sent to the DMU once the first response team is fully operational in crisis areas. The following will be included in the data:

Update on Environmental Conditions

- Determine the Crisis's magnitude, for example, by counting the number of victims.
- Amount of food, medicine, water, etc. that must be consumed.

This real-world data will be useful for long-term crisis relief planning. As a result, data processing will be split into two phases:

1. When the DMU receives the crisis site sensor and satellite data. This will assist in determining the extent of damage and environmental conditions at the target location first-hand.
2. When the first relief team sends the information This information will be put to good use in figuring out how much food, medicine, and water people need.

Phase III

In this phase, the research problem is empirically studied through the lens of Task-Technology Fit. The following sections go over the methodology used to assess the IoT-based crisis management solution that was proposed:

Task-Technology Fit Approach

This chapter covers the TTF concepts that are used here, but they have been slightly tweaked. Task requirements and IoT technology characteristics are two terms we use to describe the same thing. However, since IoT technology is still in its infancy in crisis management, the term "performance impacts" is used to describe the overall benefits derived from using IoT technology to meet crisis management's information needs.

Task Requirements

RTF tasks can be defined as the things people do to get the information they need to do their jobs (Goodhue and Thompson 1995). This definition aided us in modelling the tasks as personnel requirements for relief operations planning. Information comes in many forms, including environmental data from the crisis site, the number of people killed or injured, and so on. We can easily deduce that this information is required for assessing the crisis's impact and efficiently planning the rescue operations. Reliability and consistency of the received information are also important considerations.

Depicts the flow of information and the order of activities during the relief operation. Existing literature models the task construct as a non-routine and interdependent one; a set of managerial questionnaires; communication centrality; tasks with varying structural complexity; and the use of the Internet to resolve uncertainty in personal travel. In the existing literature, the task construct has However, emergency management-related research is more relevant and significant for our investigation. Research has modelled the construction of emergency management tasks like resource, information management, automation, training and authentication.

However, this new exploratory study looks at task characteristics as a composite requirement for efficient and effective rescue operation planning as opposed to the previous task modelling. The task requirements construct has been measured using requirements such as crisis impact assessment information, the ability to easily monitor obtained information, and the reliability of the received data.

Technology: Proposed IoT Solution

Technologies are the tools that users use to accomplish their tasks more quickly and efficiently (Goodhue and Thompson 1995). Technology implies the IoT-based solution proposed to meet the need for various information required for planning the relief operation following any natural disaster in the context of IoT-based crisis management (Xu et al. 2014). Adapting crisis management technology to individual needs is critical, and the RTF model stresses this (Yang et al. 2013). There is a substantial body of literature indicating that better fit results in improved benefits. To design the scale items for measuring technology characteristics, we considered various functionality of the proposed IoT-based solution.

Modelling TTF for IoT Supported Crisis Management

The current TTF framework is based on eight underlying factors that help us better understand technology adoption. Authorization, quality, ease of use/training, accessibility, dependability, timeliness of production, compatibility, and relationships with others are some of the factors to take into consideration (Goodhue and Thompson 1995). Crisis management, on the other hand, could lead to different realisations of these factors. This leads to the identification of four constructs to be used in the research model. Constructs include being aware of the current situation, being consistent, being reliable, and monitoring one's own behaviour. Being aware of one's situation means having the ability to assess one's current situation based on all the available information. This is crucial for the proposed IoT-based crisis management solution's adoption because it is relevant to the assessment of the crisis's impact (Carver and Turoff 2007).

According to consistency, information about a particular entity that is gleaned from several different places should not be significantly different. Goodhue and Thompson dubbed this concept "compatibility" for Goodhue and Thompson, respectively (1995). There must be a way for the proposed solution to provide constant information from multiple sources to fully understand the calamity's impact. If the proposed IoT-based solution is reliable, it should be able to provide data even under adverse circumstances. This feature ensures that even in the worst-case scenario, information can be obtained and that the system must be ready for use at any time (Goodhue and Thompson 1995). As a final note, monitoring is concerned with how well the proposed system can present information to end users in an easy and efficient manner, allowing for better analysis of the received data (Robillard and Sambrook 2008; Jiang et al. 2004; Li and Visich 2006; Fang et al. 2014).

Performance Impact: Strategic Value

Performance impact in crisis management refers to the overall strategic value that can be inferred by putting technology to work to meet the project's requirements. Greater RTF and satisfaction with technology are correlated with higher levels of strategic value (Goodhue and Thompson, 1995). It is no secret that good RTF adds to the overall value of a system. Crisis management personnel must have as much information as possible about the crisis's impact as early as possible. Planning the rescue operations after a crisis necessitates making important decisions about the size of the rescue teams, the operation's route, and the amount of relief resources needed. Current circumstances necessitate longer response times for rescue operations because this information is frequently delayed before reaching the appropriate authorities (Anparasan and Lejeune 2017). The proposed Internet-of-Things (IoT)-based solution provides the rescue authorities with the necessary information in real time so that the relief operations can be planned efficiently as early as possible. It is necessary to determine the impact of the proposed IoT-based solution's benefits on the overall strategic value.

CONCLUSION

The process of disaster management is not linear. Appropriate response at each stage of the disaster management cycle improves preparedness, increases early warning reliability, decreases vulnerability, and mitigates the impact of a repeat disaster. Public policies and strategies must be developed at each stage of the disaster management process in order to prevent or mitigate the impact of disasters. This article proposes an innovative Internet of Things-based solution for providing real-time information about disaster-affected areas in order to expedite and efficiently coordinate rescue efforts. The primary objective of this chapter was to determine the suitability of an IoT-based solution for immediate relief operations following a natural disaster. The study accomplishes its objectives by adapting the existing TTF model for use in disaster management. Certain types of data are required immediately following a disaster relief operation in order to accurately assess the disaster's impact and plan an efficient response. On-scene information systems are required to assist incident responders in making the best rescue operations decisions possible given the environmental conditions, casualty count, response personnel, and available rescue resources.

This study chapter significantly to our understanding of how the Internet of Things (IoT) affects disaster management. It delves deeply into the use of IoT in disaster management, from defining critical requirements for relief operations to developing and validating an IoT-based solution to address those requirements. Any emergency system will be successful if the appropriate data is collected, shared with the appropriate people, and presented in the appropriate format. As a result, the Internet of Things-based solution proposed in this chapter has the potential to support a broad range of emergency response applications. IoT technology can be used effectively in disaster management. It cannot be emphasised enough how the information presented in this chapter will serve as a foundation for developing Internet of Things-based solutions that meet the needs of personnel managing post-disaster rescue operations. For more information about IoT and similar technologies in this domain, please refer to the following studies (Ali, 2019, 2020; M. Ali, 2019; Ali M et al., 2018; Ali & Abdel-Haq, 2021; Ali & Edghiem, 2021; Ali et al., 2017; Ali, 2021; Ali et al., 2020a, 2020b)

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Chapter 3
An Artificial Intelligence (AI) Approach to Controlling Disaster Scenarios

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ABSTRACT

Natural disasters have the potential to cause catastrophic damage and massive economic losses. Actual damages and losses have been increasing in recent years. As a result, disaster managers bear a greater responsibility to safeguard their communities in advance by developing effective management strategies. Numerous studies have been conducted on the processing of disaster-related data using artificial intelligence (AI) techniques, all with the goal of developing more effective disaster management strategies. This chapter summarises current AI applications in the four phases of disaster management: mitigation, preparation, response, and recovery. Numerous AI techniques can be applied to various stages of disaster management, and several practical AI-based decision support tools are demonstrated. It seems that the vast majority of artificial intelligence applications are focused on disaster preparedness and response.

INTRODUCTION

Natural disasters are claiming an increasing number of lives and livelihoods (Hoeppe, 2016), and has cost the US economy more than $300 billion in 2017, with Hurricane Harvey alone causing $125 billion in socioeconomic losses (Stephens et al., 2020). Local governments are being forced to revisit their disaster management policies because of the difficulties faced by disaster response managers, who are increasingly constrained by a limited supply of resources and a fatigued workforce.

Daily massive amounts of data, both real and virtual, are generated. Both types of data can be beneficial for disaster management. Massive amounts of real-time information are now available via social media, telecommunications data, and remote sensing (Novellino et al., 2019). Regardless of the type of data, data acquisition, management, and processing are critical components of disaster management. Artificial intelligence is increasingly being used in disaster management to aid in effective decision-making by

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rapidly extracting useful and reliable information from large amounts of data (Ali & Abdel-Haq, 2021; Eskandarpour & Khodaei, 2017; Yu et al., 2018).

Numerous published studies examine the use of artificial intelligence in disaster management. According to Fotovatikhah et al. (2018), computational intelligence methods can be used to manage major floods and disasters, but there are significant challenges. However, in their review of disaster management data mining and machine learning applications, Zagorecki et al. (2013) omitted any practical AI-based decision support tools. As demonstrated in other studies, disaster management can benefit from the application of computer vision techniques such as target recognition via deep learning (Zhang et al., 2016), fire detection via wavelet analysis and neural networks (Yuan et al., 2015), and estimation of three-dimensional structures from remote sensing data (Zhang et al., 2016). Although AI has been used in various phases of disaster management, few have discussed the progress and challenges associated with its application, considering hazards and infrastructure as well as data in general.

Following an overview of the research context for AI and disaster management, the four phases of AI research and practise in disaster management are discussed in this chapter, along with the associated challenges. There has been considerable interest in practical decision-support tools for disaster management that are based on artificial intelligence methods. This study provides a comprehensive overview for new researchers on how to choose an appropriate artificial intelligence model and practical decision support tool based on their community's needs.

HISTORICAL CONTEXT

Artificial Intelligence Methods

Artificial intelligence is classified into two types:

To summarise the current state of research and practise in disaster management, this study categorises AI methods into six categories: supervised models, unsupervised models, deep learning, reinforcement learning, deep reinforcement learning and optimisation.

Instructor-Supervised Models

Pre-existing data is used to train supervised algorithms. Supervised models make use of labelled training data to predict the value or category of an output variable using regression or classification methods on previously identified input/output pairs (Russell and Norvig 2016). Sustaining models have been used to extract data, recognise objects in computer vision, recognise patterns, and recognise speech, to name a few applications.

Unsupervised Models

Unsupervised models, which do not require human intervention, use statistical techniques to uncover hidden structures in unlabelled data based on inherent characteristics ((Russell & Norvig, 2016). Unsupervised models are effective at detecting anomalous data and reducing its dimension, and they have a wide variety of applications in clustering and data aggregation problems. Clustering algorithms are used to categorise unlabelled data by dividing it into multiple groups based on shared characteristics.

Bandyopadhyay and Maulik, Reduced-complexity algorithms, such as principal component analysis (PCA), can assist in avoiding overfitting.

Deep Learning

Deep learning is a class of algorithms that employ multiple layers to extract features incrementally from input data, resulting in improved learning performance and a broad range of application possibilities (Deng & Yu, 2014; Pouyanfar et al., 2018). Even though they require a lengthy training period, deep learning algorithms are particularly well-suited for resolving damage assessment, motion detection, and facial recognition problems, as well as transportation prediction and natural language processing for disaster management support. For example, natural language processing (NLP) has benefited from the application of recursive and recurrent neural networks (RvNN and RNN) (Socher et al., 2011). Convolutional neural networks (CNNs) are well-suited for image recognition, computer vision, natural language processing (NLP), and speech recognition (Krizhevsky et al., 2017).

Engaging and Motivating Learning

Reinforcement learning algorithms are modelled as Markov decision processes to address goal-oriented problems requiring sequential decision making. They learn from a series of reinforcements (using punishment and reward as positive and negative signals, respectively) (Russell and Norvig 2016). As demonstrated by its successful applications in robotics, resource management, and traffic light control, reinforcement learning is well-suited for solving problems that require a series of decisions in an uncertain and complex environment. The primary challenge in reinforcement learning is creating an environment that is highly relevant to the tasks at hand. Two popular reinforcement learning algorithms are Q-learning and SARSA (State-Action-Reward-State-Action) (Sutton & Barto, 2018).

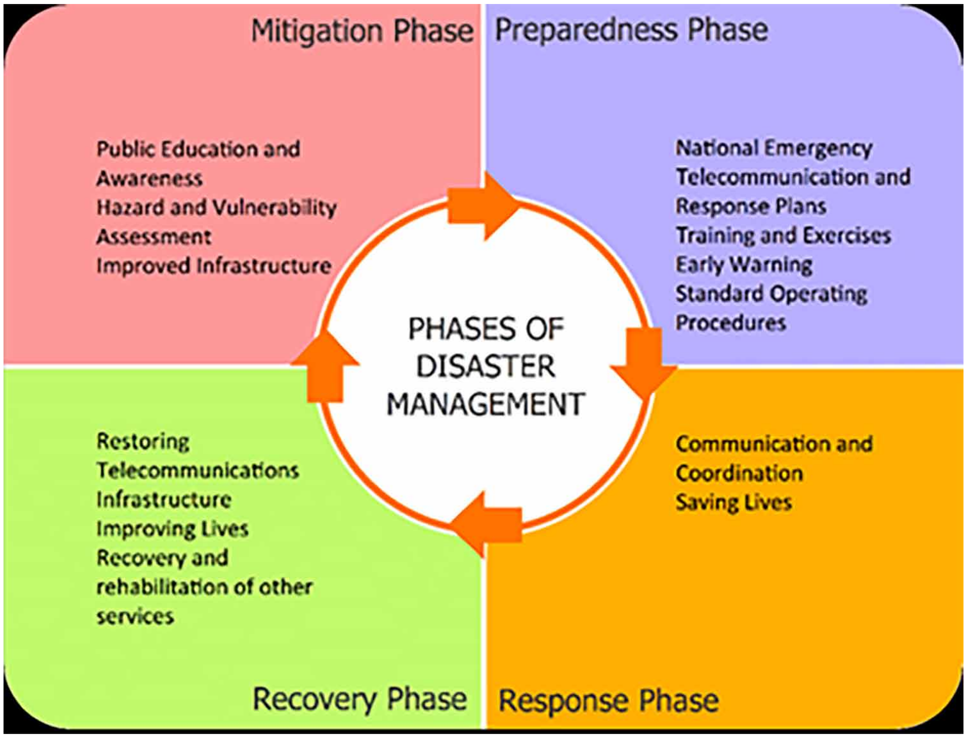
Deep Reinforcement Learning

Deep reinforcement learning is a technique that combines reinforcement learning and deep neural networks with the goal of developing software agents that can self-learn how to create successful policies for long-term reward maximisation. When it comes to solving problems involving complex sequential tasks, such as computer vision, robotics, finance, and smart grids, deep reinforcement learning outperforms traditional machine learning. Deep reinforcement learning, which requires a large amount of training data and time to achieve reasonable performance, can become prohibitively expensive computationally.

Optimisation

While this study focuses on the application of AI methods to disaster management, most AI methods require optimisation to find the optimal model as defined by an objective function. As a result, this study discusses three optimisation techniques in detail and examines their application to disaster management.

Figure 1. Four phases of disaster management (International Telecommunications Union, 2019)



MANAGEMENT OF DISASTERS

Phases of Disaster Management

Disaster management, as illustrated in Figure 1, is divided into four stages: mitigation, preparedness, response, and recovery. The mitigation phase entails management activities aimed at averting or mitigating future emergencies and their consequences in the long run. The disaster management process is divided into four phases, as illustrated in Figure 1.

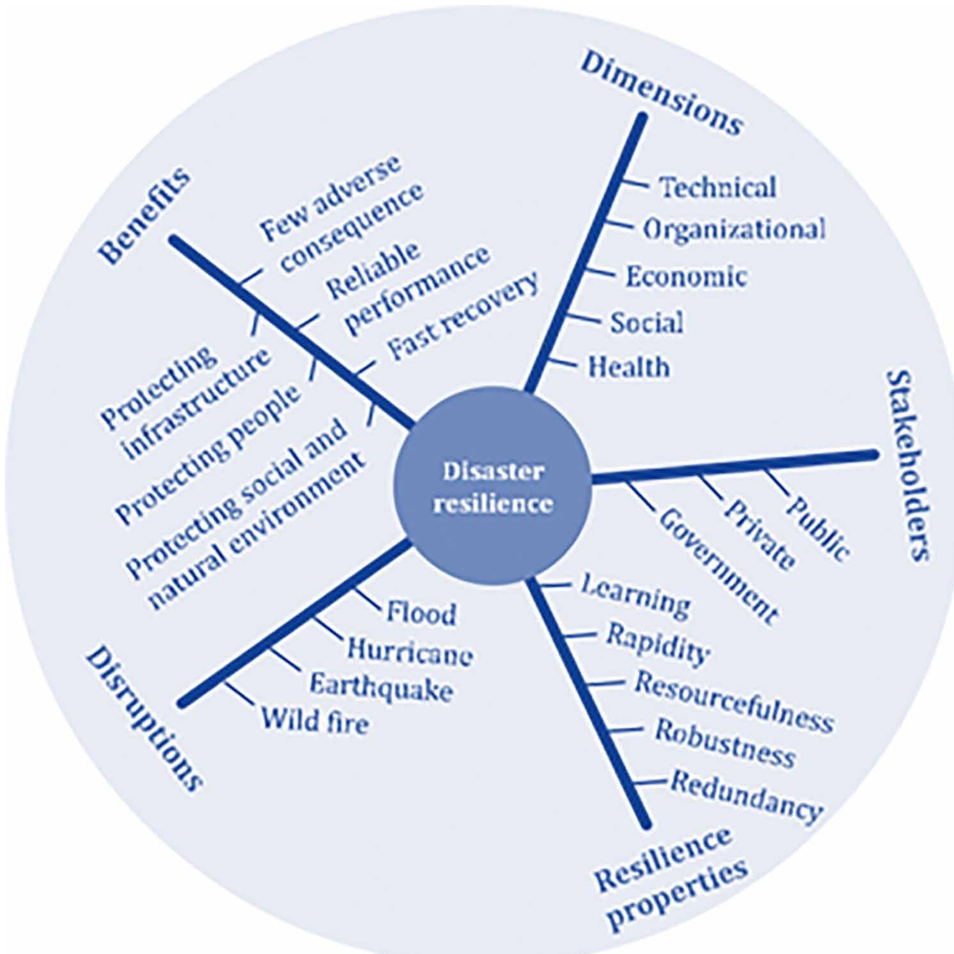
Mitigation activities may include enforcing advanced building codes and standards, retrofitting highway overpasses, hospitals, and shelters, as well as educating and informing the public and other stakeholders about potential hazards and mitigation strategies. When an emergency or disaster is imminent, the preparedness phase begins. It refers to actions taken in advance of a disaster to save lives and aid response and rescue operations, such as stockpiling food and water, posting emergency contact information, and preparing evacuations. Following the development of plans and strategies in advance, the response phase primarily enacts them. Typically, response activities include evacuation of threatened areas, firefighting, search and rescue operations, shelter management, and humanitarian assistance during a disaster. Following a disaster, the recovery phase is concerned with restoring the property to its pre-disaster state, if not better. Recovery efforts typically include debris clean-up, accurate damage assessment, infrastructure reconstruction, and financial assistance from government agencies and insurance companies.

Disaster Preparedness

Disaster management's objectives are to implement operations and strategies that enable effective preparation, rapid response and rescue, efficient resource allocation, rapid dam-age correction, and restoration of full functionality, ultimately protecting the community and minimising adverse impact. That is, disaster management that is effective should increase a community's resilience to disasters. The term "disaster resilience" refers to an organisation's ability to anticipate, resist, absorb, adapt to, and recover quickly from a sudden disturbance (DHS 2010). The dimensions, stakeholders, disruption types, resilient entity properties, and benefits of disaster resilience are depicted in Figure 2. In the event of a disaster, such as a hurricane or an earthquake, a resilient community is expected to protect its residents, infrastructure, and socioeconomic environment through reliable performance and rapid recovery, with the least number of negative consequences. Increases in rapidity, robustness, resourcefulness, and redundancy, as well as in learning capability, refer to residents' changing expectations for infrastructure performance and infrastructure operational adaptations to new circumstances during and after a disaster (Sun et al., 2020). Governments and other stakeholders structure their operations in a variety of ways (technical, organisational, economic, social, and health-related), developing and implementing a variety of management plans and strategies.

Numerous programmes have been established to advance disaster resilience research and practise, with the goal of facilitating informed disaster management decision-making. Several examples from the United States of America are provided below. Since 2013, the Campus Resilience Program has developed effective tools and guidelines for assessing the vulnerability of the aca-demic community across the country. The Hazard Mitigation Grant Program (HMGP) assists communities in implementing cost-effective hazard mitigation measures, such as structure retrofits and reconstruction, to eliminate future disaster-related fatalities and property damage. The Community Resilience Planning Guide outlines a six-step process for assisting local community authorities in identifying vulnerabilities, developing resilience plans, and implementing strategies to strengthen community resilience in the face of future disasters. Additionally, local governments and private organisations have enacted resilience-enhancing policies. For example, Los Angeles County in California has developed a community resilience toolkit to assist decision-makers in disaster management (Bromley et al., 2017). The 100 Resilient Cities programme assists local governments in promoting urban resilience, mitigating the effects of climate change, and advancing equity. Simultaneously, other countries have been pursuing this objective aggressively as well. The Horizon 2020 Research and Innovation Programme developed the European Resilience Management Guideline and tools to assist in the effective management of disasters and the enhancement of disaster and climate change resilience. As part of the Sendai Framework for Disaster Resilience Network, the Asia-Pacific region has been undergoing significant reforms in terms of developing disaster management policies, with an increased use of artificial intelligence in disaster response (Renwick, 2017). All these guidelines and computational tools are intended to aid in the management of disasters and to strengthen disaster resilience. By processing large amounts of disaster-related data more efficiently and effectively, AI has the potential to significantly reduce the burden on disaster management decision-makers.

Figure 2. Disaster resiliency characteristics



APPLICATIONS OF AI FOR DISASTER MANAGEMENT

Between 1991 and 2018, the number of World Cat publications on the use of artificial intelligence in disaster management increased steadily. According to the number of publications in this field, AI is most frequently used in disaster response. While AI will never be able to fully replace disaster management professionals' experience and wisdom, AI techniques can rapidly analyse large amounts of data and perform predictive analytics to aid in disaster management decision-making in the future.

To demonstrate how various AI methods have been used in disaster management, examples of AI methods and application areas are presented below. Hence, this section discusses the use of artificial intelligence in disaster prevention and mitigation.

During the disaster mitigation phase, decision-makers must identify hazards and risks, forecast possible impacts, assess vulnerability, and develop mitigation strategies. Artificial intelligence has been widely used in four areas of disaster management. However, there is a dearth of deep reinforcement learning and reinforcement learning applications in the four domains.

The community should be made aware of potential dangers and risks. Natural hazards require the development of hazardous zone maps, which requires an analysis of the land's characteristics, lithology, meteorology, and human activities. To identify hazards and risk factors, conventional methods such as field monitoring, physics-based models, expert surveys, and multi-criteria decision making are used. These labour-intensive methods may result in a high rate of false alarms (Bellaire et al., 2017). Rapidly analysing large amounts of data using AI techniques enables the identification of potential hazards. Numerous studies have been conducted to develop susceptibility maps for a variety of hazards using artificial intelligence. For instance, predictions of snow avalanches have been made using logistic regression (LR), support vector machines (SVM), and neural networks. Other types of hazards have been addressed using AI techniques, including mapping forest fire susceptibility, predicting fire size, and forecasting precipitation. It is also possible to assess the vulnerability of structures and communities using data from physical sensors and social sensing, as well as spatial regression models, neural networks, and deep neural networks. In comparison to the number of publications on hazard forecasting and risk assessment, the number of publications on hazard impact estimation and community vulnerability is significantly smaller (Wang et al., 2019).

Impact and vulnerability analyses can assist decision-makers in gaining a better understanding of their situation and developing effective mitigation strategies, such as retrofitting vulnerable structures (Bittencourt et al., 2016), elevating electric substations and utilising underground cables (Duffey, 2019), and developing effective disaster-related policies (Sun et al., 2022). AI can aid in this process by assisting in the development and comparison of mitigation strategies. Numerous artificial intelligence (AI) techniques have been used to establish management priorities, forecast the needs of those impacted by natural disasters, and recognise human activity (Sadiq et al. 2018). Clustering and optimisation algorithms can be used to analyse remote images and develop contingency plans, respectively (Dou et al., 2014).

APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN DISASTER PREPAREDNESS

Once decision-makers identify an impending disaster, they should issue early warnings and notify the public, implement emergency training systems and tools, and plan for evacuations if necessary.

The ability to detect impending disasters in real time and the dissemination of early warnings are two practical strategies for disaster preparation. Artificial intelligence techniques can be used to forecast impending hurricanes and storms, earthquakes (Mousavi et al., 2019), ice jams, floods, volcano eruptions and fires (Nunavath & Goodwin, 2019). In Europe, the Urban-Flood project has developed an internet-based platform based on the analysis of thousands of sensor streams, which includes an artificial intelligence component for detecting abnormal dike behaviour (Noymanee et al., 2017). A tweet crawler can be used to perform semantic analysis on Japanese tweets, determining the earthquake's location, and developing a reporting system called Toretter that was faster than the Japan Meteorological Agency's broadcast announcements. The accelerometers on smartphones can also be used to send out early earthquake warnings. Utility companies can forecast the extent and duration of service outages prior to a disaster event using AI-based tools, allowing them to be prepared. For example, predictive analytics assisted Hydro One, a large utility company based in Ontario, Canada, in restoring power service within four days in April 2018, significantly shortening the restoration time (Partovi & Magnan, 2018). Due to the Internet of Things (IoT), cloud network services can share information about disaster situations quickly and accurately for early warnings (M. Ali, 2019; Ali, 2021; Chung & Park, 2016).

While it is possible to plan for a day or two before evacuating, in some cases, immediate evacuation is required in the event of a disaster. Prior to evacuations, potential problems and countermeasures should be thoroughly considered and developed. Contraflow operations, for example, can be implemented during hurricane evacuations in coastal areas, and AI methods can assist in implementing practical implementations by determining when to activate lane reversals for contraflow operations (Burris et al., 2015). The evacuation process is dependent on crowd dynamics (Zheng & Liu, 2019), the best evacuation routes, and evacuation support systems (Peng et al., 2019). SVM and neural networks, reinforcement learning, and optimisation algorithms are the most frequently used AI techniques when conducting evacuations.

AI APPLICATIONS IN DISASTER RESPONSE

When disaster strikes, it is a matter of life and death. Efforts must be made to comprehend the situation and optimise decision-makers' response efforts. Effective situational awareness and user-friendly disaster information systems are required to ensure disaster relief and address people's immediate concerns. Artificial intelligence can aid in disaster relief and recovery efforts. A disaster response that is effective requires accurate maps of the affected areas (Ramchurn et al., 2016). Numerous AI techniques can be critical for planning search and rescue operations, staging and deploying resources, and determining short-term housing needs (Rizk et al., 2019). Maps of disaster events can be created using data generated by satellites, unmanned aerial vehicles (UAVs), robots, social media, and robots, as well as other sources such as robots. Using satellite images to create maps of infrastructure inventory models, damaged buildings and bridges, and disaster-affected regions, is a common practise. By rapidly analysing these data, "live maps" of disaster situations can be created using computer vision techniques (Valkaniotis et al., 2018). Classifier algorithms are used to analyse maps and images. By comparing pre-and post-event maps and images, the extent of damage to structures and infrastructures can be determined and response efforts prioritised (Colin & Jan, 2017).

Crowdsourced information is gaining popularity in disaster response. Volunteer efforts are being made to expedite the data analysis process, allowing for the faster generation of maps and crowdsourced information for situational awareness and damage assessment (Butler, 2013). Over 1000 experts from 82 countries assisted the Humanitarian OpenStreetMap Team in creating maps of the Philippines' affected areas following Typhoon Haiyan, allowing for rapid damage assessment and response efforts (Butler 2013).

Social media, robots, and mobile phone data are frequently used in disaster relief and rescue operations. Individuals and local communities can use social media platforms to solicit assistance, while governments and organisations can use them to disseminate disaster relief information (Takahashi et al., 2015). Social media data, which includes time and location information in addition to disaster-related information, can significantly benefit disaster information systems. This ultimately aids in disaster relief, resource allocation decision-making, and the development of disaster information systems (Aydin & Fellows, 2018). Other sentiment analysis tools, such as classifiers or deep reinforcement learning, are also widely used AI techniques for social media data analysis. However, using social media data as a source of information raises concerns about its credibility and reliability, as well as the difficulties associated with verifying information and processing large amounts of data into useful knowledge.

The harsh environment that follows a disaster impedes disaster relief efforts. Responders and stakeholders can monitor and respond to disasters using disaster robots even if they are not physically present in the affected areas. To extinguish dangerous fires (Ando et al., 2018); conduct search and rescue operations;

and map and interact with the destroyed environment, robots can be used as remote (Lattanzi & Miller, 2017). Robotics makes extensive use of machine learning to assist robots in acquiring new skills and adapting to their environments. Deep learning has been used to perform visual detection, multiple data handling (Ngiam et al. 2011), and robotic manipulation. Optimisation algorithms are frequently used to aid in dynamic path planning, communication, and coordination between multiple robots (Takeda et al., 2014).

Many people contact emergency services immediately following a disaster (and their loved ones). As a result, telecommunications traffic surges in a jump-delay pattern. Disaster management agencies must quickly classify information gathered from these calls and communicate the public's urgent needs to the appropriate agencies and utility providers as part of disaster response. Machine listening can benefit from automated voice recognition, the identification of high-priority keywords, and the rapid processing of voice data from multiple regions (Ramchurn et al. 2016). To assist disaster managers in managing crises and providing disaster relief more effectively, sentiment mining can help them gain a better understanding of the situation, such as where to send first responders and how resources should be distributed. Following natural disasters, mobile phone data has been used to estimate and track the movement of people (Bengtsson & Johansson, 2012; Bengtsson & Raza-Ullah, 2016). Disasters frequently destroy mobile communication network base stations, necessitating the rapid establishment and allocation of alternative base stations to support emergency communication, with various countermeasures proposed in the aftermath of these incidents (Suriya & Sumithra, 2020).

Due to the dynamic nature of the disaster environment, information sharing, and coordination are frequently bottlenecks in multi-agency disaster response. At times, information about a disaster may be out of date and unpredictable by the time it is shared, complicating life-or-death decisions. This can be addressed through disaster information systems that are simultaneously accessible to multiple agencies and organisations, such as collaborative geographic information systems, and shared information management platforms (Abdalla & Esmail, 2019; Rasouli, 2019). Collaborative data analytics enables you to learn about the disaster situation and identify relief needs using shared data (Tucker et al. 2017). The ability of disaster information systems to automatically share data benefits decision-makers from a variety of organisations. Numerous prototypes have been developed to realise these concepts (Hochgraf et al., 2018). Deep learning models and supervised models have a wide range of applications in disaster information systems based on information extraction from social media (Sun and Tan 2019), mobile phone data, remote sensing data, and aerial images. Disaster information systems include CrowdHelp and DMCsim (Mehdi et al., 2017).

Physical and psychological devastation are just two of the numerous consequences of natural disasters. Emotions direct people's attention to a wide variety of pieces of information, resulting in a wide variety of decisions and actions. Disaster relief efforts would be more effective if they were more sensitive to the victims' emotional and psychological needs. Artificial intelligence (AI) can be used in a variety of ways.

APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN DISASTER RECOVERY

Disaster recovery is a collaborative effort involving governments and public authorities, as well as private organisations. Complex decision-making skills are required to rapidly assess the complexity of the situation, identify operational requirements, develop, and implement recovery plans, and conduct rehabilitation and restoration activities. Artificial intelligence (AI) can play a critical role in assisting disaster recovery management in a timely manner, as the various stages of disaster recovery require a significant amount of time and resources to complete. Artificial intelligence techniques have been applied to disaster recovery management, including the detailed evaluation of the disaster's effects, the creation of recovery plans, the supervision of the recovery process, and the estimation of loss and repair costs.

For a speedy recovery, an accurate assessment of the disaster's impact is necessary. Disasters can wreak havoc on both the physical and psychological well-being of victims, as well as economic turmoil. Visual inspection is currently the primary method for assessing physical damage to structures; bridges; tunnels; and storage tanks (Choi et al., 2018; Lenjani et al., 2020). While visual inspections can be tedious and time-consuming, they are frequently necessary. Aerial photographs, social media images, and sensor data can all be used to assist in reducing the need for human intervention. Social media data can be used to monitor human activity patterns following a natural disaster (Resch et al., 2018). Surveys are the most frequently used method for assessing psychological distress following a disaster. Regression, dimension reduction, and neural networks are all widely used unsupervised and supervised models for the analysis of survey data, both for identifying risk factors and evaluating the effectiveness of preventive interventions (Rosellini et al., 2018). Additionally, artificial intelligence has been used to forecast the economic consequences of a threat, with supervised models frequently used to establish quantitative relationships between critical factors and the economy and to identify potential stimuli for economic growth (Yamaguchi & Shirota, 2019).

Following an accurate assessment of the disaster's impact, post-event recovery plans must be developed to conduct recovery and renewal activities effectively. In comparison to pre-event planning, post-event planning is frequently conducted in a hostile environment with limited time and resources, making effective collaboration difficult for participants. Recently, genomic algorithms, simulated annealing, and other optimisation techniques have been used to identify efficient restoration plans or to estimate human recovery planning decisions (Sun et al. 2021). There are also a few studies on the application of reinforcement learning and deep reinforcement learning to the planning of post-event recovery strategies.

To foster community resilience throughout the recovery process, practitioners require metrics and tools for assessing and monitoring community recovery over time. Supervised models and deep learning algorithms are frequently used to analyse data from a variety of sources. Because social media data is geotagged or hash tagged, disaster recovery tracking can benefit significantly from sentiment analysis and image classification (Mihunov et al., 2020). Economic indicators and spatial variations in light intensity can be correlated using regression models developed over time to provide quantitative insight into the regional economy's recovery process (Qiang et al., 2020). Google Street View is being used by an increasing number of people to monitor disaster recovery remotely.

Following a disaster, governments must immediately aid rebuild homes and lives; an accurate assessment of loss and repair costs is critical (Deryugina, 2017). Artificial intelligence techniques can be used to estimate disaster losses and repair costs. Models such as regression and neural networks have been used to rapidly process imagery to detect structural damage, identify repair requirements, and estimate repair costs. They have also been used to analyse historical disaster recovery fund disbursement data to make budget allocations and to expedite insurance claim processing.

AI applications are still in their infancy. Currently, disaster damage losses and repair costs are estimated using data from a variety of sources, including insurance claims, post-disaster assessments, assistance grants, and personal loans to victims. The availability of big data and the rapid development of data analytics present a once-in-a-generation opportunity to rapidly advance AI applications for disaster loss and repair cost estimation (Ali & Abdel-Haq, 2021; Ali & Edghiem, 2021). However, the absence of standard data collection and recording procedures may result in widely disparate estimates of these projects' economic impacts (Ladds et al., 2017). As a result, data collection policies and standards must be developed.

Rumours and fraud may emerge in the aftermath of a natural or man-made disaster, necessitating the awareness and vigilance of both disaster victims and governments. Data mining, as well as the tracking of information flow trends, can aid in fraud and rumour detection (Badmus, 2020). For instance, insurance companies and law enforcement agencies can quickly determine the veracity of a flood claim by comparing high-resolution satellite images taken before and after the flood.

PRACTICAL AI-BASED DECISION SUPPORT TOOLS

Several artificial intelligence-based decision support tools for disaster management have been developed over the last few decades by research institutes and industrial firms. We discovered these AI-based disaster management decision support tools by conducting a Google Scholar and Web of Science search for "disaster management," "decision support tool," and "artificial intelligence." Disaster management can benefit from a variety of AI techniques. These tools extract useful information from a variety of sources, including social media, mobile phone data, sensor measurements, on-scene reports from first responders, and crowdsourced information from volunteers. These tools can be applied to a wide variety of infrastructures and hazards, advancing AI applications, and facilitating informed disaster management. The disaster response phase employs the greatest number of tools of any phase. While most tools use social media data as an input, a few also use sensors, remote sensing, or mobile phone data.

Certain tools are designed to assist in the development of retrofit and evacuation management plans during the disaster mitigation and preparedness phases. For example, the Optima PredictTM software assists dispatchers and operations personnel in determining the most cost-effective ways to prepare for unexpected emergencies, such as by simulating and forecasting changes in emergent medical service demand and ambulance availability in the aftermath of a disaster (Mason, 2013). Other tools, such as text, audio, and location services, provide comprehensive platforms for efficient communication for professional disaster response teams, as saving lives is typically the priority in the days following a disaster, necessitating communication and situational awareness. Blueline Grid, a real-time mobile phone data analysis platform, analyses this data to aid in disaster response. There is one concern that forecasts potential damage and consequences using historical disaster data and infrastructure data. Artificial Intelligence for Disaster Response (AIDR) classifies crisis-related tweets and aerial images based on crowdsourced information to determine the needs of victims and the extent of infrastructure damage. Solr's data mining capabilities are used to process real-time Twitter data to create SensePlace3, a geovisual interface that visualises the time, location, and relationships between events (Pezanowski et al., 2018). DeepMob simulates human behaviour and mobility during natural disasters by training deep belief networks on millions of GPS records (Song et al., 2017). A crowdsourcing tool for assessing damage in disaster-affected areas has been developed with the assistance of the National Geospatial-Intelligence Agency (NGA), the Presidential Innovation Fellows Program, and the Federal Emergency Management Agency (FEMA).

Meanwhile, implementing these AI-based decision support tools is fraught with difficulties. Practically speaking, these tools typically require a large amount of data to be entered. It is possible that different communities have varying degrees of access to input data, or that some communities have access to input data that other communities do not have due to legal or commercial constraints. It is possible that small towns and rural areas lack the detailed and comprehensive data that large cities must make accurate predictions using AI. Even if all the input data is available, many of these tools may have issues with data ownership. Regulations and procedures must be established to ensure that data is collected, cleaned, and protected in accordance with the law. Numerous socioeconomic and environmental factors contribute to community diversity. The data of one community may not be applicable to the AI-based decision support tools of another. As a result, generalising AI-based decision support tools across a diverse range of communities is challenging. To round out the picture, some tools may require a high level of skill to deploy, limiting their utility to practitioners. Big data analytics requires sophisticated software and high-performance computers, both of which may be unavailable to many local governments and emergency response agencies in impoverished regions (Ali & Edghiem, 2021).

CONCLUSION

In disaster management, artificial intelligence faces several data-related challenges, including issues of accessibility, completeness, security, privacy, and ethical considerations. Numerous high-quality data points are required to build an AI model capable of making accurate predictions. It is not always straightforward to locate this type of information. Certain infrastructure data cannot be easily accessible for national security and commercial competitiveness reasons. Additionally, there is the issue of trustworthiness of data. Because raw data from social networks contains numerous inaccuracies and biases, advanced data filtering and verification are required. The collection and analysis of personal data raises concerns about fairness, accountability, and human rights. Even when all the necessary data is available, data incompleteness is a common issue in disaster-related data analyses. This is due to the dynamic nature of the disaster environment. Thanks to numerous platforms and databases created to address the issue, disaster-related data can now be collected and shared in a standard format.

Three computational problems are notoriously difficult to solve. Because of the increasing volume of data and the scarcity of manpower. Utilising and improving unsupervised learning techniques may be the most effective method for dealing with real-world data that does not require human labelling. Another issue is that as the volume and variety of data increases, the computational burden also increases significantly. This complicates the process of processing, managing, and learning from data in the event of a disaster. Disaster management, particularly disaster response, is heavily reliant on data management, storage, and processing efficiency. This issue can be resolved by implementing cloud-based data retrieval and storage systems (Ali, 2019, 2020; M. Ali, 2019; Ali M et al., 2018; Ali et al., 2020). Clearly, more efficient AI methods will be beneficial in the long run. To address this issue, reservoir computing as well as the use of GPUs and artificial intelligence accelerators have been used. By combining crowdsourcing and real-time AI analysis, complex computations can be completed faster and with less time and effort than is typically required on-site. Thirdly, disaster management tools must be user-friendly. This effort includes the development of simple-to-use AI-powered tools that require little technical knowledge.

The outcomes of artificial intelligence models used in disaster management should be understandable and repeatable. As a result, work has been done to improve the understanding and explanation of artificial intelligence models, such as explainable artificial intelligence. Reproducibility of new results is a frequent issue in the development of artificial intelligence-based disaster management solutions. Disaster-related data is particularly susceptible to non-reproducibility due to the rarity of disasters and their varying effects on different regions. Both scientific progress and the development of AI models are contingent on the ability to replicate successful experiments. To address this issue, AI research initiatives such as IBM's OpenScale and OpenML have been launched. These efforts aim to increase the transparency and trustworthiness of artificial intelligence by documenting the processes, data, and parameters required for experiments to be repeatable (AI).

This chapter looked at how artificial intelligence can be used to improve disaster management across four stages: mitigation, preparation, response, and recovery. This study examines artificial intelligence methods across various application areas, covering all four phases of disaster management. According to academic research and real-world experience, the output of the analysis of artificial intelligence (AI) models has been shown to be extremely beneficial in disaster management. Now, disaster response and mitigation are the most popular application areas.

The amount of data that AI can analyse is greater than the amount of data that humans can analyse. When the scope of the forecast is kept within the range of the training data, it can produce acceptable forecasts. However, when the scope is exceeded, it may produce unacceptable predictions. Because both the hazard and society are constantly changing, the initial model's attributes may become obsolete in the future. It is not simply a question of whether AI algorithms can accurately forecast the future; it is also a question of whether we should blindly trust AI algorithms' predictions and recommendations for resource allocation or disaster planning, even if they are reasonably accurate. This is not a straightforward question to answer.

Issues with data and computation, as well as the inseparability and reproducibility of analysis results, are just a few of the technical obstacles that must be overcome before AI can be used in disaster management. Additionally, this chapter identifies many potential application domains for various forms of artificial intelligence. The challenge for the research community is to develop more powerful and cost-effective AI-based tools to support practical disaster management with increased analysis accuracy and speed. Despite these obstacles and uncharted territory, AI techniques provide numerous opportunities and straightforward solutions for a wide variety of successful disaster management applications.

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Chapter 4
Human Resources as a Stakeholder in Cyber Risk Management

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ABSTRACT

The regulatory and cyber risk landscapes are reshaping the role of human resources. As a result, information security/information technology (InfoSec/IT) professionals are increasingly being asked to assist organisations in determining and enforcing employee data permissions, training employees on cybersecurity policies, and assisting with employee-related cyber incidents in order to be prepared for any kind of cyber attack. This chapter delves into the role of HR in managing cyber risk and provides recommendations on how organisations can manage cyber risk effectively to support their HR departments.

INTRODUCTION

Information security and information technology (InfoSec/IT) professionals are increasingly being asked to assist organisations in determining and enforcing employee data permissions, training employees on cybersecurity policies, and assisting with employee-related cyber incidents (Ma, 2021). Increased employee reliance on technology and devices, combined with a greater emphasis on cybersecurity as an organisational value, has all contributed to increased human resource involvement. HR is also responsible for managing data disclosures and breaches. As a result of these incidents, businesses may incur significant financial losses, face legal action, and lose the trust of their customers. Employees' initial (and final) contact with human resources is critical for establishing and maintaining a robust cybersecurity culture. As the value of cybersecurity training for employees has grown, human resources have taken a greater role in developing training sessions (Thuraisingham, 2020).

Employee data and security practises are critical in determining an organisation's overall security. According to Mercer's 2020 Global Talent Trends Study, more than six in ten executives (62%), believe

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Figure 1. Cyber security trends (Marsh, 2020)

that the greatest threat to their organisation's cybersecurity is not hackers or vendors, but rather their employees' failure to follow data security rules (Marsh, 2020). Despite this, a recent survey conducted by Marsh and Microsoft discovered that human resources are rarely the primary owner or driver of cyber risk management, as over 88% of businesses continue to delegate cyber risk to information technology/ information security, which is then delegated to risk management, legal, and finance (Marsh, 2020). This situation must be corrected. Even in a remote work environment, it is critical for data and technology risk management to have a strong partnership between information security, information technology, and human resources (Ali & Edghiem, 2021). In four critical areas, the regulatory and cyber risk landscapes are reshaping the role of human resources (Trim & Lee, 2016). Therefore, this chapter explores the role of HR in cybersecurity, with particular emphasis on cyber risk management and recommendations to manage such risk.

CYBER RISK MANAGEMENT

Cyber Security in Organisations

To protect our systems, networks, programmes, and data from hackers and cyber criminals, we must adhere to a set of procedures and practises collectively referred to as "cybersecurity." Cybercriminals are constantly on the lookout for new ways to breach corporate networks, cause device damage, and steal personal information in order to profit or advance political agendas. Malware infections, ransomware, social media scams, as well as phishing and swindling attacks, are all examples of cyber threats (Paul & Wang, 2019). To protect the entire ecosystem from such attacks, organisations and users must remain vigilant at all times. At times, none of our anti-virus programmes will suffice. Antivirus software is constantly updated to keep pace with the ever-changing techniques employed by cyber criminals and malicious software developers (also known as malware). If human resources in organisations are unaware of the motivations of hackers, they will be unable to defend themselves against their attacks. This objective can be accomplished through the implementation of security measures (Brooks, 2021).

A business's cybersecurity is only as strong as its weakest employee. Cybersecurity is widely believed to be the exclusive domain of an organisation's security and information technology departments (Wendy & Gunawan, 2019). Understanding cybersecurity best practises and how to maintain cyber hygiene is critical regardless of the organisation's position within a company, as well as their marketing, legal, or even human resources. Why? because each employee is a potential hacking target. According to a recent IBM report, employee negligence accounts for more than two-thirds of all data breaches worldwide. Even the smallest oversight on the part of a single employee can result in a security breach that affects the entire organisation. According to a recent study by Ponemon Institute and IBM, Cost of Data Breach 2017, insider threats were responsible for 60% of all breaches (HackerEarth, 2018).Scams such as the BEC one are a good illustration of this. The BEC ruse Cyber criminals send malicious emails to other employees via an employee's corporate email account in BEC scams. Because they believe the email was sent from a coworker's account, naive employees download malicious attachments without verifying them first.

Hackers can breach a system's defences even through the tiniest gap. Consider the following scenario, which occurs far too frequently: Most of us conduct remote work from coffee shops and coworking spaces that offer free WiFi (Chaubey & Prajapati, 2020). However, these free WiFi networks are public and are therefore vulnerable to hacking because they are accessible to the general public. Cyber criminals can easily breach these internet connections, gaining access to the company's network. Through unsecured WiFi connections, hackers can even gain access to the company's system's confidential data. In these instances, a VPN (Virtual Private Network) can assist an organisation in protecting their network systems and data. Additionally, a virtual private network (VPN) prevents third-party services from accessing the browsing history (MANOJ, 2020).

Cybersecurity Laws and Policies

Given the critical nature of cybersecurity in our daily lives, it is natural for relevant stakeholders to be concerned about cybersecurity legal issues. State and federal legislation have a significant impact on how businesses respond to and mitigate cybersecurity and information security risks, particularly when it comes to balancing privacy rights and law enforcement needs (Kosseff, 2019; Paul & Wang, 2019). Cybersecurity regulations should protect a business's information and computer systems, as well as individual users, from cyberattacks. Apart from promoting organisation, these regulations seek to protect the personal information, financial security, and financial privacy of internet users.

Numerous media and telecommunications companies already collect and store user data. Facebook, Twitter, and Instagram already store troves of our personal information as well as that of our friends and family members. We should be concerned if this massive amount of data falls into the hands of criminals looking to profit from it. In these instances, cyber laws assist users in defending their data and identities against platform misuse.

Employees are accountable for the security of the systems and data with which they interact. Using personal social media accounts at work can have a detrimental effect on the network security of an organisation. Criminals are increasingly using social media to defraud employees, steal their personal information, and infiltrate a company's computer system (Wong, 2018). A company can maintain its integrity and security by practising basic cyber hygiene, such as not disclosing corporate email addresses to strangers and refraining from downloading personal documents, photos, and videos onto work computers. It is critical for a business's employees to be fully educated and informed about the precautions that should be taken when using the internet. Furthermore, employees must be aware of the cyber laws and policies in place to safeguard their identities, information, and privacy against hackers (Schreider, 2020).

A business's responsibility is to educate its employees about potential threats and impending attacks and teach them how to protect themselves by enabling two-factor authentication for all accounts, scanning all attachments and URLs in an email prior to clicking or downloading them, and regularly updating software and firmware. Businesses and their employees must be aware of any changes in legislation or policy that could affect their operations. Businesses must adapt their information technology and security policies to stay current with the constantly changing landscape of cybersecurity regulations.

ROLE OF HR IN CYBER RISK MANAGEMENT

HR and Cyber Risk

Human resources (HR) have emerged as a critical component of a business's cyber risk management strategy in recent years. The demand for information security and information technology (InfoSec/IT) professionals has increased to assist organisations in determining and enforcing employee data permissions, training employees on cybersecurity policies, and assisting in the investigation of employee-related cyber incidents (HackEarth, 2018). Numerous factors, including a more proactive regulatory environment and widespread adoption of technology and devices, have contributed to an increase in human resource involvement, including the recognition that an organisation's cybersecurity culture is critical to its success.

The overall cybersecurity of an organisation is influenced by its employees' data and security practises. According to Mercer's 2020 Global Talent Trends Study, organisations do not need to be concerned about hackers or vendors posing a threat to their businesses (Mercer, 2020 in Marsh, 2020). Employees are the ones who violate data security policies. According to Marsh and Microsoft's 2019 Global Cyber Risk Perception Survey, human resources are not typically the primary owners or drivers of cyber risk management. The majority of businesses (88%) continue to delegate cyber risk to information security/technology, followed by the CEO, risk management, legal, and financial departments, and the board of directors (Marsh, 2020). This situation must be corrected. Risk management for data and technology requires a strong partnership between information security, information technology, and human resources, even in a remote setting. As a result of regulatory and cyber risk changes, as detailed in the following sections, the role of human resource management is being reshaped in four critical areas.

Compliance with the Laws

It is critical to note that some regions of the world, as well as some states in the United States, have enacted strict privacy laws. The General Data Protection Regulation (GDPR) is a regulation that regulates the collection and use of personal data (Gobeo et al., 2019). Numerous businesses face severe fines, penalties, and even the threat of legal action as a result of breaching these new rules and regulations. Regulators/legislation were ranked as the fourth most concerning risk by business leaders in our 2019 Global Cyber Risk Perception Survey. (Marsh, 2020) A growing number of businesses rely on human resources to assist them in complying with privacy regulations, as well as information security and technology.

Traditionally, human resources has included training on data security and responsible device and technology use as part of the onboarding process (Valcik, 2021). Human resources and information technology frequently collaborate to educate employees and third-party vendors about the critical nature of workplace privacy regulation compliance. Internal accountability for errors and wrongdoing is typically the responsibility of information technology, compliance/legal, and third-party investigators. Due to the fact that human resources is responsible for enforcing the company's policies on employees, they are best equipped to advise on how to discipline or remediate employees who commit data-handling misdeeds or errors, both HR and IT departments must collaborate to develop an effective data incident response plan when dealing with employee-related incidents (Marsh, 2020). Both parties must agree on how their respective roles intersect during the process of developing and enforcing policies and procedures for dealing with regulatory data violations.

Confidence in the Security of Employee Data

Cyber risk management must incorporate appropriate standards and controls for the handling of personally identifiable information. Human resources can assist in determining which data is most critical to the business, who should have access to it, and how that data should be protected. This is frequently established during the hiring and onboarding processes. If guided by the IT team, human resources can play a critical role in promoting sound cybersecurity practises after an employee leaves a company (Williams & Beck, 2018). Numerous malicious insider cases have resulted from job terminations, whether mutual or non-mutual. Employee data access privileges must be revoked as soon as possible following a departure, typically within 24 hours, which requires coordination between HR and IT.

Personal Data Confidentiality

In order to assist in the management of data disclosures and breaches, human resources must play an important role. These incidents can result in significant financial losses, legal action, and a loss of customer trust for the businesses involved (Rees et al., 2011). Confidential information can be exchanged between employees via social media platforms like Facebook. For example, when a former employee asks for their personal information to be deleted, the incident response plan should specify which department will be informed and who will respond. Employees who have left the company frequently approach human resources for help, and the department's ability to communicate with other departments is critical to the situation's resolution (Ma, 2021).

In most cyber incident response plans, IT and third-party investigators are typically assigned to determining who is responsible for disclosure events. A second reason human resources is well-equipped to advise on corrective or punitive actions is that they are in charge of the company's overall policies, and the conversations between employees and their co-workers are critical to avoiding a data breach in the workplace.

Cybersecurity Culture

A strong cybersecurity culture is critical as it is frequently the first and last point of contact for employees with the company. In recent years, as the importance of employee education has grown, human resources (HR) has become more involved in cybersecurity training (Hadlington, 2017). Educating new employees about the importance of good cybersecurity hygiene can have a significant impact on their level of confidence in the event of a cyber-attack. It is critical that students understand how to identify and respond to phishing and password security threats. Remote access, business continuity, incident response, and device use best practises for digital transformation and new technology adoption should be included.

Because cybersecurity protocols and practises used at home may be less secure than those used at work, the COVID-19 environment places a premium on training and policy compliance (Okereafor, 2021).

Noncompliance must be punished as part of a robust cybersecurity culture. This trend has resulted in increased penalties in performance evaluations and even pay for failing to follow safety best practises or failing to complete training. To accomplish this, human resources and information technology must collaborate. This begins with continuous communication and training for the company's top executives. Cybersecurity incidents can result in a variety of consequences, ranging from financial loss to reputational damage. Table-top exercises facilitate collaboration across departments on how to respond to these incidents. Human resources professionals participate in response testing exercises as part of comprehensive corporate cyber risk management programmes. Human resource planning can also assist in ensuring that workers are treated fairly and in accordance with applicable employment regulations and laws, thereby reducing the risk of litigation in the event of an incident.

RECOMMENDATIONS FOR MANAGING CYBER RISK

After a successful cyberattack, the majority of employees will begin to view cybersecurity as a personal responsibility. When this mindset prevails, a company's reputation is jeopardised. When a business's cybersecurity is compromised, both small and large businesses are put at risk. According to statistics released by Heimdal security, cybercrime costs businesses worldwide $100 billion per year (HackEarth, 2018). Corporate spending on cybersecurity is also increasing at a rapid pace throughout the world. According to studies, organisations must be vigilant for both external and internal threats. Human resources is critical when it comes to educating employees about the importance of cyber hygiene. The human resources department can ensure cyber hygiene in a variety of ways. Based on the recommendations presented below, the following model of managing cybersecurity risk for HR has been proposed to help organisations tackle this modern information security problem (see Figure 2).

Establish Proper Training and Awareness Sessions

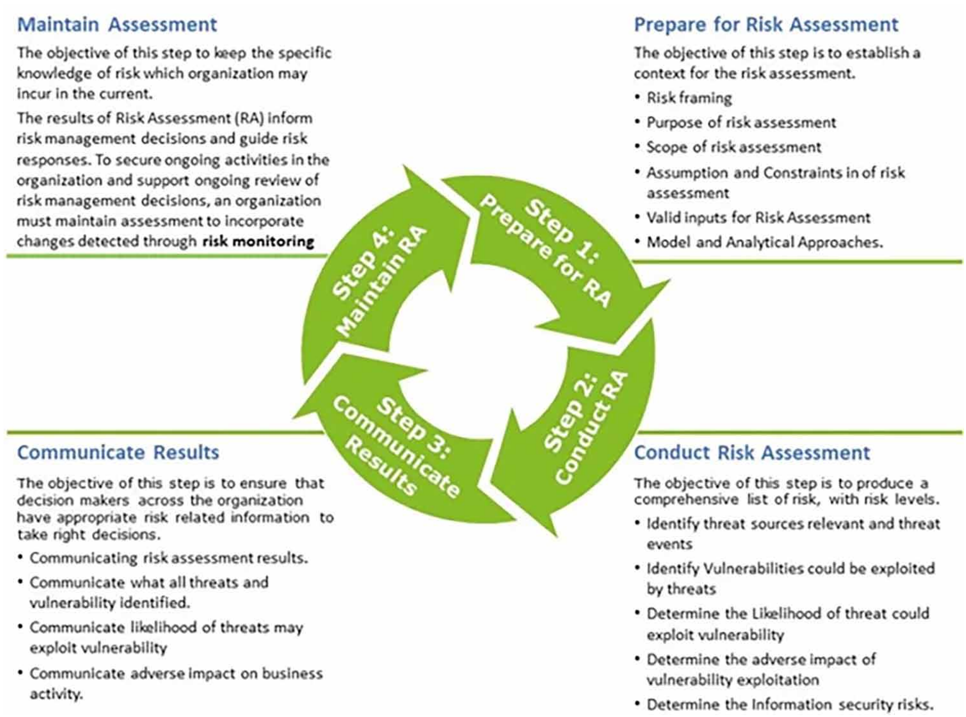
To be most effective, human resources must educate all human resources staff and employees about cybersecurity protocols. Employees must be educated on topics such as how to access and use confidential company data on social media channels, as well as receive basic security training (Singh, 2020). Cybersecurity education and awareness sessions should be included in the onboarding process for new hires.

Fundamental security training must include instruction in the following areas:

- How to select robust password combinations for account login;
- How to select appropriate security questions;
- How to maintain email security and integrity;
- How to identify malicious online behaviour and scams, etc.

Numerous sensitive aspects of an organisation's human resources department exist, including the organisation's most private and confidential data and sensitive employee identity information, such as birth dates and identification certificates. Thus, the department must understand how to protect data while also ensuring that it plays a critical role in its preservation.

Figure 2. Model of human resource cyber risk management



Build Up Securities and Competencies

Hackers do not randomly breach a company's network. They developed advanced attack methods after conducting extensive research on the network's security, employees, and vulnerabilities. By utilising social media to identify and exploit vulnerable targets, security controls can be circumvented. For instance, an attacker may develop a relationship with a target employee in order to ascertain when the employee is most vulnerable and then exploit that vulnerability by inciting him or her to act against the organisation (Singh, 2020). At all times, the human resources team should be on high alert to identify and address potential problems before they arise. Human resource departments can use check-ups and mock drills to identify weak links. Numerous businesses send out bogus emails purporting to be from well-known brands and requesting personal or confidential company information. Employees who open and respond to such emails can be offered an email security course.

Numerous businesses monitor their employees' online activities. While this approach has a number of advantages, the human resources team must exercise caution to avoid interfering with people's personal and professional lives. The human resources department must conduct an in-depth investigation of the situation and determine the company's best course of action.

Creating Relevant Policies

Security policies are statements that outline the decision-makers' responsibilities for protecting a company's critical physical and information systems. These policies are not intended to provide a technological solution to cyber threats, but rather to educate employees and employers about the intentions and conditions necessary to safeguard a company's security controls (Vishwanath et al., 2019). The human resources department's primary responsibility is to establish procedures and protocols and to ensure that employees are aware of them. As a result, organisations will be better able to contain the danger and mitigate the overall damage. If a security breach occurs, the business must take immediate action, including changing all employees' login credentials, notifying employees and customers, determining the cause of the breach, and implementing changes to prevent future breaches to ensure the company's and customers' safety (Radoglou Grammatikis et al., 2019).

Working with the IT Department

Due to the dynamic nature of cybersecurity, IT cannot be held liable for security breaches and cyber scams. When it comes to cybersecurity, human resources and information technology departments must collaborate to ensure that employees receive adequate training and education on how to defend themselves against hackers (Singh, 2020). An organisation's human resources department and information technology/security team can collaborate to mitigate a wide variety of internal cyber threats. The information technology management team is well-versed in security threats and mitigation techniques. Often, an organisation's IT and security teams have no idea what data is being stored where or who owns it, and thus are unable to assign a value to it. Human resources and information technology teams should collaborate to create a data classification system that enhances information security in these situations (Vishwanath et al., 2019).

Hiring the Right Cyber Talent

From a human resources standpoint, it is extremely difficult to find the right cybersecurity professional who fits the organisation's needs. According to a 2021 article published by Cybercrime Magazine, there will be 3.5 million job openings in the cybersecurity sector (Cybercrime Magazine, 2021). There is a severe shortage of qualified candidates to fill cybersecurity positions. Demand for cyber professionals has increased in both the public and private sectors, but the demand is not being met. A business's reputation, earnings, and data are all at risk if it lacks a well-trained cybersecurity team to guard against cyberattacks. As a result, businesses are struggling to maintain a sufficient cybersecurity workforce, which makes them attractive targets for hackers, exposes them to the risk of losing proprietary data as a result of a data breach, damages their reputation, and impairs their ability to develop new products and services. This has resulted in an organisational cybersecurity workforce shortage for a variety of reasons.

HOW CAN HR TACKLE THE CURRENT CYBER RISK MANAGEMENT PROBLEM?

The human resources department must be constantly educated in order to identify, examine, hire, and retain cybersecurity professionals (Hadlington, 2017). Ascertain that organisations are aware of their cybersecurity requirements and expectations for cybersecurity professionals. Make a list of all requirements prior to beginning the recruitment process.

Consider yourself a hacker and hire someone who is capable of doing so. Organisations should not be discouraged from hiring qualified and talented individuals due to a lack of degrees and certifications. Cyber criminals and hacker groups that conduct cyberattacks lack the credentials necessary to demonstrate their expertise. If the organisation hires only candidates with Tier I educational backgrounds, it is time to rethink their recruitment process. To attract the best candidates for available positions, organisations should adopt a more liberal and progressive hiring process.

Organisations should not be afraid to look for candidates in unusual locations. Bear in mind that cybersecurity is still a specialised field that requires a diverse set of skills and knowledge, making it critical to stay current on industry developments (Singh, 2020). Keep in mind that a sizable portion of ethical hackers are also avid gamers. They simply require the appropriate motivation to make the switch.

Make a long-term investment in the workforce's future. Businesses must collaborate with universities and invest in their students to ensure continued collaboration and mutual benefit. Throughout the year, numerous high schools and colleges host competitions in cybersecurity defence and ethical hacking. Utilise these types of events to recruit and hire exceptional employees.

Risk Management

If the human resources department has a sound risk management strategy in place, it will be better equipped to deal with and mitigate security threats. The human resources department is responsible for monitoring cyber-risks and preventing cyber-attacks (Ma, 2021). Any policy should include the following items:

Configuring an organisation's authentication and approval processes according to its employees' rank and hierarchy: Each employee does not require access to the enterprise's networks, databases, and offline accounts. When granting access to authentication, it is critical to consider the employee's rank. Prior to granting access to a system to an employee, the human resources department must conduct a review of the employee's job description and other pertinent duties and responsibilities.

Consequences of non-compliance with security measures include the following: Employees who violate the company's cybersecurity principles and policies are subject to severe disciplinary action and fines (Schreider, 2020). Developing robust policies and practises for remote work; cloud computing, mobile devices and applications, and remote access, for example, all contribute to the increasing importance of device security (Ali, 2019, 2020; M. Ali, 2019; Ali M et al., 2018; Ali & Edghiem, 2021; Ali et al., 2020).

When employees' personal devices are connected to the office network, security risks can arise. Human resources must communicate to employers and employees the importance of protecting devices from unauthorised access. The maximum number of devices that can connect to the corporate network should be minimised. This allows organisations to keep an eye on their online activities. Avoid spending an excessive amount of time on social media while using the company's WiFi. Include clear, unambiguous communication rules. Taking strict measures following an employee's termination: According to Heimdal Security, employees who quit or are fired steal proprietary company data. Employee data theft is a problem for both small and medium-sized businesses and larger ones. Ex-employees commit unethical acts for a variety of reasons. Hackers, third-party sources, or competitors purchase confidential information from employees with the intent of profiting from its sale. to sully the company's reputation and commit negligence.

Steps to take when terminating employees to avoid potential threats Deactivate all of an employee's accounts and access cards as soon as possible following termination. The employee's email account should now be deactivated. To name a few examples, remove the employee from email distribution lists, client distribution lists, and website directories. Disconnect from all VPN and Remote Desktop connections immediately! Remote access to web tools and enterprise applications such as SAP should also be discontinued when not in use. Turn off the employee's computer and change all passwords and PINs for sensitive databases to which the employee has access. Dispose of any personal effects left in the work area by the employee. Inform team members and other employees that they are not permitted to share business information with the aforementioned individual.

Empowering Employees with the Right Tools

To ensure that the security department is capable of effectively detecting, analysing, and resolving threats, the human resources team must ensure that the department is equipped with the necessary technological resources. Additional assistance is required to safeguard employees against cyber-attacks. All computers and mobile devices connected to the company's WiFi network must be protected by a strong antivirus programme.

CONCLUSION

This chapter has delved into the role of HR in cyber security risk management. It has been established that the human resources department of an enterprise may struggle to design adequate cybersecurity defence mechanisms, as even a sliver of a mistake can have dire consequences. Training and security awareness sessions, the acquisition of necessary tools and competencies, the hiring of cybersecurity talent, and the strict enforcement of policies can all help protect organisations from cyberattacks. When it comes to cyber hygiene, the human resources department of an organisation must not only influence employee attitudes, but also ensure that all policies and principles are strictly adhered to. When it comes to accomplishing tasks, the department cannot afford to be hesitant. Finally, the employer is responsible for ensuring that all employees follow the company's security policies and procedures, which include password selection and email security.

Additionally, the department has access to all staff members' sensitive records, personally identifiable information (PII), and financial records. To safeguard the privacy and security of user data, explicit policies should be implemented. The guidelines, however, will be exempt from the upcoming GDPR. Human resources can significantly simplify the process of complying with the new GDPR regulations if they understand how they will affect their employees and the company as a whole. Once a data footprint and processing lists are created, organisations are then able to create a unified view of GDPR implementation.

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Chapter 5
Application of Big Data and Machine Learning Approaches to Improve Decision Making During Crises

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ABSTRACT

As an occurrence that jeopardises vital national interests or the basic needs of the populace, a crisis necessitates rapid decision-making and coordination between various departments and agencies in order to resolve it effectively. As a result, crisis and disaster management systems are necessary and critical. Crisis and disaster response systems are intricate, requiring numerous phases, techniques, and resources. These systems require useful and necessary data that can be used to make future decisions more effectively, such as historical and current data on crises. The use of machine learning and big data technologies to process data from crises and disasters has the potential to yield significant results in this area. The first section of this document discusses crisis management systems and available tools, such as big data and machine learning. Additionally, a machine learning and big data approach to crisis management systems were developed, which included a description and experiments, as well as a discussion of the findings and the field's future directions.

INTRODUCTION

Globally, the frequency of crises and disasters is increasing. The consequences of these various crises and disasters are numerous, resulting in numerous fatalities and losses (e.g., automobile accidents, natural disasters such as tsunamis, and terror attacks, among others) (Andharia, 2020). In some ways, these crises and disasters can deteriorate our capacity to cope with some of these adverse events. Numerous social entities may be attempting to deal with crises. individuals, households, groups, and societies, as well as

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private and public sector organisations. Effective crisis management employs unique tactics and perseverance to address current situations or those that arise during an emergency (Akter & Wamba, 2019).

Crisis management is heavily reliant on the application of tactics that are tailored to the unique circumstances surrounding a particular community disaster (Bundy et al., 2016). Adversity has evolved in this area, posing new challenges for a wide variety of organisations and individuals, including governments, crisis management organisations, and social workers. Additionally, it lays the groundwork for a new research agenda for students and scientists. This also enables the application of diverse technical and theoretical approaches to diverse scientific fields in order to address specific issues in the field of crisis and disaster management. Big data and machine learning tools and technologies can be applied in a variety of ways (Akerkar, 2020; Boersma & Fonio, 2017; Castillo, 2016; Tsihrintzis et al., 2019).

Big data is advancing at a breakneck pace across all fields of science and engineering. Learning from this massive data set creates enormous opportunities and has the potential to transform a wide variety of industries (Qiu et al., 2016). This is especially true when massive data is used in machine learning algorithms that employ big data techniques. The field of crisis management systems is just one of the numerous applications of big data and machine learning, and it has a long way to go. While the flow of information within a crisis and disaster management system is significantly increased, making decisions during times of crisis may be more difficult. By incorporating all available information from previous crises and disasters, the decisions that must be made in the event of a crisis or disaster can be improved. This will benefit decision-makers engaged in crisis management (Farrokhi et al., 2020; Qadir et al., 2016). As a result, this chapter proposes to investigate potential machine learning and big data approaches for improving crisis management system decisions in the field of crisis management.

BIG DATA IN CRISIS MANAGEMENT

Now that we live in the age of big data, nearly every aspect of our lives is impacted. As a result of the increased interest in big data, numerous new technologies have emerged, and these technologies are expected to play a critical role in the collection, storage, and analysis of big data. According to crisis management theory, crises can be managed more effectively through the use of big data. This has created opportunities to improve and control crisis management. Scientists and analysts face a significant challenge in managing the massive amounts of data generated during disasters and crises. As a result, the role of big data in disaster and crisis management has evolved over time.

A paper by Bellmoa et al. on decision-making toward information management and crisis response proposes an essay on understanding human behaviour and managing crowds in extreme situations using big data (Belloma & Alfonso, 2016). They stated at the time that a review of crowd dynamics and safety issues demonstrated that the literature in this field can make significant contributions to the management of human crowds in emergency evacuation situations. Hayley Watson and colleagues' case study of the big data roadmap (Watson et al., 2017) corroborates findings from other studies demonstrating how big data can aid in crisis response efforts. According to the authors, research has demonstrated that expanding the use of disparate datasets, particularly big data, can improve crisis and disaster preparedness and response. Activities emerge as a significant benefit of big data in this sector due to their ability to aid in response decision-making.

Ma and Zhang (2017) propose a data-driven knowledge management system (KMS) to facilitate decision-making, coordination, and collaboration within emergency operations centres (EOCs) and with the general public. According to experts, knowledge management processes are being integrated with big data analytics to enhance data processing and crisis management capabilities. Case studies demonstrate how the proposed knowledge management solution enhances situational awareness and decision-making in the context of social security incidents. By utilising the big data of mobile and social network users to detect and manage emergencies (Doka et al., 2017), Katerina Doka and colleagues developed a storage and processing platform that can support a diverse range of big data-related applications and services. This system is used to collect and analyse pre and post-disaster data. They emphasised the scalability of big data frameworks. According to a systematic review of the literature conducted by Shahriar Akter and Samuel Fosso Wamba in Akter and Wamba (2017), big data in disaster management is examined in order to identify significant contributions, gaps, challenges, and a future research agenda. Their research aims to improve public understanding of the role of big data in disaster management. According to them, decision-makers must address a range of issues, including crisis analytics platforms, data governance, data quality, and analytics capabilities. They acknowledged the research's limitations, noting that they examined only papers that met a set of criteria they determined to be relevant to disaster management. Unpublished works, book chapters, and conference proceedings were left out of the mix.

MACHINE LEARNING IN CRISIS MANAGEMENT

While technology advances at an exponential rate, organisational change occurs at a logarithmic rate. Alternatively, crisis management technology is evolving at a breakneck pace, and this trend appears to be accelerating. It is challenging and time-consuming to alter an organization's mindset and behaviour (Dugdale et al., 2019). Numerous additional works must be reviewed and applied in this field, but the most important are those that show how crisis management systems can be improved by using large data sets and machine learning, building on previous work.There is a need to develop a few metrics for comparing or, at the very least, comprehending the various machine learning and big data models proposed. Numerous publications in this field, such as Zagorecki et al. (2013) and Lin et al. (2011), will serve as inspiration for these criteria.

Robert de Hoog and Guido Bruinsma (2006) of the University of Amsterdam address the issue of tailoring information to different types of users. Their primary proposal is a system that can be trained to distribute information, which they believe will alleviate some of the problems associated with information overload and improve collaboration among all actors in the crisis management system environment. Machine learning techniques were investigated in order to automatically create context-specific task profiles and to use a description of user activities as a guide for information distribution and system training. They demonstrate a method for transforming massive amounts of unstructured citizen-generated data into more informed decisions in Schulz et al. (2012) by Axel Schulz and colleagues, and aim to process social media data using Linked Open Data and crowdsourcing. To reduce the amount of manual effort required for information filtering, machine learning techniques such as clustering and trained classifiers were introduced. This was accomplished in three stages: collection of data, classification, and enrichment.

Adam Zagorecki et al. have discussed the use of data mining and machine learning techniques to aid decision-making in disaster management. A significant challenge in disaster and crisis management is obtaining useful data for disaster and crisis management methods to use. This information can be static in the run-up to a disaster or dynamic during one when it is generated in real time. Additionally, they discussed the issue of processing simulated data rather than real data. Axel Schulz and colleagues

(Schulz et al., 2013) discuss the use of emotional tweets for crisis management by conducting a systematic evaluation of a sentiment analysis approach on micro-posts that detects seven different emotion classes. The researchers concluded that using tweets labelled with a seven-class sentiment classifier is more accurate and recallable than simply using tweets with a negative sentiment labelled with a three-class sentiment classifier.

Dat Tien Nguyen et al. (2016) proposed using Deep Neural Networks (DNN) in disaster situations by using a new online algorithm based on stochastic gradient descent to train DNNs in real time during disaster situations. However, when different training data sizes (between 2200 and 3900 tweets) were used, model performance varied significantly, particularly when using a binary classification model with in-event data. Additionally, there is a very low level of accuracy when the model is used in the Multi-Class Classification run, and this accuracy degrades as more training examples are added.

Vitaveska Lanfranchi (Lanfranchi, 2017) analyses the ethical risks and implications of using automated systems that learn from social media data to provide intelligence in crisis management. She also provides an overview of the use of social media data in crisis management and how it affects both machine learning and social media data. According to their findings, combining social media and crowdsourced data with machine learning algorithms to understand and filter the data has significant ethical implications when it comes to providing fast, agile crisis information. Additionally, they stated that a corpus of Twitter data pertaining to crisis and emergency management will be used to pre-train the system, which will then be analysed to determine its performance in real-world situations.

In response to the Australian state's fire emergency, Lagerstrom et al. (2016) proposed an approach for image classification based on low-level features and pretrained classifiers. Convolutional neural networks were used to extract features from images, and Random Forests were used to classify them. They demonstrated that images could be accurately classified into fire and non-fire classes using these methods. Giannakeris et al. (2018) presented a detection approach for classifying objects (flood, fire, etc.) in disaster scenarios in order to develop a warning system framework for detecting people and vehicles in danger. They classified the images accurately, using transfer learning in this context. Khan Muhammad et al. (2018) proposed a framework for early fire detection using convolutional neural networks for surveillance cameras to detect fire in both indoor and outdoor settings. Additionally, they used transfer learning based on AlexNet to classify images and detect fire disasters, which increased the accuracy.

Arru et al. (2019) presented a data analysis method that assists crisis decision makers in determining whether or not to notify the public in the event of a crisis. The work describes a four-step decision-support process based on decision trees that will assist decision-makers in determining how a population will react to an alert. They claim that by analysing this data, they can determine whether or not to send out a crisis alert based on the general public's behaviour during a crisis (Buettner and Baumgartl, 2019).

Baumgarti and Buettner (2019) examined how deep learning can be applied to evacuation situations. They demonstrate how computer-generated agents can recognise objects such as doors and stairwells and use that information to assist with evacuation planning. They used a network of convolutional neurons to perform image recognition in emergency situations and obtained an intriguing result and a level of recognition accuracy that is superior to current methods.

Based on our evaluation of existing machine learning-based crisis management research, a great deal of work has been done and a great number of innovative ideas have been implemented. According to researchers' models and approaches, the most frequently used machine learning models in this field are binary and multi-class classification methods, as well as modern deep learning techniques such as the role-task framework. The most frequently used techniques appear to be classification (binary or multi-class) and one of the deep learning techniques. Due to the fact that some have proposed models in conjunction with their experiments and results and others have simply proposed models without conducting experiments, these methods have been suggested for use in future research only in the last few years.

Studies that propose machine learning models and include experiments and results frequently employ a variety of performance measures, including precision recall, receiver operating characteristic (ROC), and F-Measure, in addition to more generic measures such as average performance, completion, and so on. This is because the experiments' measurements are not standardised. According to the data gathered, Twitter appears to be the most frequently used source, as evidenced by tweets sent by users during the crisis. Human involvement and participation in the data labelling process are also critical factors to consider. The majority of datasets used in these studies are small, particularly those that contain only labelled tweets, and large datasets, as previously stated, typically contain simulated data rather than actual tweets. This may necessitate a revaluation of the datasets and data quality used in the investigation. Apart from that, some studies discovered that the models and experiments they developed could be enhanced by making wise dataset selections or by optimising the model's learning process.

BIG DATA AND MACHINE LEARNING APPROACH

Due to the approaches taken in these previous studies and the possibility of improving each approach in light of the nature of crisis management systems, an approach that is primarily used to classify decisions (knowing their types previously) can be proposed. Real-world crisis reports as training datasets were recommended, in addition to informative data from Twitter users.

Generally, crisis management systems generate reports that include additional information about the method and plan used to manage the crisis and express an opinion about the management approach. This information includes the severity of the crisis (Response Level), the amount of time spent managing the crisis, and the percentage of available resources that were actually used. This approach (Figure 1) may be modified in light of the results of the experiments described in this or subsequent papers. The primary issue that may arise is a model's inability to learn effectively due to a lack of real-world data.

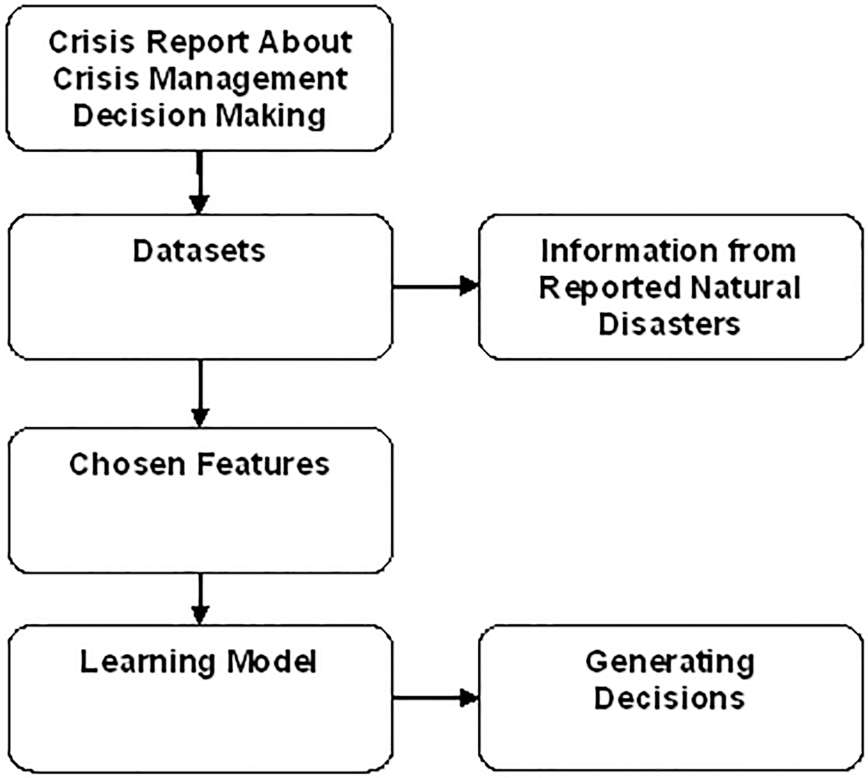
Datasets

The selection of a database is a critical stage in any machine learning approach or endeavour. Even when no useful database is available, using real data can provide an opportunity to obtain good results and useful interpretations, even when no useful database is available. The dataset should have a large number of dimensions and conform to the characteristics of big data (Ali & Edghiem, 2021). Along with crisis management plans and reports, databases used in this domain must contain accurate information about crisis management systems.

Extracting and Selecting Features

The feature extraction problem in machine learning is a common one because it is critical to understand which aspects of the problem are the most critical and necessary to solve. To put it another way, in order to extract the maximum value from data, there was a need to understand the critical criteria and components that should be used and considered during the data's implementation and use. To begin with, the

Figure 1. Machine learning approach



database's most useful features were extracted; however, if there were fewer features, all of them were extracted. This is true for databases of a small size. Depending on the information and criteria provided by the reports in our case, which databases may include reports from crisis management systems or user-supplied crisis data, features such as management time, resources, crisis levels, or types of crises, as well as informative data may include management time, resources, crisis levels, or types of crises.

This extraction is more or less accurate in order to produce a good learning algorithm, as these features contain information about the data used, but they may occasionally contain information that is not necessary. This is the origin of the notion that you are not required to use all of the extracted features. As long as you can obtain all the necessary information, limiting yourself to a few features is preferable. A learning algorithm makes use of a subset of the input variables to determine which ones to focus on. The remainder of the variables are omitted. That is, a reduction in size can be described in this manner. Models choke on very high-dimensional data because training time scales exponentially with feature count. This can result in overfitted models.

There are characteristics of crisis management reports that are derived from databases, such as the time and resources required to manage them, as well as the severity and type of the crisis. The dimensions of these variables can be reduced to those that are most useful for learning, resulting in a reduction in the number of features.

Learning Models

Considering the types and characteristics of machine learning, as well as its definitions and properties, does not always indicate the best machine learning model to use. While this explains how these models work in general, it may leave us perplexed as to which model is best suited to our particular problem. When it comes to machine learning, there are numerous techniques for developing a model. Classification models are the simplest to develop. Because the discussion is based on decision making, and the method for generating these decisions has been defined in our work as knowing the classes of specific decisions or the components of these decisions, as long as the researcher knows in advance what types of decisions will be made in which classes Additionally, a logistic regression model can be used to estimate the proportion of decisions made in this manner (for example, the percentage of resources needed to manage a given crisis).

PROPOSED MODEL

The researchers considered the preferred type of crisis data, such as real-world crisis reports, when searching for datasets in this area. This type of data is occasionally compiled by crisis management organisations and is not always available for free. There is also an abundance of information available on natural and man-made crises. A database comprised of several datasets was used pertaining to natural disasters that occurred in the Middle East over a specific time period (2010-2020, for example). These figures are based on reports received from Red Crescent Societies, national non-governmental organisations, and international non-governmental organisations, among others. Since this dataset was created, a number of natural disasters have occurred in Middle Eastern countries, and it includes information on each one, such as the number of people killed, the number of homes destroyed, and more.

To begin with, a classification model was used to classify the type of crisis based on data on natural disasters in the Middle East. For instance, the researchers chose to categorise two distinct types of crises based on the information provided. Knowing the type of crisis based on certain information (such as the number of victims and affected homes) enables us to prioritise crisis management and also estimate the resources required to manage the crisis. The purpose of this classification is to isolate a component of a decision that led to a crisis.

The first dataset, which contained data on natural disasters, served as the foundation for a classification model that was used to determine the type of crisis. For instance, the researchers classified crises into two categories based on the data provided. By determining the nature of the crisis (such as the number of victims and affected homes), the level of urgency with which it should be managed can also be determined, as well as the resources that will be required. This classification is used to denote a decision-making element preceding a crisis. According to information on natural disasters, this component represents the type of crisis: individuals killed, individuals harmed, families harmed, homes damaged or destroyed, and so forth. Furthermore, it is our responsibility to determine in advance which classes of types are used (e.g., for the first dataset, two types of classes to carry out a binary classification were chosen).

Table 1. Dataset results

Dataset	Features	Accuracy
Crisis Type	Houses destroyed	4
	Families displaced	4
	Families affected	5
	Individuals affected	5
Community Damage	Death	5
	Injury	5
	Missing	5
	Victims	4

The second dataset was then used to create a new classification. This scale is designed to quantify the magnitude of a natural disaster (i.e., low community damage and high community damage). This system of crisis levels can be used to determine the priority of a crisis. Additionally, and based on available data, it enables an assessment of the extent to which crisis management systems should intervene in a given situation. This classification serves the purpose of providing an additional piece of the decision puzzle to the decision maker. This component is used to determine the extent of a crisis's impact on a particular community based on data gathered during the crisis's impact assessment. This information will assist us in determining the magnitude of a crisis's damage, allowing us to prioritise each case and improve our response in the event of a future crisis of comparable magnitude. Demographics, vulnerable groups, and costs are all examples of this type of information.

DISCUSSION OF MODEL OUTCOME

After selecting the features, adjustments were made to the feature selection based on the results. The first, and most obvious option, is to make full use of all available numeric features. Decisions are made based on the information contained in each feature and its relevance to the desired outcomes. The researchers chose to evaluate the classification model's performance on a scale of 1–5 (1 being the least accurate and 5 being the most accurate) because it is straightforward and provides us with the desired interpretation of the degree of performance. As a result, it is possible to summarise the classification into two stages. The first is for the component of crisis type, and the second is for community damage classification (see Table 1).

Several significant conclusions from the experimental results of the model can be deduced. For the reasons outlined in the preceding sections, it was determined that prior to utilising the two decision components for crisis management, it was necessary to classify the type of crisis and the extent of community damage. After training the models, the outputs are acceptable because they have distinct connotations. When all features are used to classify the type of crisis, the model has a noticeably high level of accuracy.

To extract the most information from the first dataset, fewer features were used (such as crisis-affected families and individuals) to summarise the most data. The outcome was satisfactory. The second dataset produced nearly identical results, even when only a few relevant features were used, such as deaths, injured, missing, and victims. Due to the fact that the two datasets used to classify crisis types are distinct and contain data on crises in distinct countries, the classification of natural crises can be performed using nearly identical features despite their differences. These features detail the individuals and families impacted by these crises, as well as the individuals killed as a result.

The features produce nearly identical classification results for the other decision component, the degree of harm to the community. This is especially difficult to accomplish because a large dataset was used and only a limited number of features were extracted, resulting in little learning for decision support systems to make clear decisions to avoid a crisis.However, our findings are acceptable at this stage because they demonstrate that as more data on natural disasters is generated in the future, the more decision support systems will be able to make better decisions. Due to their infancy, such technologies simply lack the data necessary to demonstrate their true potential.

FINAL THOUGHTS

The application of big data tools, machine learning techniques, and algorithms across multiple fields typically produces positive results that are beneficial in each area, provide something additional, and are able to be improved over time. This chapter has demonstrated that the area of crisis and disaster management is not an exception to this rule.

As there is a great deal of work being done in this area to apply big data and machine learning techniques, utilising a variety of different types of data and data sources. These works, too, have the potential to be improved in order to achieve better results, according to the researchers who have published in this field and the results they have obtained.

According to our knowledge of machine learning and the published research in this field, the results obtained using this approach remain acceptable, particularly as a first attempt. Additionally, the proposed approach is adaptable, allowing it to be modified and adapted to the unique circumstances surrounding crisis management. Additionally, the approach and this work in general have a great deal of potential for future work. Although the datasets used in this work are real and pertain to specific crises and disasters, there is a need to use several additional datasets pertaining to other crises and disasters in order to improve the accuracy of these models and thus be able to extract good decisions in the future.

The primary objective of our work is to continue investigating machine learning applications for crisis management systems and for the field of crises in general. There are still numerous things to be done at the management level, as well as crisis prediction and risk mitigation. especially when dynamic and varied data sources, such as social network data, are available. Additionally, there are numerous applications for big data techniques, including massive data storage, parallel and real-time processing and calculation, and massive data quality measurements.

The field of automobile and road accident research is an extremely interesting area in which to apply machine learning and big data approaches. This is due to a number of factors, including the increasing number of road accidents and the necessity of utilising existing data on these types of crises in multiple countries. The same can be said about local and global epidemics, as well as earthquakes, floods, and forest fires. Additionally, it would be interesting and beneficial to use this type of data, as well as other types of data, to develop a predictive model capable of predicting crises in advance. It would also be interesting to explore alternative industry 4.0 innovation similar to big data and machine learning, such as the Internet of Things (IoT), cloud computing and artificial intelligence to predict and manage crisis situations (Ali, 2019, 2020; M. Ali, 2019; Ali M et al., 2018; Ali & Abdel-Haq, 2021; Ali & Edghiem, 2021; Ali et al., 2020; Ng, 2021). Therefore, future research could explore the role of Industry 4.0 innovations to predict and manage future crises.

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Chapter 6
Artificial Intelligence (AI) as a Decision-Making Tool to Control Crisis Situations

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ABSTRACT

Recent events have emphasised the critical nature of making key decisions with the support of innovative technologies to manage crises. This chapter will review pertinent literature on crisis management and existing categorizations or typologies before delving into crisis decision-making. Two distinct modes of decision-making are discussed: rational and intuitive decision-making. The following subsection conducts a review of articles in the literature on artificial intelligence and data-driven approaches, categorising them as rational and intuitive decision-making.

INTRODUCTION

This chapter will review the available relevant literature to explicate the concepts articulated as intended outcomes from this chapter, which focuses on Artificial Intelligence (AI) as an influencing technology to make key decisions on controlling crisis situations. It starts with a brief overview of crisis and its existing characterisations or typologies before considering decision making in crisis situations. Two broad decision-making regimes are reviewed – rational and intuitive decision-making. A review of articles in the literature relating to artificial intelligence and data-driven approaches are reviewed, whilst considering them under the subsections of rational and intuitive decision-making.

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CRISIS MANAGEMENT

According to Coombs (2014), a crisis can be defined as "an unpredictable event that threatens important expectancies of stakeholders relating to health, safety, environmental, and economic issues, which can seriously impact an organisation's performance and generate negative comments" (p.3). Examples of crises involving multinational companies, governments, etc. can be found in the media around the world on a regular basis. For instance, the recent impact of the coronavirus (COVID-19) on the global economies, tourism, and virtually all aspects of human endeavour. In the multinational organisations, some prominent crises over time are the falsification of metal quality reports by Kobe steel (Mitchell, 2002), the disappearance of Malaysia Airlines Flight 370, the BP oil spill in the Gulf region, unexplainable acceleration in Toyota cars, or the collapse of the building in Bangladesh. Due to globalisation resulting from technological advancement, there will be even more increased impacts of crises on organisations due to the complexity and depth of supply chains in multinationals today. For instance, consider the suppliers identifiable in the Nike supply chain, or the composition of the agricultural food supply chains. Crisis management is becoming an interesting topic of research having many implications for both academicians and practitioners, which has led to the development and promulgation of various articles in the area of crisis management. For instance, a systematic literature by Cleeren et al., (2017) highlighted the need for an enhanced understanding of product harm crises considering an international perspective. The findings from that study reveal the overwhelming number of studies on product harm crises in developed countries, however, with little or close to nothing of such being conducted in emerging economies.

Crisis Typologies

In the literature, there exist several attempts at typifying or characterising crises, exposing the need for adopting some structure in the academic body of knowledge. Recent advancements and global happenings (e.g., COVID-19) reinforce the shortcomings and expose the unsuitability of the extant typologies for handling complex crises happening now and in the future. As represented in Paraskevas et al., (2013), there are similarities – and differences – between various categories of exceptional circumstances. For instance, a conventional viewpoint of crises may characterise disasters, riots, terrorist actions, etc. as outright crises. However, if it is accepted that crises may be viewed as occasions for decisions, then perhaps an approach that is specially designed for handling the decision-making and management aspects of crisis management may be suitable and timely. There have been multiple attempts in the literature at characterising or typifying crises in management literature. Crisis analysts have presented efforts at imposing some structure to this variety of crises, originally discussed in Rosenthal and Kouzmin (1993). More recently, there is a coherent agenda towards classifying these criteria, some of which stem from rather dated research (Drabek, 1986). It is important to note that the relevance of these classifications have lost relevance in recent times.

Digging through the literature, it can be observed that some typologies of crises appear to be almost natural, for example the distinction between man-made (i.e., relating to technological) and natural causations (Rosenthal and Kouzmin, 1993). Evidently, there is a consistent search both for industry and practice towards an efficient characterisation or typology of crises, like some of the extant typologies. In another study, there is an additional characterisation of crises into man-made, natural and social crises (Rike, 2003). Presenting an attempt towards applying this characterisation or typology in recent crises (e.g., COVID-19) shows that although there is some merit in this characterisation (i.e., man-made, natural and social crises), there is some subjectivity or controversy introduced by presenting an opportunity to identify fundamental influence possibilities. Popular criticism of this approach in recent times have argued for the difficulty, complexity and almost impossibility of clearly separating multiple, often linked but geographically widespread causations of crises since modern crises come as an ongoing process (Rosenthal and Kouzmin, 1993). Consider the global warming crisis, a situation wherein the population is both victim and offender. It is easy to see that this is unequivocally a natural catastrophe without any act of God as, for example, an earthquake or Tsunami. This exposes some shortcomings by this simplified characterisation of crises, as an attempt to sum up these two events by classifying them as ‘‘natural disasters’’ therefore does not seem to be an appropriate procedure. Using the Rosenthal and Kouzmin (1993) characterisation discussed so far, it shows that the typology is exhaustive as all crises can be traced back to either social, natural or man-made origin, but the subsets are surely not mutually exclusive. Besides, there are some more examples than the ones above that can show some limitations of adopting the existing typology of crisis management.

Gundel (2005) argue that the first step to coping with or controlling crises is the classification or characterisation of the same, which provides an attempt to analyse and plan for crisis management activities. Gunder (2005) defines four conditions for a good typology, which is (i) mutually exclusive classes, (ii) exhaustive, covering also future events, (iii) practicable, i.e. covering measures of prevention and (iv) pragmatic thus manageable. From the foregoing, four relevant typologies can be identified, which provide guidelines for risk and crisis management as well as for assessment of the crisis cause and impact (Taleb, 2004; Gundel, 2005) or for crisis communication stratagems as well as appraisal of stakeholders’ perspectives (Weiner, 1995; Bundy *et al.*, 2017). Table 1 presents an interdisciplinary approach, which allows a decision maker to assess crisis situations a variety of perspectives, applying scenario planning for the purpose of identifying strategic alternatives. This approach not only structures potential scenarios, but also highlights the appropriate management and communication measures that can be applied before, during and after the said crisis.

DECISION-MAKING UNDER CRISIS SITUATIONS

Emergency situations typically warrant the collaboration of multiple agencies and teams working together to mitigate the impact or control the consequence of an unexpected situation. Despite the existing approaches and methods, time pressure and the extremely variable nature of the resultant environment contributes towards increasing the complexity of establishing a structured decision-making approach towards the agencies, respondents and the public. In other words, it is very rarely the case that protocols are well established and applicable, rational and guided thinking and decision-making however come into play when different stakeholders collaborate. The stochasticity and rapidly evolving nature of the environment as well as the speed at which the event unfolds make it hard for participants to develop appropriate situation awareness or introduce some rationality into the thinking and thought process for grasping the situation to decide on a relevant solution or way forward. The implication of this is that disaster response does require improvisation and creativity, elements which are typically associated with resilience (Kendra and Wachtendorf, 2003). It is evident that decision making is much more difficult and challenging in crisis scenarios than in more controlled situations due to a number of factors, some of which have been listed above. In the literature, there are some decision-making approaches or frameworks that have been proposed. For instance, Sayegh, Anthony and Perrewe (2004) argue that managers

Table 1. Summary of crisis typology theories

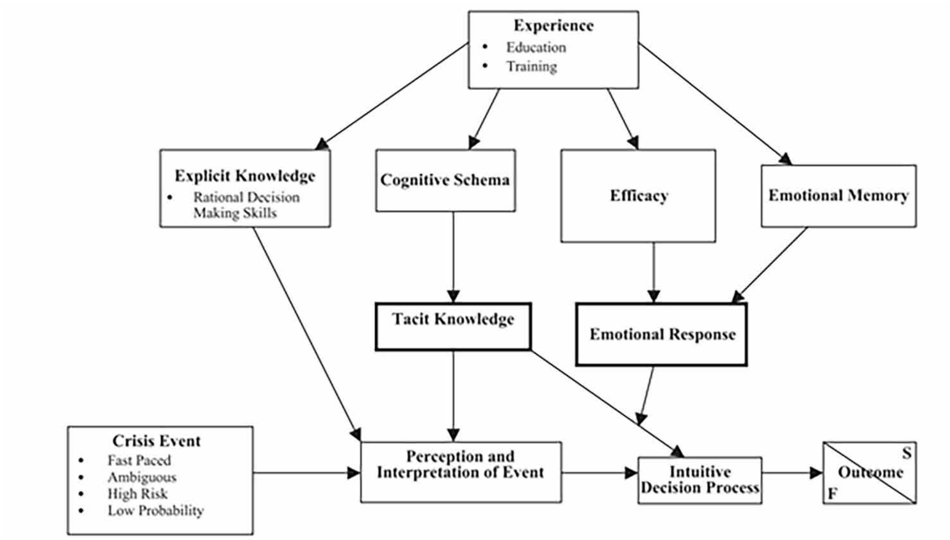
Source	Dimensions of Crisis Management	Position and discipline	Implications and application stage
Gundel (2005)	Predictability and influence possibilities on the cause of crisis	Crisis and disaster management	Crisis management measures and can be applied in pre-crisis and crisis scenarios
Taleb (2004, 2007)	Probability of crisis occurring and impact	Mathematics Risk and crisis management	Worst case scenario, resilience of organisations and applied in pre-crisis and post-crisis scenarios
Weiner (1995)	Root causes of crisis (both internal and externally) as well as how to control/mitigate the cause	Sociology General audience and stakeholders	Responsibility by stakeholders attributed, emotions, behaviours, etc. Can be applied in pre-crisis and crisis phase
Coombs et al., (1995)	Root cause of crisis	Crisis communication for stakeholders	Stakeholders, emotions, behavioural factors, etc. Applicable in pre-crisis and crisis phase

in today's business world are expected to make decisions using paradigms that are gradually deviating from traditional rationality and bounded reality conceptions. This requirement further complicates itself in crisis conditions, mostly when there is either limited amount of time and information, or both (Sayegh, Anthony and Perrewé, 2004). The work presented in the study proposes a conceptual model for decision-making in crisis situations, which underscores the role of emotions in intuitive decision processes under crisis conditions.

Figure 1 above presents a graphical representation of the model proposed in Sayegh, Anthony and Perrewe (2004). As can be seen from the model, the conceptual model underscores the importance of knowledge and emotions in decision making. From the findings, the work proposes that emotion contributes to good decision-making as well as being an essential element or component in the intuitive decision-making process. From the findings in the study, it becomes evident that an emotional response should be considered as a requisite element in rational decision analysis especially under crisis conditions in organisational settings.

Another concept that can be applied towards decision-making in crisis situations is the concept of some biases that show up during emergency. This concept is referred to as cognitive bias. Cognitive biases are defined as systematic errors in human decision-making. These biases can lead to objectively irrational decisions that are typically suboptimal for the decision maker or other key stakeholders impacted by the decision. As a concept, cognitive bias was first proposed by Tversky and Kahneman as a phenomenon that explained defective response patterns utilised by humans in judgment and decision making (Tversky and Kahneman, 1974; Kahneman, 2011). Tversky and Kahneman (1974) state that cognitive biases are the descendants of dependence on judgmental heuristics in decision making. According to Whelehan, Conlon and Ridgway (2020), heuristics can be likened to the shortcuts implemented by humans to reduce task complexity in judgment, while biases are the resulting gaps between normative behaviour and heuristically determined behaviour. In other words, the one concept is a derivative of the other and is therefore directly impacted by its application. Due to the significance and relevance of cognitive bias in aviation and flight safety research, it is – however – rather surprising that this research space has remained relatively scant. The significance of gaining a better insight into how cognitive biases relate to – and can lead to – critical incidents is a research area/topic that cannot be oversaturated. Due to the criticality of air travel and the critical safety involved, it is imperative to gain an in-depth understanding

Figure 1. Decision-making processes model (Adapted from (Sayegh, Anthony and Perrewé, 2004)

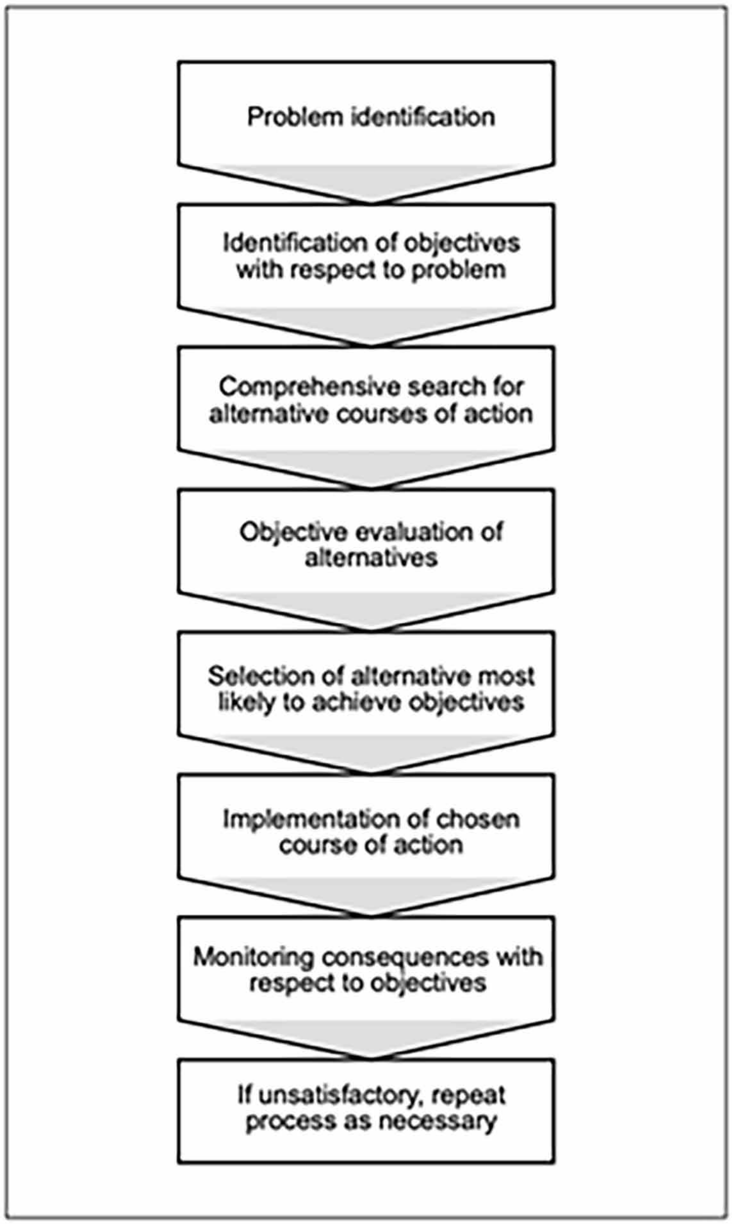


of how human cognitive processes contribute to accident sequences is vital to aviation safety management systems. Cognitive bias presents itself in decision-making as systemic ways in which a held belief influences the decision maker to ignore other features of a situation which may lead to better decisions and more favourable outcomes. Cognitive bias as a research topic has been investigated by many scholars in various disciplines, for instance, in relation to clinical decisions by a surgeon (D O'Sullivan and Schofield, 2018; Balakrishnan and Arjmand, 2019), visual analytics (Wall et al., 2017), crisis management (Reis et al., 2021) and the aviation sector (Wang and Li, 2019). As pointed out in Simon (1955), it is unassuming to exclude external interference in individual cognition during the cognitive process, which may dissuade or influence the decision-making process.

Rational and Intuitive Decision-Making

From the foregoing, it is evident that decision-making is a central process in organisations and a basic task at all levels of management. In other words, an understanding of the decision-making process is vital if managers are to make some progress in improving them. A rational decision-making process typically suggests the approach in which decisions should be made, sometimes involving structured mechanisms for the sequential process (refer to Figure 2). As can be seen from the figure, there is an assumption that the decision makers have access to a clear and unambiguous understanding of the problem nature, as well as a comprehensive search for alternative courses of action, assumptions which are invalid in emergency or crisis situations. The functionality of the rational decision-making model is limited to relatively simple problems, for instance problems that have situations with which the objectives are clear, unambiguous and agreed, cause-effect causalities are very well-known.

Figure 2. A rational decision-making model (Adapted from Heracleous (1994))



The Role of Leadership on Decision-Making Processes

In crisis situations, the set of decisions or actions undertaken by a leader to ensure immediate change is what is referred to as crisis leadership (Gardner and Laskin, 1995). In a crisis situation, the leader provides a sense of stability, reassurance, and sense of control (Lussier and Achua, 2004). According to Hadley, Pittinsky, Sommer and Zhu (2011), leadership is crucial in crisis situations as the leaders are under immense time pressure and the lack of time to effectively assess the alternatives relating to time and information within the situations. In Alkharabsheh, Zainal and Kharabsheh (2014), the authors investigate the mediating role of leadership styles on the relationship between characteristics of crisis and decision making styles by analysing 847 Jordanian civil defense officers and the findings showed that both transformational and transactional leadership styles have partial mediation effects on the relationship between characteristics of crisis and decision-making styles. In other words, the findings can challenge the popular notion that in crisis situations, transformational leaders are more effective than their transactional counterparts. Leadership in management of crises can reduce the impact of the damage by an event, and the lack of successful leadership can exacerbate the impact. Demiroz and Kapucu (2012) propose a conceptual framework for leadership in managing emergencies and disasters. Table 2 summarises the characteristics of good leaderships from the study. As can be seen from the table, the lack of requisite leadership traits and skills can contribute to exacerbating the impact of crises leading to undesirable consequences.

Table 2. Summary of leadership characteristics

Characteristic	Impact of contribution	Impact of lack of trait
Decisiveness	Rational decision-making	Erroneous decisions and untimely decisions
Flexibility	Broad consideration of all possible options	Rigidity can lead to stubbornness, poor decision making
Problem-solving	Positive	Negative
Managing creativity	Lead to innovative solutions and on-the-spot thinking	Negative impact
Managing teams	Appropriate delegation, division of labour, etc.	Ineffective decision-making
Decision-making	Essential	Can lead to disaster

ARTIFICIAL INTELLIGENCE AND DECISION-MAKING

Whilst there is no specific account of the precise origin of AI, it is argued to have commenced in the early 1940s with the establishment of the McCulloch Pitts (MP) law (McCulloch and Pitts, 1943) and Hebb rule (Samuel, 1967) explaining the functioning of the neurons in the human brain. This initial work is what ushered in the pioneer rush of AI as a research field. In recent times, artificial intelligence (AI) as a research field is gaining interest and being applied in virtually all aspects of human endeavour such as engineering, science, education, business, transportation management, and economics, amongst others (Ali & Abdel-Haq, 2021; Cioffi et al., 2020; Farrokhi et al., 2020; Goralski & Tan, 2020; Završnik, 2020). The research field has witnessed tremendous growth so much so that it is almost impossible to effectively track the progression of studies researching around this topical subject. AI is now viewed as a vital means of analysing intelligence and has even been listed in Gartner's Top 10 strategic technology trends for 2020 (Gartner, 2019). According to Russell and Norvig (2016), AI is all about how to instil computers or machines with intelligence that is typically attributed to humans. More generally, there is a consensus in the academic community that the application of AI will affect some business activities more than others, and this impact will be greatly dependent on the degree of "creativity" obtainable in the activity.

Benefits of AI

There is an increasing level of abstraction from obtaining the data to getting an understanding of the situation to take decisions about the understanding of the stored knowledge. Given the increasing interest in crisis management, it is imperative to consider the significance and benefits of applying AI and data-driven approaches in crisis management. It is also interesting to point out that speed and accuracy are two crucial factors when making decisions in crisis situations. Therefore, it is possible to promote a model for 'successful decision-making in crisis situations' which encompasses the roles of intuition and rationality as well as abilities and limitations were clarified for both, human and artificial intelligence. As is known, the particular significance in terms of benefits of AI relates to the speed with which it processes data/information as well as the accuracy. These two benefits could contribute to enhancing the decision-making space found in crisis management.

DECISION-MAKING WITH AI

When it comes to decision-making, a major limitation of AI with regards to this is the applicability of an explainable or traceable element. Although there is a perspective that considers the techniques or rationale driving AI, which sometimes can be gathered from past experience or mathematical backward processing, it is imperative to understand what impact AI can have in decision-making processes in crisis situations. As emphasised in the previous section, AI has permeated all aspects of human endeavour and decision-making is no different. Within the existing literature, adopting AI for crisis management has been proven to help humans make better decisions (Duan, Edwards and Dwivedi, 2019), leading to concerns that the technology may soon replace humans in decision-making. There are two contrasting schools of thought relating to the adoption of AI for decision making in existing literature, with Wirtz, Weyerer and Geyer (2019) of the opinion that AI is more beneficial in crisis situations for decision-making due to the speed of decision-making, a trait that humans lack from. On the other hand, Polonski (2018) opine that AI might be better in complex decision-making, but humans still outperform the smart agents in uncertain and rationally unbounded situations.

Rational Decision-Making with AI

AI is being applied to make rational decisions. For instance, Bag, Gupta and Sivarajah (2021) propose a study that showcases AI for rational decision-making, emphasising that with regards to AI, the more the technology overtakes rational decision-making, the more accurate the decisions are made. Therefore, the approach, which is seconded in Jarrahi (2018), goes to show that the decision-making approach should be controlled and some models can be developed via either supervised or unsupervised learning approaches. In Chamorro-Premuzic et al., (2018), there is an argument for the adoption of AI in making more decisions.

Intuitive Decision-Making with AI

In crisis management, the characteristics involved in rational decision-making are inverted to uncertain, unavailable or sometimes ambiguous, making rational or intuitive decision-making inapplicable. In the real world of multiple decision makers, "objective" rationality becomes inapplicable and decision making is influenced by what may be referred to as "conditioned rationality". The main conditioning influences, according to Heracleous (1994), are social, political and cognitive. Therefore, although the rational decision-making model is not "wrong", in situations such as crisis and emergencies, it is clearly inadequate in both a descriptive and a prescriptive logic. AI can adopt a heuristic-based approach in the field of intuitive decision-making to influence the task portfolio, select and prioritising these accordingly. However, it is imperative to highlight the complexity involved in clearly articulating these including the vast availability of data, analysing these using the computational prowess of recent developments in algorithm design and implementation, areas with which AI might excel in decision-making (Lauras and Comes, 2015)

CONCLUSION

This chapter has reviewed the existing literature to obtain relevant articles that investigate the topical subject of crisis management but with specific applications relating to data=driven approaches – specifically artificial intelligence. The Coombs (2014) definition of a crisis as "an unpredictable event that threatens important expectancies of stakeholders relating to health, safety, environmental, and economic issues, which can seriously impact an organisation's performance and generate negative comments" (p.3) formed the basis for this review. From the findings in the review, it is evident that it may be interesting to consider the possibility of allowing a collaborative approach for both humans and computing algorithms (i.e., AI) to be involved in the decision-making process. For more information about AI and similar technologies in this domain, please refer to the following studies (Ali, 2019, 2020; M. Ali, 2019; Ali M et al., 2018; Ali & Abdel-Haq, 2021; Ali & Edghiem, 2021; Ali et al., 2017; Ali, 2021; Ali et al., 2020a, 2020b).

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Chapter 7
An Artificial Intelligence (AI)-Based Decision-Making Framework for Crisis Management

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ABSTRACT

The recent coronavirus pandemic has wreaked havoc on global economies, heightening interest in crisis management. As a result, it is critical to provide decision-makers with some assistance in improving their decision-making. As a research field, artificial intelligence (AI) has permeated nearly every facet of human endeavour, gradually displacing humans in tasks with promising outcomes. By combining these two fields of research, this chapter proposes ADDS: an artificial intelligence-based decision-making framework for crisis management. It proposes a decision-support framework. The development of such a framework can be beneficial for two reasons: (1) it can aid in advanced crisis preparedness, and (2) it can result in effective and productive communication during a crisis. It is worth noting that a thorough understanding of this can aid in planning, controlling, and managing the situation.

INTRODUCTION

A crisis is a highly visible, unexpected, and potentially disruptive event that puts an organisation's existence in jeopardy (Bundy et al., 2017). While such environments present organisations with a unique set of challenges, it is critical to remember that every organisation, large or small, global or local, faces the threat of a crisis, which can be caused by either man-made or natural disasters. In such situations, crisis managers are responsible for managing and leading the crisis (Cavico & Mujtaba, 2016). Effective

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crisis management necessitates timely and candid communication with employees and stakeholders, as well as ensuring that decisions and actions taken in response to those communications are consistent with the message spread. As a result, managers must devise a process for arriving at sound, reasonable, and satisfying decisions that can then be translated into actions. This is easier said than done, however, because decision-making processes are frequently fraught with uncertainty, complexity, and ambiguity (Jarrahi, 2018). In uncertain environments, such as those encountered during organisational crises, making critical decisions becomes a win-or-lose proposition. Rapid decision-making is required, as every second counts during a crisis. Additionally, a trade-off exists between decision speed and accuracy. Alternatively, managers must be capable of making both rapid and qualitative decisions. As a result, rational decision-making is defined as the systematic execution of a series of logic steps, including problem recognition, alternative evaluation, and actual selection of the prioritised alternative. The dynamic nature of the business world, combined with the plethora of choices available to the customer, means there is no space for reactiveness as decisions need to be rapidly made and highly accurate (Davenport & Harris, 2017).

Humans are also intelligent; they can recall previously memorised information and apply it to decision-making. However, content may occasionally be incomplete (Banerjee et al., 2018), owing to knowledge gaps and limitations in our short-term memory, such as memorising numbers or lists. Today, we also have additional forms of assistance, many of which are facilitated by computers and many of which are facilitated by mathematics. The impact of technology on stored knowledge and, consequently, decision-making processes has become apparent, and technology intelligence is now expanding at an alarming rate. Additionally, because humans take longer to gather information, they take longer to make decisions. As a result, there are now semi-autonomous decision-makers operating in increasingly complex and diverse contexts (Jarrahi, 2018). These semi-autonomous decision-makers are a subset of the engineering science known as "machine learning" or Artificial Intelligence (AI).

The most recent global crisis was the coronavirus (also known as the coronavirus) pandemic, one that had a tremendously harmful impact on the global ecosphere, influencing both the financial, medical, logistics and political terrain all over the world. The coronavirus crisis was officially declared a worldwide pandemic by the WHO on March 11, 2020 and is still ongoing. This pandemic has damaged human life as it was known, impacted orgainsational and country performance/reputation, threatening physical and mental health, safety and well-being of citizens globally. According to the Worldometers (2021), there have been over 200 million cases of the virus, resulting in nearly five million deaths globally, as at September 2021. A situation of this magnitude necessitates the need for a crisis management plan that is robust, resilient and dynamic, which can result in social change (Dess et al., 2014). Within this perspective, therefore, there is the proliferation of scholarly efforts and various discussions relating to crisis management, some of which had occurred in the past – for example, the Hong Kong flu in 1968 and the Swine flu outbreak in 2009 (Butler, 2009; Peckham, 2020). In another perspective, there are other crises that have occurred in the past decades, relating to natural disasters, terrorist attacks at country level, economic crises (e.g., the 2008 world economic recession), and many other such crises or disasters, some of which might be in a less critical perspective.

In recent times, research scholars have discussed various approaches to crisis management and contingency plan development based on scenario methods (Fabián et al., 2019; Saide & Sheng, 2021), crisis leadership (Bhaduri, 2019; Canyon, 2020; Jaques, 2012), stress management (Guenthner, 2012; Haus et al., 2016; Robert & Lajtha, 2002), crisis response system studies (Bundy et al., 2017; Paraskevas, 2006), etc., have all been studied within the literature. AI is simply the ability of machines to perform intellectual tasks previously performed by humans, such as learning, reasoning, planning, making decisions, and communicating in natural language. The objective of AI researchers is to create machines that think and behave similarly to, if not better than, humans. In the context of decision-making, the objective is to transform semi-autonomous decision-makers into fully autonomous AI agents capable of decision-making. The current state of the art in AI enables rapid response to disruptions or specific crises, as seen in the operation of multiple manufacturing companies. According to Ransbotham (2017), less than 39% of all businesses have implemented an AI-driven decision making strategy, even though AI is expected to have a significant impact on management and organizational practices within the next five years. It is fascinating to consider how decision-making processes would have changed in the absence of AI in order to predict crisis situations such as natural disasters or perhaps a health and safety issue within an organisation. While the Internet and other technological tools have altered how organisations and society conduct business, this new ease of access has not eliminated all barriers to decision-making, particularly during times of crisis.

We intend to bridge this gap by combining AI and decision-making in the context of crisis management. Two schools of thought can be discerned in recent literature. To begin, there is an established view that AI can augment human cognition when confronted with complexity, while humans retain a more holistic, intuitive approach when confronted with uncertainty and ambiguity in organisational decision-making. The belief that humans' decision-making abilities deteriorate in uncertain, crisis-like environments necessitates the development of AI agents free of such constraints. It is debatable whether AI will affect only rational decision-making in the coming decades, or whether it will also affect intuitive decision-making processes, and, indeed, whether it will affect decision-making in crisis situations. Thus, in order to shed light on the recently hot topic of how AI can affect crisis management, this chapter aims to contribute to the literature by focusing exclusively on decision-making processes as a critical component of crisis management and a core component of AI. Additionally, this chapter aims to promote additional research into other aspects of crisis management considering AI. Therefore, this chapter will be guided by the research question: "how can AI affect decision-making processes in crisis management?", as well as informed by a self-conducted literature review.

By applying real-time data analytics using AI, a decision-making support framework is proposed, which can enable companies to handle the situation and prevent it from blowing up into a crisis. We argue that the development of such a framework can be useful for two reasons: (i) it can help improve the preparedness of a crisis in advance and (ii) can result in an effective and productive communication in a crisis. It is pertinent to mention that the comprehensive knowledge of this can help in the planning, controlling and managing the situation.

LITERATURE REVIEW

Crisis and Crisis Management: An Overview

According to Faulkner (2001), a crisis is defined as a triggering event, "which is significant that it challenges the existing structure, routine, operation, or survival of the organisation" (p. 138). Still considering this perspective, another definition from Fearn-Banks (2016) is identified as "a salient event having likely negative consequences that can alter the normal operations of the organisation. Given that crises are unique in their nature, as "history does not repeat itself" (Gundel, 2005, p.114), containing the definition of the concept of crisis becomes challenging and complicated. According to Bundy et al., (2017), the concept of crisis management can be defined as "the action taken by managers in the immediate aftermath of a crisis" (p. 1664). The authors also underscore the fact that crisis management has evolved in the past decades and has shown signs of convergence. From the foregoing, organisational crisis can be defined as the observation of an unpredictable event that can threaten important expectancies of stakeholders, severely impacting the performance of the said organisation, typically resulting in adverse outcomes (Coombs, 2004).

To obtain a cogent definition and description of the concept of crisis, it is important to identify its main attributes, and even more important to create typologies of crises that can allow for better differentiations. According to Rosenthal and Kouzmin, (1993), it can be a daunting and almost impossible task to clearly separate a clear typology of crisis due to the presence of multiple causations of crises. However, the typologies can contribute towards providing a better understanding of how certain crises occur, the main challenges thereof, as well as how these characterisations can be applied towards controlling them. Table 1 presents a succinct summary of the theories typifying crisis and crisis management and are discussed in the succeeding paragraphs.

Table 1. A summary of crisis typologies [adapted from (Weber & Noizet, 2018)]

S/No	Paper	Typology of crisis
1.	(McGinn, 2017)	Unfolding and exploding crises
2.	(Gundel, 2005)	Unexpected, conventional and fundamental crises
3.	(Mitroff, 1994)	Normal and abnormal crises
4.	(Rosenthal & Kouzmin, 1993)	Man-made and natural crises

As can be seen from the table above, a simple characterisation of crises presented in Rosenthal & Kouzmin (1993) is man-made (i.e., artificial or technological) or natural crises. In this typology, crises are classified according to their intentions as either normal or abnormal (Mitroff, 1994). McGinn (2017) also characterised crises according to their time component by differentiating the unfolding crises – those that are slow-moving (e.g., a lawsuit) – and exploding ones, for instance, terrorist attacks or natural disasters. However, a crisis such as the COVID-19 pandemic can be regarded as an exploding and natural crisis, given the genesis and contribution or impact it has dealt to the global ecosphere. As mentioned in the introductory section of this work, the coronavirus pandemic is affective all areas of human life and has contributed to changing the old life as we knew it.

Crisis Management and Social Change

In relation to the previous definitions, the unexpected, catastrophic event has challenged all governments, organisations, and even individual life (Rao et al., 2020). Therefore, suitable, rapid, and robust responses, in addition to proactive strategies to overcome such crises become essential. According to Gundel (2005), during a crisis, there is intense danger of difficulty with a turning point especially when there has been a significant change that has just occurred, in other words, impacting either recovery or death. Taking a broader perspective, the implication of this is that a set of conditions in which individuals, organisations or institutions, and communities or societies face the high risks of social change that transcends past the customs of daily routine functioning, although this said significance and impression within these said circumstances might diverge (Booth, 2015; Drennan et al., 2014). The implication of this is that there must be a developed crisis management plan, which enables these stakeholders to deal with unforeseen future events at anytime, which may have harmful, negative impacts on the operations and nations entirely.

Although there is a striking similarity between crisis management and risk management, it is imperative to differentiate between the two. Broadly speaking, crisis management somehow relates to the power of unexpected or unanticipated events that may cause probable destruction and amazement to an individual or organization and its stakeholders at the micro-level, or even a country at the macro-level. Conversely, risk management can be defined as the process of managing risk and maximising potential prospects, and minimising potential threats and damage, which would have an impact on an organization. It is important to mention here, however, that both terminologies and concepts are vital to ensuring the stability of an organisation, or country and play vital roles in a stout governance configuration (Drennan et al., 2015). Although there is a plethora of well-constructed risk management procedures in place in organisations, some situations are inevitable, meaning that the organization may face some problems that may require crisis management. Hence, when an organisation has both processes in place, it can act rapidly in times of crisis, with the least possible losses. Besides, if this is the case within the said organisations, it becomes easier to better recover from this loss quickly by ensuring that operations can return to normal as soon as possible (Darbonnens & Zurawska, 2017).

Decision-Making in Crisis Situations

In our everyday lives, we make many decisions, some of which have inconsequential consequences, and others being life changing. This is the same in the daily operation of a manager. Managers in organisations face many decisions on daily basis, making decision-making an important part of a manager's daily life, some of which can linger on and have enduring effects for the organisational stakeholders and shareholders alike. In crisis situations, the manner in which managers make decisions becomes vital and essential, especially when one considers that the consequences of the deisions taken by these managers can be more direct and sometimes result in threatening the organisation, in comparison to the conventional or "normal" organisational settings (Pearson & Clair, 1998; Walumbwa et al., 2014; Wenzel et al., 2020). Viewing this from a different perspective, we argue that when organisations find themselves in situations characterised by uncertainty and face the dire necessity to make critical and rapid choices dynamically (i.e., where every moment matters), these organisations – and the decision-makers – can find themselves in a situation where a decision can be seen as a win-or-lose point (Rosenthal & Kouzmin, 1997, p. 279; Walumbwa et al., 2014, p. 284).

If an organisation finds itself in such position, the constraints of time can result in a lack of information required to make suitable and correct decisions, as well as speedy but also risky decisions (Rosenthal & Kouzmin, 1997; Pearson & Clair, 1998, p. 66). This means that the longer the decision-maker or the manager searches for an optimal, rational solution, the larger is the risk that the crisis will run out of time and control (Rosenthal & Kouzmin, 1997, p. 294). According to Dane & Pratt (2007), there becomes a trade-off between decision speed and decision accuracy. In these situations, therefore, there is the inevitable need to have a better understanding of how to make rapid, robust and dynamic decisions that are also accurate and qualitative. To overcome the inherent complication of real-world decision-making, Weber & Noizet (2018) argue that explicit knowledge, rational decision-making skills, and the logical and clear processing of information are of course required. Besides, Jarrahi (2018) argues that, under crisis environments, only focusing on analytical thinking is insufficient (p. 4), due to the inevitability of balancing both speed and quality. Therefore, it accentuates the need to consider switching the focus to other factors that might impact the decision-making process, especially under crisis situations.

AI and Big Data Analytics

Whilst there is no specific account of the precise origin of AI, it is argued to have commenced in the early 1940s with the establishment of the McCulloch Pitts (MP) law (McCulloch & Pitts, 1943) and Hebb rule (Samuel, 1967) explaining the functioning of the neurons in the human brain. This initial work is what ushered in the pioneer rush of AI as a research field. Frank Rosenblatt presented the perceptron in the late 1950s, which simulated the human nervous system using linear optimisation (Rosenblatt, 1960). The Adaptive Linear Unit (Widrow & Hoff, 1960) was developed in 1959 and used in simple practical applications, including weather forecasting. The Hopfield network circuit in 1986/7 gave rise to a second wave of AI adoption, about when Geoffrey Hinton and colleagues proposed the backpropagation (BP) algorithm for solving non-linear problems in complex neural networks (LeCun et al., 1988). This era ushered in the growth of statistical learning, with the Support Vector Machine (SVM) developed including kernel functions and transformations in 1997, algorithms that significantly outperformed in classification and regression problems (Cortes & Vapnik, 1995). With the evolution of neural networks, multilayer perceptron (S.-C. Wang, 2003) and statistical algorithms, there was an upsurge in the adoption of AI and machine learning. However, these conventional machine learning models required human expertise and intervention in curating the data that was fed in for the analysis. The most significant challenge was the need for manual feature extraction, engineering, and dimensionality reduction, making the performance of these techniques strongly reliant on the expertise of the data analyst and quality of the engineered features.

In some respects, the emergence of DL was accelerated by the abundance of traditional/statistical machine learning and statistical algorithms in existence at the time (I. Goodfellow & Bengio, 2015). The Restricted Boltzmann Machines (RBM) (Salakhutdinov & Hinton, 2009) was proposed, where the hidden layers were used as feature extractor vectors on the input data. The Auto Encoder (AE) was proposed in 1988, a model which uses a layer-wise, greedy learning algorithm for minimising the loss during an optimisation problem (Rumelhart et al., 1988). These existing models, when applied to neural networks, had significant challenges relating to the diminishing or explosion of the gradient during optimisation. El Hihi and Bengio (1996) presented the Recurrent Neural Network (RNN), a set of models that showed significant performance improvement in feature learning from sequential data. This model also had its own challenges, which were addressed in an improved version proposed by German engineers Sepp Hochreiter and Jürgen Schmidhuber (1997), called the Long Short-Term Memory (LSTM) neural network. This improved model addressed the vanishing gradient problem that pplagued the RNN version (Hochreiter, 1998). The Convolutional Neural Network (CNN) was proposed in 1998 to accommodate three dimensional inputs, such as images by which the features were automatically extracted by stacking convolutional layers and pooling (or dimensionality reduction) layers (LeCun et al., 1988). Some challenges with the hierarchical arrangement of DL models became imminent. For instance, as DL models got "deeper", model training suffered, and parameter optimisation became more difficult and time consuming – conditions that result in model 'over-fitting' and local optima problems.

The most recent boom in the adoption and application of DL was in the early 2010s, where the bidirectional DBM was proposed (Salakhutdinov & Hinton, 2009). The Deep Convolutional Neural Network (DCNN) was proposed in 2012, an algorithm that showed best-in-class performance in image recognition (Krizhevsky et al., 2012). Ian Goodfellow proposed the Generative Adversarial Network (GAN) in 2014 (I. J. Goodfellow et al., 2014), a neural network containing two independent models, each acting as adversaries. The concept of the GAN is having a generative model – which is trained to generate random samples that resemble real samples – and the discriminative model – which is used for training and classification with both real and generated (i.e., fake) random samples. More recently, the attention-based LSTM was proposed by integrating an attention mechanism with the LSTM (Y. Wang et al., 2016). More advanced models have been developed in recent times for instance, more architectures for sequential data analysis and NLP – BERT (Devlin et al., 2018), pre-trained DL models (Wen et al., 2019) and advanced image recognition models (Krizhevsky et al., 2012; Qassim et al., 2017). A prominent model – (You Only Look Once) YOLO – is a real-time object detection algorithm which is extremely effective in object detection in the computer vision community (Redmon et al., 2016).

AI-Driven Decision-Making

It is now imminent with the proliferation of data and data-driven technologies that AI and machine-driven decision-making will become more and more popular. This begs the important question of "Can AI be used to affect decision-making processes in crisis situations?" From the preceding subsection, it should be clear by now how much AI has permeated organisational processes, and that the technological advancement in this research field is evolving at a rapid pace. From the literature, it is important to note that there are already practical applications of AI-driven decision-making, as applied within the context of decision-making under crisis environments. In other words, semiautonomous decision-maker agents already act in increasingly complex and uncertain contexts, helping their human counterparts to make better decisions (Jarrahi, 2018). The concern for this technological breakthrough, however, results in increasing fear amongst employees and managers alike, that machines will soon replace many humans in decision-making (Jarrahi, 2018). However, it is pertinent to point out the presence of two divergent themes existent in the literature. On the one hand, Banerjee et al., (2018), argues that, because "critical decisions need more time made by human", and due to the "decline in the strength of decisions making in humans when they are in the state of shock" (p. 210), as is mostly the case in crisis situations, AI agents should be especially used in critical situations (p.209). Polonski (2018) shares the similar conception with the hooks up with the Banerjee et al., (2018) study, arguing that in most cases, AI makes better predictions than humans. On the other hand, Jarrahi (2018, p. 7) argues that although AI tends to be better for complex decision-making tasks, humans still outperform these smart agents in uncertain and equivocal situations, in other words, relating to the definition the case in crisis situations. The application of information and communication technologies (ICT) for crisis management during emergencies is referred to as "crisis informatics" and "disaster informatics" (Anderson & Schram, 2011). In the context of this present chapter, the adoption and application of data analytics and AI to address managerial challenges are still at the relatively infant stage, although the impact is already being felt in numerous transformative components for the many organisations already adopting it. For instance, in corporate finance, there is already a large application of data science for handling tasks such as fraud detection and credit risk assessment (Wu et al., 2014).

ADDS: AN AI-DRIVEN DECISION-SUPPORT APPROACH FOR CRISIS MANAGEMENT

Multi-Source Integration for Data Collection

As previously mentioned, this chapter aims at presenting a conceptual framework for decision-making that combines AI and big data analytics for decision-making in the context of crisis management. Figure 1 summarises the proposed conceptual framework underpinning this research. As can be seen from the diagram, two sets of data are collected as input data sources. Consequently, the scope of the data can be obtained from a broad range of sources. First, the unstructured data is crowd-sourced from social media sites, including Twitter, Instagram, Facebook, YouTube, Google trends, amongst others. By unstructured, it means that this data obtained could be in the form of either text of varying length (and language), images, videos, etc. This can be collected using the application programming interface (APIs) of these respective platforms and integrated to a unified source. Second, structured data can be collected from financial institution reporting websites, for instance, Bloomberg, Financial Times, and other sources of financial reporting. The data collection method allows for a robust approach for simultaneously comparing information from various sources using a data fusion technique, such as one applied in Essien et al., (2019).

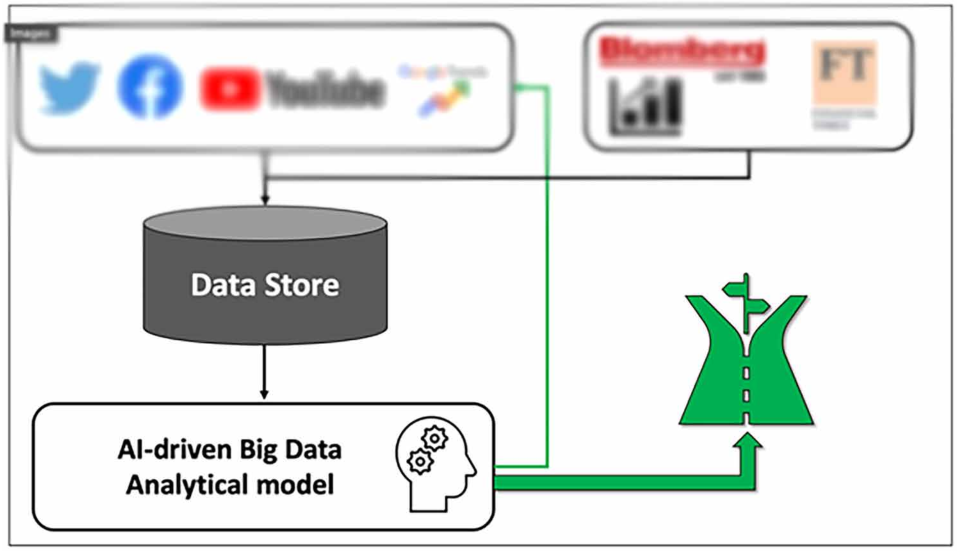
Using the COVID-19 pandemic as case study, it is possible to discover critical priorities in crisis management by presenting this integrated data analytics framework. As can be seen, this research work follows a theoretical and conceptual basis, deviating away from the conventional empirical research. The coronavirus was declared a pandemic on March 11, 2020 by the WHO, resulting in set alert levels (from 1 to 6). This data will be broadcasted on social media sites as well as organisational websites, etc. Together, these data sources are combined to a data store, which is represented by the cylindrical shape in the framework.

Deep Learning and Data Analytics for Decision-Making

Consequently, a deep learning and AI-driven data mining and predictive analytics model comprises the heart of the proposed decision-making framework for crisis management. The justification for adopting deep learning is due to its automatic feature extraction using a standardised learning approach. For this main reason, these models are fast gaining popularity and becoming best-in-class for many applications including image/object recognition, speech analysis/translation, natural language processing (NLP), sentiment analysis, amongst other applications. Therefore, DL is gaining research interest as these DL models demonstrate exceptional performance in various research areas, as evidenced in a myriad of applications, including traffic parameter forecasting (Essien et al., 2020; Essien & Giannetti, 2019), smart manufacturing (Essien & Giannetti, 2020; Giannetti & Essien, 2021), speech recognition (Zhang et al., 2018) and image recognition (LeCun et al., 2015).

Consequently, a dynamic network analysis approach is executed by the deep learning model, which integrates procedures for increasing the visibility of network dynamics in the given settings. This approach can be adopted towards analysing heterogeneous entities, uncovering complex relationships and providing a simplified decision-making support, which can be passed on to the company executives. In the literature, there is evidence of studies that are in support of this data-driven approach, for instance (McCulloh et al., 2010; Shiau et al., 2017). By integrating deep learning into this network analysis,

Figure 1. Research framework for AI-driven decision-making for crisis management



these organisations can realise the benefits of improved capabilities and enhancing crisis management. A significant capability of this approach to crisis management is being able to predict the connections and interactions existing between the various entities, thereby enhancing the interoperability of operations and managerial decisions.

DISCUSSION AND FUTURE RESEARCH TRAJECTORIES

The recent COVID-19 pandemic has shown to global and organisational leaders the importance of crisis management. Given the criticality of decisions made – some of which can have lingering consequences – it is important to make timely and qualitative decisions. Therefore, managers must devise a process for arriving at sound, reasonable, and satisfying decisions that can then be translated into actions. Rapid decision-making is required, as every second counts during a crisis. Additionally, a trade-off exists between decision speed and accuracy. The dynamic nature of the business world, combined with the plethora of choices available to the customer, means there is no space for reactiveness as decisions need to be rapidly made and highly accurate (Davenport & Harris, 2017).

As a technology, AI is simply the ability of machines to perform intellectual tasks previously performed by humans, such as learning, reasoning, planning, making decisions, and communicating in natural language. This chapter has presented a framework for decision-making that combines AI and big data analytics, which can be applied in the context of crisis management. This theoretical and conceptual chapter has shed light on the possibility of developing a data-driven framework for decision-making. We presented a contrived theoretical analysis to show the possibility of an AI-driven decision-making framework. Data collected from multiple sources are analysed using this deep-learning model, presenting the decision makers with a possibility of making easier decision.

Theoretical and Practical Implications

The main contribution of this chapter is articulating a robust and dynamic data-driven framework for crisis management that can be applied in business and organisational settings. We argue that this framework can serve as a steppingstone for future researchers to explore this terrain towards developing crisis management in real-world settings. In terms of practical implications, we develop the AI-driven decision support (ADDS) for crisis management in this conceptual or theoretical study. We show that this model has the possibility of developing a structured analysis method that can provide decision support to key organisational executives. The outcome of this study can suggest to managers the consolidated, analysed and predicted result from external and internal communication platforms, including social media, financial, and governmental/organisational channels, enabling real-time dialogue between stakeholders and shareholders.

Theoretical and Practical Implications

It is pertinent to reflect upon the findings of this research in light of some identified limitations. First, being a theoretical study, there is a want of validation, evaluation and putting the framework to test, for instance in a real crisis (e.g., the COVID-19 pandemic). However, this can also be served as future research, presenting a unified and integrated deep learning model for decision-support during the COVID-19 pandemic. We argue that this will enhance the speed and objectivity of decision-making to both organisational and governmental decision-makers. For future work, this study can also consider how this methodology will allow researchers to explore its application in multinational corporations (MNC) and multi-country governmental or global agencies (e.g., WHO, UNESCO, etc.). For further reading into other potential innovations for managing crisis situations, please refer to the following literature (Ali, 2019, 2020; M. Ali, 2019; Ali M et al., 2018; Ali & Abdel-Haq, 2021; Ali & Edghiem, 2021; Ali et al., 2017; Ali, 2021; Ali et al., 2020a, 2020b).

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Chapter 8
Implementation of Innovative Accounting Technologies in Crisis Management

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ABSTRACT

Demand for the implementation of innovative technologies in accounting continues to grow in lockstep with the advancement of technology innovation. The objectives of this chapter are to familiarise readers with current and potential innovative accounting technologies for obtaining high-quality data and to identify success factors for enterprises implementing these technologies. This chapter expects to provide businesses with practical approaches and recommendations for successfully implementing innovative accounting technologies through a thorough presentation and critical evaluation of the aforementioned key topics. In terms of business success, an effective application can help businesses gain a competitive edge by providing more relevant and reliable accounting and management information necessary to navigate today's difficult economic conditions and volatile business environment.

INTRODUCTION

It cannot be denied the significance of innovation in a business success, especially when firms must deal with vast amounts of information on a daily basic. In processing the information, accounting plays a significant role not only in reporting but also in consulting for business activities. Accounting involves both operational and financial data to provide financial and non-financial information for internal and external users. With a significant increase in data size, companies need to implement innovative accounting technologies to use the data effectively and efficiently for reporting and consulting purposes. Current technological innovations such as Big Data Analytics, Cloud Computing, or Forensic Accounting have brought a new phase to the accounting industry (Khan et al., 2018). Successfully applying these technologies in supporting accounting tasks can facilitate decision making and competitive strategies (Sleihat et al., 2012), or detect or prevent fraud (Cockcroft and Russell, 2018). However, presently, re-

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search on practical implementation of these technologies is still limited, for example, big data analytics is approached at an early stage (Big Data Finance, 2021).

Moreover, the recent pandemic has led companies around the world to uncertainty. This uncertainty makes it difficult for a firm to allocate firm resources. Firms may be unsure about how suppliers manage their orders or if customers can pay back their debts. As a result, decision making is increasingly challenging and imprecise. In this crisis, the more and better the information, the easier it is for companies to handle unexpected circumstances. To have quality information, implementation of innovative accounting technologies as mentioned above can provide appropriate solutions.

Due to the limitation of current research about practical implementation of innovative accounting technologies and the need of these technologies in generating better quality information under uncertainty, this chapter aims to introduce current and potential innovative accounting technologies to obtain quality information and identify success factors for implementing these technologies for enterprises.

BACKGROUND

Technological innovations have made accounting tasks more effective and easier due to speedy and precise data processing. The innovations have dramatically improved accounting information system which records, classifies, summaries, and communicates business's financial position and performance. Integration with technologies makes accounting tasks not only focus on reporting but also consulting for business success.

According to (Khan et al., 2018), innovative accounting technology is accounting programs that support accountants in performing their jobs. Innovative accounting not only concentrates on financial information but also non-financial information such as social media responses, customer behavior or web page data. To handle a huge volume of data, accounting must be tied to technology innovation to be able to process data and obtain relevant and reliable information to meet the needs of firms.

Currently, some of the trending technological innovations that have significant impacts on the accounting industry include Robotic Process Automation, Cloud Computing, Blockchain and Artificial Intelligence. The first section in the focus of this chapter will discuss advantages and disadvantages of using these technologies. Then, the needs of innovative accounting technologies in crisis management will be evaluated. Challenges in implementing innovative accounting technologies are presented next and success factors for implementing these technologies are identified in the last section.

INNOVATIVE ACCOUNTING TECHNOLOGIES

Advantages and Disadvantages of Innovative Accounting Technologies

Robotic Process Automation

Robotic Process Automation (RPA) is a pre-configured package to replicate the tasks of humans (Moffitt et al., 2018). Not all human jobs can be reproduced by applying RPA as some of these tasks require the assessment from humans. For accounting, repetitive, and bulk transactions such as invoicing, payroll, accounts receivable or accounts payable can be replaced by robotic automation.

Once proper RPA software has been implemented for firms, it can improve accounting information quality and quickly response to business requirements. Adoption of RPA can lead to error-free processes and results which in turn enhance reliability and relevance of accounting information. Indeed, the software is developed in accordance with required accounting standards, thus enhancing accuracy and compliance. Due to automation features, the tasks are performed faster and more accurately than humans. With prompt processes and instant outcomes, accountants are more likely to have available information to consult with the business when needed. As a result, operations become more efficient and more competitive.

However, if RPA is not controlled or implemented properly, it can increase high risks to companies' operations. Especially when RPA is designed with mistake, it can create systematic risk which negatively impacts on quality of accounting information. Or if there is unauthorized access, it can lead to fraud. In addition, the adoption of RPA also requires firms to spend additional costs for training along with fixed and variable costs to develop and deploy RPA software.

Clouding Accounting

Clouding Computing has formed an innovative accounting technology called Clouding Accounting. Clouding Accounting is also known as virtual accounting which allows accountants and other employees remotely access the company's information and data (DorDevic et al., 2018). Instead of being limited to office space, accountants can now do their tasks from any location.

Cloud Accounting can create huge benefits for firms, especially during the current world pandemic. Being able to access a company's data from various locations provides more flexibility for accountants to work from home while still meeting company needs and support client demands. All processed data and information are saved and updated automatically and shared in the real time basic. Therefore, implementing cloud accounting enhances business competitive advantages due to speedy responses to customer requests and environmental fluctuation. Furthermore, clouding accounting helps companies avoid storing data in hard drives which can be lost because of damage or stolen computers. The application of cloud accounting is also considered as much easier and quicker than the implementation of normal accounting software (Singerova, 2018).

Besides the above benefits, some downsides also exist with cloud accounting. Database breaches from hackers, viruses and employees are the main reasons that firms hesitate from using cloud accounting. Disclosure or losing critical data or strategic information because of breaches can cost firms more than benefits that they get from clouding accounting. Moreover, significant costs are also required to implement cloud accounting and maintain high security for data protection.

Blockchain

A Blockchain has been known as distributed ledger technology (Nordgren et al., 2019). Parties of the Blockchain can make transactions and keep the records in the platform, then the information in the platform can be disclosed privately or publicly to users of the chain (Ghosh, 2019). This process is different from the traditional accounting approach when each business entity uses their own accounting books for their transaction. With Blockchain, for a single transaction, all parties involved can account their transactions in an identical block of the chain.

Table 1. Caption should be sentence case with no ending punctuation if only one sentence

	Advantages	Disadvantages
Robotic Process Automation	• Improve accounting information quality • Quick response to business requirements	• Systematic risk which negatively impacts on quality of accounting information can be created. • Database breaches from hackers, viruses, and employees.
Clouding accounting	• Being able to access the company's data from various locations. • Data and information are updated automatically and shared in the real time basic. • No need for a hard drive. • Quick response to business environment.	• High costs involve implementation and maintenance of cloud accounting. • Database breaches from hackers, viruses, and employees.
Blockchain	• Enhance accounting information transparency and prevent fraud • Transactions can be recorded in real-time • Information asymmetry is being minimized among information users	• Workload increases dramatically in the first implementation. • Database breaches from hackers, viruses, and employees.
Artificial Intelligence	• Create financial statements with text based on processed information • Improve financial information quality, • Provide more relevant and timely information for decision making. • Enhance internal control system.	• AI only learns from specific examples then tries to enhance its performance rather than develop its skills • To maintain AI performance, aside from implementation costs, business needs to pay significant fee for maintenance and update the system

Source: Own development

Using Blockchain can enhance accounting information transparency and prevent fraud. When all related parties of business transactions keep their records in one platform, these records can be compared to avoid errors. These transactions can be recorded in real-time, from which updated financial statements can be prepared and disclosed to users of the information. Stakeholders can view not only these statements but also transactions recorded in public ledger, which means that information asymmetry is being minimized among information users (Cong et al., 2018). In addition, with cryptographic hash and timestamp, users can be verified, and record dates and times can be tracked, thereby providing good trail for auditing and security purposes.

Along with these advantages, Blockchain also has some limitations. Firstly, there is still the possibility that Blockchain can be taken over by hacker which then data of related parties may be lost, or accounting information can be distorted. Additionally, with real-time financial statements, some concerns are raised related to the accounting treatment of accruals or deferral transactions. Finally, when business first attempts to use Blockchain, workload increase dramatically due to the high number of transactions that need to be recorded to the platform (English, 2019).

Artificial Intelligence

Artificial intelligence (AI) is described as machines that can perform cognitive tasks such as learning from the past, adjusting to the environment, solving problems, or making decisions similar humans (Rai et al., 2019). Accounting systems tend to move toward intelligent and automatically processes by implementing Artificial Intelligence (Canada et al., 2009) which comprise of big data analysis and provide more reliable financial information for the users.

With the superior ability in performing human-like tasks, AI can support accountants efficiently in both structured and unstructured duties. According to Gotthardt et al. (2019), AI can gather relevant data, understand the information to support decision making and fraud detection, then create financial statements with text based on processed information. Implementing AI can help accounting reduce handling repetitive transactions, improve financial information quality, and provide more relevant, timely and correct information for decision making (Ali et al., 2018). Moreover, AI is also able to enhance internal control system by identifying, evaluating, and eliminating weaknesses of the system.

Although AI is on the right track to achieve its purposes in duplicating some of accountant tasks, AI is far behind the general intelligence of biological world. AI is still in progress to learn new tasks, and the challenges are rising when the learning process in some areas only uses a small number of examples (Shevlin et al., 2019). In this case, AI only learns from specific examples then tries to enhance its performance rather than develop its skills. Another limitation of AI is the availability of data and costs required to implement AI system. If the data is unclear, inconsistent, or of inadequate quality, it cannot expect good outcomes from AI. In addition, to maintain AI performance, aside from implementation costs, businesses need to pay a significant fee for maintenance and update the system.

While disadvantages come along with the advantages of implementing Innovative Accounting Technologies, the needs of innovative accounting technologies are still increasingly. On the one hand, the benefits from using these technologies contribute significantly to business success and improve accounting tasks. On the other hand, existing drawbacks often have suitable solutions to them. For instance, risk of data loss from hacking and viruses in cloud accounting can be prevented with regular or automatic security updates. Moreover, because of real-time and online data updates and sharing features of cloud accounting, cybercrime can be identified faster than the other system. Moreover, in implementing innovative accounting technologies, it has been shown that the benefits outweigh the downsides of the adoption. It has been argued that implementing and usage costs are the negative factor that make firms hesitate from applying of these technologies. However, if firms consider the benefits from reduction of administrative costs from using less paper or not having to spend on computers' drives and maintenance fees, they can find spending on the internet and cloud accounting software worthier. To sum up, with the development of technological innovation, the accounting industry has been influenced by these technologies in performing accounting tasks. While each accounting innovative technology has both benefits and drawbacks, the importance, and the needs of these technologies in business success, especially in crisis, cannot be neglected.

Need for Innovative Accounting Technologies in Crisis Management

Management tasks and business operations can be performed under conditions of certainty, uncertainty, or risk. It seems more straightforward for a firm to plan and make decisions in certain circumstances as information about expected results in various alternatives is regularly available. However, this is not the case for companies to fall into uncertain situations or face some potential risks. Under risk conditions, one alternative may lead to more than one outcome involving different possibilities. It can become worse in uncertain situations when the information and possibility are not confirmed, the best alternatives may not be available, and the results generated from each alternative need critical analysis to avoid bad situations (Dahal, 2019). Innovative accounting technology aims to enhance accounting tasks by processing data faster and more accurately. They will provide accountants with prompt outcomes to interpret, evaluate and consult with management for appropriate decision making. These techniques and solutions can help management comprehensively understand and critically evaluate sophisticated business circumstances and make decision-making processes simpler in uncertainty conditions (Dekoulou and Trivellas, 2014).

The implementation of innovative accounting technologies is not meant to replace all of accountants' duties but only provide accountants with more time and resources to perform more valuable tasks. Some repetitive tasks should be automated by implementing accounting innovative technologies so that accountants can focus their time on other complicated tasks and support more for decision making and crisis management. Indeed, it is possible for robotic process automation or AI to perform routine and time-consuming tasks such as bookkeeping accurately and in a timely manner. As a result, accountants will move beyond financial statements preparers (Gamage, 2016) and need to take on new roles and contribute more to the organization (Marshall et al., 2018). With more time available for accountants, they spend more time on data analytics and consult more for business strategic management, decision making and problem solving which will contribute more to crisis management.

Innovative accounting technologies can contribute to business success by providing more accurate forecasts during uncertainty. With the ability to generate relevant data from diverse sources such as the internet, social network or email, more reliable information can be formed to support forecasting tasks in business. For example, one of benefits of AI is provide sales forecast (ICAEW, 2017) which is considered as the beginning step of operating budgeting. A reliable sales budget will result in the reliability of all budgets which take information from sales budget. Accountants of course still need to be involved in the forecasting process by providing appropriate and quality data for forecasting. In case of uncertainty, the more data generated and processed by using innovative accounting technologies, the higher possibility for firm to have more accurately forecast.

Considering a real case, Deloitte has applied BrainSpace as a machine learning and network analytics tool to enhance financial advisor. BrainSpace can search through unstructured data, investigate large data amounts, cluster the data, and summarize them. This in turn can support Deloitte in delivering comprehensive statistical information (Deloitte, 2018). According to Data Analytics and e-Discovery manager at Deloitte Financial Advisory, BrainSpace identifies relevant data more efficiently and quicker than humans can (Deloitte, 2018). In addition, BrainSpace can obtain new knowledge while doing current tasks by recognizing vital information that the users identify. To maintain proper performance of BrainSpace, a review should be done regularly by taking a random sample from its work and checking if the outcomes are appropriate and accurate (Deloitte, 2018).

To sum up, business environment is constantly changing due to the cross-border competition, customer behaviour's changes, and technological enhancements. Businesses that fail to adapt to such changes will face an inevitable crisis. To quickly realize these changes or to get through a crisis with minimal impact or eliminate it completely, businesses can use the support from accounting innovative technology. Proper adopting the technology will raise awareness among management about the movement of both financial and non-financial information not only at present but also in the future. Therefore, provide managers with insights into what they need to confront and be well prepared for these changes.

Challenges in Implementing Innovative Accounting Technologies

Challenges in using innovative accounting technology not only in the implementation stage but also later stages when firms are using it. Along with financial and human resources challenges, the firm needs to make critical evaluation to choose the right accounting technology that can bring the most benefit to the business. To produce more complete and relevant information needed for decision making and problem solving, accounting technology is required to be able to capture and process big data sets, but at the same time requires the firm to invest and train more. For some superior technology such as AI, using it effectively is also a challenge as it is not easy to set an AI algorithm that is able to capture all regulations and business environment which do not maintain the same, especially during crisis. In short, the more companies want to collect valuable information, the more money they need to invest in the implementation, training, and maintenance.

After implementing innovative accounting technology, another difficulty faced by the companies is the requirement of accountant knowledge and skills. Accounting technology can only benefit the business if the outcomes of the technology can be used properly. Due to the big data set with complex and diverse features, it requires accountants to have new competence in big data analytics. Many accountants work with innovative technology such as AI without knowing their abilities and potential (ICAEW, 2017) thus making it hard to capture and utilize all valuable outcomes from the technologies. With the increasing demand for technical skills including big data analytics, even young and junior accountants are expected to have the ability to deal with data to support forecasting and problem solving. As implementation of innovative accounting technology will become trends in accounting in the short-term (Gotthardt, 2019), accountants are expected to gain these skills and knowledge to meet the need of the business.

To be familiar with innovative accounting technologies and have desired skills in using the technologies, it is in need for accountants to receive sufficient training from their education. However, building these skills into education programs and curriculum is currently a problem with accounting professionals (Shevlin, 2019). Universities and international accounting bodies also experience difficulties in associating practices of accounting technologies to the curriculum, especially with the modern and most recent technologies. The program needs to relate to many disciplines, accountants are not only trained about accounting information system or data analysis, but also information storage, computer science, statistic, and ethical issues concerning IT.

Along with the requirements of accounting knowledge and skills and the need to associate accounting innovative technology into education curriculum, one of the big challenges that firms may face is the resistance toward these changes. When implementing these technologies into firms, it is expected that roles and tasks of accountants will be changed accordingly. According to (Goffin et al., 2019), resistance to change is considered as one of the significant issues of firms. Employees are resistant to change due to their unwillingness for change or doing extra work, or their belief of inefficient changes (Heyden et al., 2017). The resistance can deepen if employees are not aware of the business strategy and goals for these changes (Renkema et al., 2016).

In brief, the need for implementing innovative accounting technologies in business is obvious, however, firms should not neglect challenges they may face with new implementation. The more carefully the challenges are assessed, the more likely companies are to effectively adopt modern technologies to achieve more value and better manage crisis. Understanding these challenges is the starting point that companies need to consider avoiding failure in the implementation and adoption of new accounting technology. To facilitate successful application of these technologies, companies should also comprehend relevant success factors involved in implementing innovative accounting technology.

Success Factors for Implementing Innovative Accounting Technologies

Selection of the Right Innovative Accounting Technology Software

With many innovative accounting technologies available today, it is important for companies to choose the right accounting technology software that best suits their business. The right software can add more value to your investment in terms of money, time, and information. Although one product cannot suit all businesses, several of them in the market would suit the needs of one company. To choose the most appropriate software, firms need to consider relevant factors. Even though there are many factors that can impact on the choice of the software, some factors can be considered as the key and cannot be ignored.

The Goals of Using Innovative Accounting Software

The first key factor that firm should consider when selecting innovative accounting software is to set the goals of what firm expects to achieve from using the software. The goals should be determined based on the needs of business and objectives of the accounting information system. As business is constantly growing and so is the accounting software, these goals should not be only set for short-term but also for long-term focus. To increase the usability of the software, firms should set these goals in relation to the people using the software and make sure that these users are able to use the software to achieve these stated goals.

Software Customization

As different businesses have distinctive features, the second factor that firm should assess is whether the software can be customized to meet the company's needs and features. Requirements of a company on innovative accounting software can be specified for its business, its strategy, and the way they run the business. All these features will significantly impact on how the software should be customized to suit the business. However, for some software vendors, the fluctuation in changing the codes to meet customers' needs is limited. Hence, it is better for the firm to check the customizability of the chosen software. Furthermore, given the business scalability and change from short-term to long-term goals, firms should ensure if the software can be customized with reasonable costs for future needs.

Budget

Setting proper goals of implementing innovative software cannot be done without considering the company's budget. With a wide selection of innovative accounting software on the market, the price for each package also fluctuates with the size and needs of the company. The more functions, requirements and needs are added, the higher the costs. And the software that can be customized for a specific company's needs is expected to be more expensive than the buy-to-use one. Therefore, firms need to balance between their needs and budget to obtain optimal software. With the development of Clouding Accounting, it also considered a cost-saving solution due to the reduction in hardware investment.

Reliable Vendor

After purchasing and implementing innovative accounting software, firms still depend on the vendor for maintenance, updating, supporting, and enhancing the software. Hence, choosing a reliable and sustainable vendor is significant for the successful application of the software eventually. In addition, vendors may have access to corporate data, so dealing with a reputation one can strengthen a company's ability to protect data. To assess the reliability and sustainability of a vendor, vendor's financial position and performance is one main aspect that firms should look at. Strong financial position and performance can be indicators for the best accounting software suppliers. They will have sufficient resources both in finance and human to meet the needs of the business.

Communication and Collaboration among Departments

Once relevant innovative accounting software is chosen, the next key success factor that firms need to take in place is how to enhance communication and collaboration among departments during and after the implementation of new software. Accounting is the heart of business, hence, implementing accounting software does not mean it is only involved with the accounting department. Data and information from other departments will flow into the accounting information system and then was generated to valuable information for management and strategic tasks. Communication will help all departments understand objectives and expected benefits of the adoption. With effective communication, employees in each department will know what their roles are in the process, how they can support the implementation, and what they expect to perform after the implementation. Thorough understanding of the process will make the adoption easier, and if there are any red flags, they can be communicated and pointed out well between the departments. Adoption of innovative accounting software also leads to changes in accountant roles. As more routine tasks will be performed automatically, accountants are required to collaborate more with other departments to generate more useful reports for management tasks. This also requires accountants to possess collaboration skills such as problem solving, effective communication, and responsibility.

Internal Control within Innovative Accounting Technology

Along with the achievement of business goals when adopting new accounting technology, effective internal controls should be implemented and maintained with the application of advanced accounting software to reduce the risks and ethical issues inherent to accounting technology systems. Internal controls are implemented into the business to ensure business efficiency, control firm performance, prevent fraud and authenticate financial records. Adoption of new innovative accounting technology in the business may change the way data is processed, affect current risk management, control procedures, and influence present control environment. Proper implementation of Robotic Process Automation can improve information accuracy or Artificial Intelligence allows firms to recognize and prevent risks in real time. However, these technologies also raise the risks of data confidentiality, ethical issues, and cybersecurity. Automation only can enhance internal controls only when it is professionally designed and strictly follows standardized procedures. Therefore, along with the application of recent technology, firms need to consider improving their current internal control system to be able to address new risks arising from innovative technology. More control processes are expected to be inserted in the automated system and professional skepticism should be continued to make sure data is protected, company information is not misused, potential ethical problems can be eliminated, and cyber risks can be avoided.

Accounting Information Interpretation and Analysis Skills

As accountant roles change from financial reporting focus to business consultant, it is necessary for accountant to have the ability to evaluate and interpret financial data and advise management for their daily and strategic tasks. To be able to use effectively and efficiently the resources from innovative accounting technologies, accountants must have a complete understanding of the outcomes of innovative accounting technologies or how data or information are generated. Once they comprehend and expect what outcomes they can have, accountants can apply their knowledge and skills in evaluating and analysis to gain useful information for management tasks and business strategic management. Therefore, knowing about the system is not sufficient, it requires accountants to improve data analytics skills. Accountants can contribute by evaluating and analysing big data for the decision-making process and strategic management. If big data are analysed properly, it can help improve forecasting, internal control, and risk management (ICAEW, 2014). And if accountants are aware of prudence and skeptical performance, they can help enhance the data quality as well.

To gain these skills of using accounting technologies and information derived from the system, accountants must receive appropriate training in these technologies. Thus, training has become another critical factor that needs to be considered when implementing innovative accounting technologies.

Training

Due to the application of technological innovations to accounting, it is required that accountants must be familiar with the use of technologies and the ability to collect and assess both structure and unstructured data to support management tasks. Appropriate training to use robotic process automation, cloud accounting, or other accounting software must be provided to accountants to be able to use the technologies and understand the inputs and outputs. In the perspective of a business, the training should start from the time a firm decides to apply accounting technology, so that accountants can be well familiar with the system once it is successfully implemented. However, training will be more efficient if the accountants are well educated about innovative accounting technology during their education. Universities and accountancy bodies should firstly understand what organisations currently need and require from accountancy positions. They then collaborate with the accounting technology industry to provide desirable knowledge and skills to accounting graduates so that they are confident and know what they are expected to perform accounting tasks when they join the accounting industry. Once accounting graduates already have theoretical concepts, big data analytical skills, and knowledge about accounting technique, it will be easier for them to work well in the business which already implemented accounting technology or will be quicker for them when firm changes or apply another innovative accounting technology.

CONCLUSION

Innovative accounting technologies have significant impacts on accounting performance. They enhance accountants' productivity, make accounting tasks easier, improve financial information quality, and provide more relevant and precise information for management tasks. These advantages have also transformed the accounting tasks from focusing on preparing financial reporting toward becoming business consultants. With more data and information available from the new system and with a new role in the business, accountants can support management tasks including support managing crisis. Even though innovative accounting technologies can bring huge benefits for the business, to successfully adopt these technologies, firms need to carefully assess potential challenges and fully understand key success factors for the implementation. Challenges firms may face during and after implementing new accounting technologies may include limitation in financial and human resources, requirement in new knowledge and skills, problem in training and resistance toward changes. Proper evaluating these challenges and propose relevant solutions for them can help firms avoid implementation failures. Along with these challenges, firms should consider key successful factors such as select the right innovative accounting technology software, enhance communication and collaboration among departments, embed internal control within innovative accounting system, improve accounting information interpretation and analysis skills, and increase training to facilitate the adoption success.

FUTURE RESEARCH DIRECTIONS

This chapter has just discussed major innovative accounting technologies in general approaches. Its aims are to evaluate the needs of adoption of these technologies, analyze potential challenges that firms may counter, and identify key success factors for the implementation processes. Further research through systematic review can be performed to thoroughly understand previous research views on these topics. From there, it is possible to propose a framework for implementing these technologies for enterprises based on the assessed challenges and successful factors. This research direction will contribute to both theoretical and practical perspectives where firms can use the research outcomes as a guideline to successfully adopt innovative accounting technologies.

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KEY TERMS AND DEFINITIONS

Accounting Information System: A system that gathers, stores, summarizes, processes, and reports financial data for management tasks.

Artificial Intelligence: A machine that can perform cognitive tasks such as learning from the past, adjusting to the environment, solving problems, or making decisions similar humans.

Blockchain: A distributed ledger technology.

Clouding Accounting: A virtual accounting which allows accountants and other employees remotely access the company's information and data.

Crisis Management: A process of evaluating potential risks and crises involved with business and solving the issues that emerge from current risks and crises.

Innovative Accounting Technology: An accounting program that supports accountants in performing their jobs.

Robotic Process Automation: A pre-configured package that replicates the tasks of humans.

Chapter 9
The Application of Robotic Process Automation (RPA) in Accounting: The Perspective of the Lebanese Economic Crisis

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ABSTRACT

The Lebanese economy has been experiencing dramatic changes marking political and financial waves of reform and turmoil over the last decade, and specifically after the latest consecutive recessions. All sectors of the local economy had been substantially affected by the economic recession. The accounting system which is directly connected with business sectors was hindered by the economic crisis developments where the compliance of business entities that are on the verge of collapse with IPSASs (International Public Sector Accounting Standards) became extremely problematic. This chapter explores robotic process automation (RPA) in the accounting domain from the perspective of the Lebanese economic crisis.

INTRODUCTION

The Lebanese economy has been experiencing dramatic changes marking political and financial waves of reform and turmoil over the last decade, and specifically after the latest consecutive recessions. All sectors of the local economy had been substantially affected by economic recession. The accounting sys-

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tem which is directly connected with business sectors was hindered by the economic crisis developments where the compliance of business entities that are on the verge of collapse with IPSASs (International Public Sector Accounting Standards) became extremely problematic. This chapter aims to illustrate the major emerging challenges to the Lebanese accounting system and SMEs compliance with accounting standards IPSASs. In view, the factors that emerged amid the Lebanese economic crisis, such as the fluctuation of currency exchange rate, the evaluation of stocks and their impact on importing and exporting businesses and accounting practices, will be explored. The theoretical framework provided in this chapter highlights the key studies addressing the challenges to Lebanese SMEs and accounting system in terms of reporting and compliance with accounting standards IPSASs. Accordingly, this chapter provide valuable and useful insight to theory and Lebanese SMEs' practitioners and regulators.

ASPECTS OF THE LEBANESE CRISES

Since the year 2011 the Lebanese economy growth started to decline marking a series of political turmoil and unrests in neighboring countries (Asonitou and Hassal, 2019). A combination of political crisis and economic recessions accompanied with venomous protests had stagnated the economy until the crisis reached its peak in August 2020. Both the explosion of Beirut port and the Covid-19 virus outbreak added substantial constrains that led to an extensive economic crisis (Ryan *et al.,* 2020). The influx of refugees from neighboring countries aggravated the economic crisis by limiting job opportunities and the personal income (Makdissi and Tannous, 2020) There was no escape from rising public debts, estimated at 172% in 2020 and made Lebanon to be the third most indebted country in the World (Waymire and Basu, 2011). The local currency deteriorated rapidly and the International Monitory Funds estimated inflation rate to phenomenally escalated from 2.9% in 2019 to 85.5% 2020 to affect all Lebanese economic sectors.

Over decades, successive governments have borrowed huge loans from local and foreign creditors. Half of the country's income goes to pay off the creditors' debt, and the majority of the remaining income is used to pay the salaries of public employees leaving a small proportion for productive investments (Nasrallah and El Khoury, 2021). The Lebanese government did not have many feasible solutions but to raise impose a new tax system which led to unprecedented levels of inflation, deterioration of the national currency and a sharp fall in personal income and savings values. The worldwide breakout of the Covid-19 virus additionally affected the Lebanese economy and necessitated imposing more than one lockdown to deepen the economic crisis (Serhan, 2020). Many businesses were forced to close their doors to contain the spread of the virus leading to further revenue cuts and staff numbers being slashed. As indicated in international reports, Lebanon sustained 6.5% contraction in 2019, and regionally the country scored the 2nd largest negative economic projection for 2020 (Nasrallah and El Koury, 2021).

A series of political protests took place in Lebanon in October 2019, known as 'October revolution' and which was triggered by imposing excessive taxes on essential commodities such like gasoline and utility bills, and non-essentials like tobacco and Voice over Internet Protocol (VoIP) calls applications. These protests expanded rapidly in retaliation to the government's chronic failure to provide basic services such as the supply of water and electricity (El-Gammal, 2012). The protests engaged the public opinion that demanded control over the unacceptable level corruption that hindered the political and economic development in Lebanon. Eventually, the explosion of the main port in the Lebanese capital Beirut on 4 August 2020 forced the government to resign leaving Lebanon in profound economic, health and political crises (Serhan, 2020).

LEBANESE SMES AND THE ACCOUNTING SYSTEM

Prior and during the current economic crisis, the state economy in Lebanon heavily depends on small and medium enterprises SMEs contribution (Nasrallah and El Khoury, 2021). SMEs can attract fresh funds from investors and generate revenues from customers (Kemayel, 2015), 98% of SMEs provide the main sources of export and import earnings and contribute around 67% of employment opportunities (Majzoub and Aga, 2015). Potentially, SMEs largely contribute to mitigate the impact of the current crisis and increase resilience against the unstable Lebanese economy structure (Makdissi and Tannous, 2020). Makdissi *et al.* (2016), proposed that the absence of a plan for economic development to support businesses had negatively affected the role of SMEs in the national economy growth. The lack of coordination between different stakeholders obstructed the business sector's improvement while the latter may be a viable solution to maintain economic growth (Elbahnasawy *et al.,* 2016; Malaeb, 2018).

The collective impact of the consecutive crises in Lebanon hampered Lebanese businesses where banks ceased business lending to provide the essential capital to businesses to fund its operations. The interest rate substantially increased due to the declining value of the Lebanese currency that lost about 75% of its original value (Ahmad and Nasseredine, 2019). In general, problems of economic structure accompanied with consecutive economic crises posed as detrimental challenges to the Lebanese business sector (Makdissi and Tannous, 2020).

Businesses and governments are obliged to provide financial statements and to reflect true and fair values of their financial positions and subsequently ensure that the credibility and transparency of statements are maintained to reflect honesty in handling private and public funds (Barton, 2009). Lebanon's accounting system adopts the International Public Sector Accounting Standards IPSASs system but there are still concerns of the actual compliance with this system's standards. The challenges to the implementation of IPSASs in Lebanon could be classified under the three main categories listed in the subsequent sections.

From a legal perspective and according to Ali and Stefan (2019), Lebanon is one of the Mediterranean countries which have a strong legal framework but due to its political instability the actual implementation of the legislations is frequently stalled. This has affected economic stability and limited law enforcement through government bodies monitoring discretionary application of accounting and reporting (El-Gammal, 2012). Another main barrier is the cost implication. Lebanon accounting system considers implementing IPSASs as a basic requirement to produce consolidated financial statements for all controlled companies which is time consuming and very costly, especially in a country that is suffering a financial regression and economic deterioration (Kemayel, 2015). Adding to the cost implication the lack of government support, resistance to change in the accounting system and a lack of understanding of the importance of IPSASs (Ahmad and Nasseredine, 2019) makes it difficult for business to comply with these standards.

The fluctuation of the Lebanese currency adds further difficulty to the accounting practice as the price of imported goods varies highly at certain times as the exchange rate fluctuates. In view, it would be extremely difficult to comply with principle accounting standards such as the FIFO (First In First Out) rule whilst businesses tend to apply the LIFO (Last In First Out) rule instead (Hakim and Bizri, 2015). The appraisal of assets may also be problematic for the accounting practice, due to the fluctuating Lebanese currency rate, to accurately report in businesses or government financial statements in view of complying with IPSASs (Makdissi and Tannous, 2020). The Lebanese government introduced some measures to overcome the above challenges which require accountants to sufficiently learn the accounting standards, undertake relevant training and replacing the outdated accounting software (Malaeb, 2018).

AUTOMATION IMPLICATION IN THE ACCOUNTING PRACTICE

The accounting practice is fundamentally based on accuracy, transparency and consistency when recording or reporting financial accounts (Serhan, 2020). The application of Robotic Process Automation RPA is widely perceived to provide a competitive edge to accounting practices to realise these requirements to a high standard. Accounting processes follow sophisticated rules and procedures that are relatively convenient to achieve through automation (Jedrzejka *et al.,* 2019). However, there are preconditions for RPA set up including the cost of implementation and RPA software (Ghasemi *et al.,* 2011). In comparison to manual processing of financial accounts, RPA can save the time and effort by reducing error margins, providing tracking checks, managing and approving documents. The accounting practice is typically task intensive; time and tedious effort are critical challenges for accountants when manually handling transactions, collecting data from fragmented systems and then processing the accounts (Fernandez and Aman, 2018).

Before the start of the millennium accounting jobs such as payroll clerks and bookkeepers were predicted to be substituted (see for example Kerremans *et al.,* 1991). Technology develops to decrease the use of labor along with creating new opportunities at more creative and advanced levels. However, technology is developing at a higher speed than expected to undermine some professions and create new avenues of employment which requires upskilling to an unprecedented level to secure employment (Serhan, 2020). The accounting practices have been widely influenced by automation which requires accounting professional bodies to set strategies that contain the impact of automation on employment, such as when computers replaced the function of bookkeepers and payroll clerks (Fernandez and Aman, 2018). Specifically, the accounting job market in Lebanon needs to be somewhat protected as successive governments are widely accused to fail in safeguarding the public interest effectively (Rkein *et al.,* 2019; Serhan, 2020).

The government initiatives to support the automated transformation of the Lebanese accounting practice are criticised for not supporting the accounting workforce with sufficient training and upskilling to accommodate the automation transition in the accounting practice (Ghasemi *et al.,* 2011). Lebanese accountants, like in other developing countries, experienced difficulty in understanding the technological accounting guidance whether in relation to ISAPS or IFRS (Rkein *et al.,* 2019). The absence of a supportive organisational vision on automation adds further complexities to the accounting profession while the country is undergoing economic regression, structural changes and political instability (Rkein *et al.,* 2019). Accountants in Lebanon are additionally under pressure due to poorly implemented accounting RPA which may cause inaccuracy in financial reports or sometimes incomplete reports which may cause serious damage to any business's reputation (Rkein *et al.,* 2019). Automation errors can affect the accuracy of accounts and consequently the quality of annual reports and regulatory compliance which may result in fines and sanctions (Fosber *et al.,* 2009).

In contrast, the increase in speed, accuracy, and volume capacity of computers compared to their existing human counterparts are the key reasons for the integration of artificial intelligence (AI) into business processes (Ali & Abdel-Haq, 2021; Jarrahi, 2018). For example, portfolio performance is analysed by traders and investors who make automated market predictions using an intelligent computer system known as "Kensho." Rkein et al. (2019) confirm that Robotic Process Automation (RPA) has transformed traditional auditing practises by enabling accounting firms to improve audit quality, business processes, and services. Auditors are expected to perform at a higher level because their time will be freed up for more important tasks. Additionally, automation has spawned new fields of application

Table 1. Impacts of automated accounting

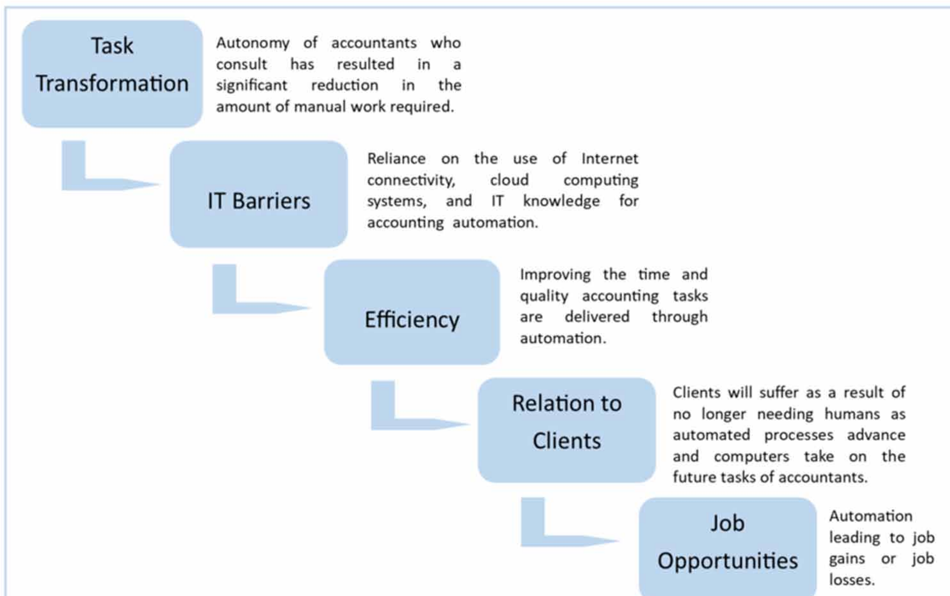
Impact	Description
Task Transformation	The autonomy of accountants who consult has resulted in a significant reduction in the amount of manual work required. On the other hand, accounting consultants can concentrate on providing analytical services. As a result, consultants have more time to devote to their clients' and businesses. Due to the increasing automation of routine tasks, advisory services have grown in popularity over the last few years.
Relationship with clients	Associate accounting consultants do not view automated processes as a negative development. As a result of automation, new services, such as consulting, will emerge, and more advanced and beneficial services will be provided, increasing the number of customers. The introduction of new services, particularly advanced consulting, will increase the demand for face-to-face customer interaction. Regardless of how advanced automation becomes (Sun & Lu, 2017), computers will never completely replace humans. According to scientists, computers and programmes are insufficient for tasks such as data analysis and interpretation.
Efficiency	Automation and the resulting reduction in manual handling allow the consultant to devote more time to other tasks.
IT Barriers	Sun and Lu (2017) assert that modern computers and software are woefully inadequate. Despite increased confidence in automation, accounting consultants continue to view misstatement risks as a contemporary issue. Additionally, automated accounting requires less human intervention, which results in decreased downtime and increased security. Consultants have had to deal with accountants being unable to perform their duties due to a lack of Internet access and power. Dimitriu and Matei (2014) argued that hacker attacks would cause significant damage to accounting firms in terms of data loss and disruption.
Job Opportunities	Automated accounting, according to Frey and Osborne (2017), will result in job losses. Automation reduces the amount of human intervention required in a process. Accounting assistants are frequently assigned repetitive tasks that are ripe for automation. Accounting consultants with less experience or accounting assistants are in a surrender risk zone. According to Shim and Yang (2018), employees with a low level of education are being pushed out of their jobs unless they develop a more cognitive orientation in order to retain their jobs. When developing new competencies, cognitive tasks are frequently performed by a senior accountant or more experienced professional, ensuring that these professionals are not replaced in the future. On the other hand, few believe that computers will soon be capable of performing some of these functions. As automated accounting becomes more prevalent, the number of accountants available to fill open positions will decrease.

as a result of the new competencies required. It is possible to automate evidence collection and complex data report generation using predictive analytics (Edwards & Edwards, 2016; Fitz-enz & Mattox, 2014; Logic, 2018), thereby saving time and improving customer service.

Other researchers express reservations about automation's ability to stimulate innovation in new applications and competencies. Rkein et al. (2019) asserts that the number of new graduates employed by companies is expected to decline significantly as AI tools are increasingly being used to replace the work performed by new graduates, resulting in expectations of a significant decline in graduate employment by these companies. Automation conjures up images of a human worker performing the same tasks as a machine in people's minds. Employees, particularly at the highest levels, cannot be replaced. It makes no difference how advanced systems and technology become; human beings will always be required to strategize, influence, and collaborate with key stakeholders to improve financial and business performance. Therefore, people working in finance must be prepared and adaptable when it comes to automation. Although accounting firms and consultants can anticipate a number of benefits from automated accounting, Table 1 summarises the key impacts of automation on accounting firms based on five critical points.

As previously stated, accounting professionals have mixed feelings about automation, making it difficult for others to adopt automated processes. When negative attitudes and distrust of systems are overcome, others are encouraged to express their opinions. Despite this, there are some positive outcomes. Account-

Figure 1. Model of automation impacts on financial sector



ing professionals' jobs will become easier as a result of automation, which is one of the primary reasons for their optimistic outlook. According to Rkein et al. (2019), automated systems enable professionals to be strategic and develop into true business partners, thereby improving their employment experience and perceived value within the organisation. Financial controllers may be able to predict potential problems based on patterns in big data (Ali & Edghiem, 2021; Subrahmanyam, 2019). What matters most in the long run is how data is used in the workplace. By analysing this data, businesses can make more informed decisions and strategic moves. As a result, big data is critical to the accounting profession.

IMPLICATIONS OF AUTOMATED ACCOUNTING IN LEBANON

Since this chapter aims to contribute to automated accounting in the Lebanese context, this motivation is inspired by researchers in Lebanon encouraged to conduct similar studies to gain a better understanding of the impact of automation on various accounting jobs and the readiness of the Lebanese and regional labour markets to address advanced needs for accountants and auditors capable of acting as informed consultants and strategists in the face of automation. Using the five impact areas in the previous section, this section analyses the situation in Lebanon with respect to automated accounting. Based on the five impact areas discussed below, the following model demonstrates the current automation impacts on the Lebanese financial sector.

Task Transformation

Due to the elimination of manual journal entries and tasks, Lebanese accountants can now focus exclusively on analytical services. According to Frey and Osborne (2017), accountants have the opportunity to improve their cognitive abilities, critical thinking, and ethical values as entry-level tasks are now automated. However, the accountant's sole responsibility is to ensure that the journal entries are accurate. According to Alarcon and Staut (2017), the rise of automation has resulted in an increase in critical thinking and judgement. In the Lebanese context, performing manual labour will advance to more strategic roles, while employees already in strategic roles will advance (Rkein et al., 2019).

IT Barriers

The adoption of automated accounting is expected to result in an increase in the use of Internet connectivity, cloud computing systems, and IT knowledge (Ali, 2020; M. Ali, 2019; Ali et al., 2020). Dimitriu et al. (2014) have argued that hacker attacks result in data loss and disruption. Anyone looking to steal data from a computer will view it as an excellent opportunity to hack or even sabotage the system, demonstrating that the organisation has a lack of control over accounting processes and data. Cloud Accounting Software, it is claimed, will eventually revolutionise the accounting profession by enhancing financial operations, client interaction, and the speed and efficiency with which clients' needs can be met on a timely basis (Rkein et al., 2019). By automating evidence collection and complex data reporting, predictive analytics can save time and improve client service. AI, for example, has advanced to the point where machines can replicate human expertise by extracting data from complex documents. This can be perceived as a threat and an opportunity for the Lebanese financial sector because where automation may result in job losses, there will always be the need for human interaction and intervention to keep automotive practices in check.

Efficiency

Automation can increase an accounting firm's efficiency improving the time and quality accounting tasks are delivered. Rather than writing and filing reports and then designing vouchers, automation streamlines all of these operations into a single double-click process, resulting in tasks being completed and reported in less time. According to several authors, cloud computing provides a competitive advantage for small and medium-sized businesses (SMEs) by making it easier for them to access cost-effective, dependable, and adaptable information technology (IT) solutions (Ali, 2019; Ali et al., 2020; Velayutham, 2021). This is a potential gain for the Lebanese financial sector given the demand for such technologies in the country to improve businesses process (Ben Hassen, 2018).

Relation to Clients

Clients will suffer as a result of no longer needing humans as automated processes advance and computers take on the future tasks of accountants. For accountants, automation had a sizable positive effect on their firm's clients. Due to technological advancements, accountants can now communicate with and serve their clients thousands of miles away simply by sending emails. If the client relationship is not handled properly, it may even come to an end (Taipaleenmäki & Ikäheimo, 2013). According to the authors, accounting consultants are frequently mistaken for computers when processes are automated, as the system handles the majority of the tasks automatically. On the other hand, Sun Lu (2017) believes that computers will never be able to completely replace humans in terms of critical thinking, analytical abilities, and the capacity to make judgments. Alternatively, AI can be used to automate accounting tasks, which is another great opportunity for the Lebanese financial sector as they can benefit from utilising existing human capital, while introducing new innovations that may not pose as much of a threat as perceived.

Job Opportunities

While technology will almost certainly create more jobs than it destroys, some industries will see more job losses than gains due to automation, resulting in fluctuations in the Lebanese economy. Businesses and government agencies are more likely to invest time and money in determining how automation can complement their current operating models and what this means for their employees. According to Frey and Osborne (2017), accounting automation will eliminate entry-level and repetitive tasks, resulting in job losses and decreased human interaction with the process. While simple accounting tasks may be automated, automation serves as a third hand for the accountants and has no bearing on their career.

Similarly, financial controllers may now be able to anticipate problems based on big data patterns, rather than focusing exclusively on detecting problems after they occur (Subrahmanyam, 2019). Machines will enable accountants to collaborate on decisions, thereby improving their work experience and perceived value within the organisation. What matters most is how organisations use data. It can be used to analyse collected data in order to make more informed business decisions and strategic business moves. Cognitive tasks, such as critical thinking, are therefore immune to automation in the future. Vermeulen et al. (2018) established this by arguing that job losses in ‘applying’ sectors are offset by job gains in complementary, quaternary, and spill over sectors. Numerous macro-level employment scenarios have been examined, and rather than facing the ‘end of work,’ humanity is confronted with usual structural change, which presents a degree of uncertainty concerning the impact of automation on the Lebanese financial sector and economy.

CONCLUSION

The consecutive crises in Lebanon have drawn attention to specific implications of robotic process automation RPA in the country and beyond in similar countries in the Middle East region. Typical shortfalls of accounting practices, in view of the Lebanese economic crisis, can include tax evasion, shortage of skills or employment cost. Further challenges to the accounting practice are the lack of transparency and accountability resulting in poor corporate reporting (Adamu and Ahmed, 2014; Naimy, 2014) that could be aggravated during the economic crisis (Pozzoli and Ranucci, 2020) to make compliance with international financial reporting standards IFRS extremely difficult.

According to Schnifer and Weder (2001), the implementation of IFRS in Asian countries, such as Lebanon, became quite problematic. Ahmad and Nasseredine (2019), proposed that Lebanese accountants have been encountering challenges when trying to apply IPSASs, particularly in relation to the evaluation of business assets such as inventories. Some businesses modified their accounting practices in order to improve or maintain their current financial performance (Hakim and Bizri, 2015). The integrity of the Lebanese accounting profession at large is increasingly challenged to cope with the deteriorating economic situation in terms of maintaining accurate financial reporting. The need reform of the current accounting practices is urgent to ensure the compliance with accounting standards and reflect accurate financial reporting to avoid alienating investment capital (Bank, 2010; Beschel and Ahern, 2015).

Although RPA application is widely believed to help overcome the aforementioned challenges, RPA implementation may be perceived with some skepticism in relation to the Lebanese economic crises. Employment opportunities in general and in accounting specifically may be slashed as a consequence of RPA to add additional pressure on the economy. Other drawbacks of RPA may also persist, such as when automation errors affect the accuracy of corporate reports and regulatory compliance as highlighted in the study of Perera and Chand (2015). This effect may be more intense in countries that are experiencing dynamic economic changes (Rkein *et al.,* 2019). The economic crisis in Lebanon had a profound effect on regulatory systems, businesses and accounting practices where poorly implemented RPA would impact the accuracy of financial reporting and the consequent investment or regulatory decisions (Fosbre *et al.,* 2009).

The body of research on RPA application in the Lebanese accounting sector may still be at an infancy stage but it has escalated in recent years, especially in response to the profound crises that unsterilised the country's economic sectors. As we illustrate the scope of the current Lebanese economy, the implications and challenges to RPA in accounting practices, we propose that future research should explore the implications of RPA from individual/accounting employee's behavior perspectives to look into the relevant skills set and acceptance of RPA. Future research should also explore the impact and application of RPA processes in different Lebanese business sectors.

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Chapter 10
Managing Crisis Situations Through a Visual Language Communication (VLC) Approach

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ABSTRACT

Visual language communication has already gained significant traction in graphic design and marketing literature as a substantial communication approach for expressing visual designs for advertising products and services. However, VLC goes beyond the marketing arena, it has been known to support critical situations such as times of crisis or disaster. This chapter explores the role of visual language communication in managing crisis situations. The characteristics of visual communication are articulated through the lens of crisis management, together with the benefits and challenges that may impede or foster visual language communication to manage crises. The chapter concludes by recommending a typology for managing future crises using VLC innovations.

INTRODUCTION

Crises occur when there is a fundamental disjunction between a group's prospects and what is happening in the environment (Karam et al., 2019), or when extremely uncertain events compel a ruling or verdict that will result in change, whether positive or negative (James, Wooten and Dushek, 2011). However, it encompasses a complex collection of Human, Organizational, and Technological issues that contributed to the initiating incident. These, in turn, contribute to organisational failures in terms of regulatory, infrastructure, and preparedness. Human issues encompass operational and administrative shortcomings, as well as goal-directed actions such as harm and extremist attacks. Organizational influences include rule violations, insufficient reserve distributions for protection, planned burdens that allow managers to overlook dangerous practises and conditions, communication breakdowns, miscalculations of danger levels, and insufficient emergency response strategies that compromise safety (Sarta, Durand and Vergne, 2021). Systemic technological issues include faulty models, substandard apparatus, contaminated tools

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and materials, and inefficient technical processes (Le Coze, 2015). Crises can also be triggered by natural phenomena such as waves, tremors, whirlwinds, and storms. Therefore, the underlying premise of crisis is not an occasion, rather it is the result of an occasion. In an organisational context, if management's actions fail to contain a crisis event or if circumstances beyond management's control exacerbate it, an invisible problem can become visible to non-stakeholder individuals or groups, or in the worst-case scenario, to the entire world. Clearly, crisis management takes on a new dimension in these situations, as observers frequently evaluate the handling and messaging differently than they do in situations involving man-made events. This is where a phenomenon known as Visual Language Communication (VLC) comes into play to potentially manage crises, and is the focus of this chapter. The chapter proposes an innovation typology to manage crises through VLC.

VLC TECHNOLOGY

Recent crises have demonstrated how existing communication infrastructures can become overburdened or even fail entirely. The need for crisis-management technology capable of coping with nondeterministic environments created by the global collapse of wired communication has never been more apparent (Fitrianie & Rothkrantz, 2007). On September 11, 2001, terrorist attacks against US targets disabled crisis management services that provided information support to rescue teams, victims, witnesses, and families . Major incidents of this nature typically involve a great deal of information and operational chaos. Personal devices, such as Personal Digital Assistants (PDAs), that combine portability and wireless connectivity, may be used to communicate in these situations (Dymon, 2003).

It is possible to define a language based on icons, that is, a visual language in which each sentence is composed of an arrangement of icons in space. Each icon has a distinct meaning. An icon's perceptible form (syntax), the relationship between its form and meaning (semantics), and its usage all contribute to its interpretation (pragmatics) (Fitrianie & Rothkrantz, 2007). To deal with the ambiguity of meaning represented by an icon, each icon's meaning is defined by a dominant word or phrase constructed using metaphors appropriate for the context. Given that icons are representations of models or concepts with which humans interact, we anticipate that this language will be simple to pick up. Once a set of iconic representations has been established, increased usage may result in more stylized and eventually abstract representations, as has occurred in the evolution of writing systems such as the Chinese fonts.

Several studies have developed VLC infrastructures in a Mobile Ad-Hoc Network (MANET) with a visual language interface to assist people who must collaborate to resolve crises (Fitrianie & Rothkrantz, 2007). These individuals include rescue teams (which may include firefighters, police officers, paramedics, military personnel, and members of other crisis management organisations), operators in a crisis centre room, and civilians (that are victims and witnesses). The users report incidents in their immediate vicinity using the developed icon interface on their PDA. The mobile devices are connected via a distributed-system architecture based on a MANET, which enables a peer-to-peer wireless network that transmits data from one PDA to another without the use of a central base station (access point). Hence, VLC provides a host of opportunities for organisations that deal with crises on a daily basis.

Benefits and Challenges of VLC

When a crisis occurs, numerous distinct organisations are involved in the crisis management process. Communication between these organisations is critical and is typically managed through the use of pre-compiled calligraphies or in an ad-hoc fashion (Chandler et al., 2007). A comprehensive investigational strategy for ensuring consistent communication during times of crisis has been developed. It entails the use of a visual language port on a PDA to convey information in a MANET-based communication (Sellnow et al., 2017). The developed port enables operators to depict a situation by combining emblems, geometric elements, and icon-loops on atlas-based ports (Chandler et al., 2007). Natural language processing has enabled the translation and transformation of iconic communications (Sellnow et al., 2017). Additionally, there are numerous rules and regulations governing the construction of portable appliance icons and ports. For instance, employing the semiotic method, in particular, to create language and society-independent icons. To facilitate rapid communication, the constructed port is equipped with a next icon forecasting apparatus.

VLC has long been a means of subsistence communication for humans, particularly when verbal communication is not feasible (Sandler et al., 2019). The alleged communication model is not intended to replace any critical communication, such as speaking, but to create entirely new avenues for obtaining information about the crisis. The use of icons to represent concepts or theories makes operator communications on the built interface particularly suited to multi-operator environments in language-independent settings. Naturally, this occurs at the expense of having to sort through all of this data and apply it rationally (Sandler et al., 2019). Numerous contributions must be analysed and synthesised in order to define the crisis's framework. On the basis of this framework, appropriate conclusions should be drawn and communicated to the relevant organisations (Sellnow et al., 2017). By delivering this functionality, the potential job must be accomplished in order to expedite communication between various organisations. This procedure is fundamentally multimodal in nature, as it requires individuals to collaborate and organise in order to resolve crises in non-deterministic settings. It should be constructed in such a way that it facilitates switching between guidelines in order to take advantage of the modality that is most appropriate for the project and its environment. As a result, human operators can operate multiple modality networks concurrently, utilising one to complement and enhance the other (Sellnow et al., 2017).

However, VLC can conjure a host of crisis communication challenges can be segmented into four main categories:

Participation Barriers: Crises necessitate communication between parties who are not physically located in the same area and may not interact on a regular basis. Government agencies, corporations, health officers, outside specialists, and community members all require data disclosure in order to respond efficiently to crises. These parties may not interact with one another on a regular basis. They are made up of individuals who may not know one another well and may lack an understanding of the non-verbal cues that occur naturally during regular face-to-face communication (Fatima Oliveira, 2013). Apart from face-to-face communication, the majority of organisations investigate and utilise alternative communication devices such as wireless radio, cell phone, and electronic mail, which do not simply enable affluent, genuine-time interactivity. These devices obstruct natural communication and encourage operators to speculate on some of the data or context surrounding what is revealed. These devices are referred to as "thin" communication networks (Fearnley et al., 2017). For daily operations, thin networks may suffice, as there is sufficient time to verify and reverify the data received. However, during a crisis, thin networks may be unable to communicate all of the data necessary to respond. Simultaneously, workers in a crisis are subjected to a high level of emotive anxiety. They must collect and translate data quickly, possibly at the risk of bodily harm (Fatima Oliveira, 2013). The thin communication devices are fundamentally incapable of avoiding the misinterpretation that can occur as a result of anxiety. Effective, natural communication is critical.

Inefficiencies in Command, Control, and Coordination (C-3): these are processes that are difficult to organise in the midst of an emergency state and are frequently the most difficult aspect of a crisis. While the emphasis is frequently on transmitting instructions, the consequences of obtaining and comprehending data are frequently left unresolved. C-3 malfunctions can have disastrous consequences, especially when assistants do not receive, comprehend, or follow supervisor commands. Additionally, the reversal is risky. Supervisors can also demonstrate a corresponding lack of understanding of field data, frequently resulting in poor decision making (Chandler et al,, 2007). While command and control may refer to a categorised, "top-down" aspect of operations management, C-3 events are rarely performed in a momentous manner by individuals wielding distinctive mandates. They are almost always the result of an efficient communication and coordination effort between a high-ranking value crew. As a result, C3 operations can benefit from clear communication guidelines, such as turn taking and the clarification of roles and responsibilities.

Information Quality: crews of information quality can degrade due to a lack of data exchange. This could be the result of insufficient exploration or information-gathering capabilities, either as a result of individual error or technological limitations in accessing the information supply. They may necessitate effective communication techniques capable of prompt response. Without a feedback loop, crews have a difficult time identifying appropriate information and removing inappropriate information. Crews are required to receive training on gathering and organising information in advance of any crisis in order to quickly identify what is most critical (Pan et al., 2012).

Collaboration Issues: Historically, high success rates in crisis response have been associated with team response rather than individual response (Wang, 2011). Organization, confidence, and the multiplicity of information can all contribute to a team's success or failure during a crisis incident. The successful team "improves the procedures for collecting, retaining, recovering, assigning, manipulating, translating, and removing information" (Hassan, 2021). Teams, on the other hand, have an additional level of coordination transparency that cannot be overlooked. Among the most likely encounters when attempting to maintain effective team communication are the following:

1. Distributed workers, together with decision creators and performers
2. Distributed decision-making procedures
3. Distributed information interchange systems
4. Intersecting techniques involving coordination (Chandler & Wallace, 2009).

These obstacles make it exceedingly difficult for a team to reach a fully informed decision that requires the support of all major stakeholders. In times of crisis, teams may be even more dispersed than they are on a regular basis. Travel interruptions may occur at precisely the time when powerful and extensive face-to-face interactions are required to treat the condition. For example, during an epidemic, isolations may confine individuals to their homes. Natural disasters may render roads and public transportation impassable. This type of dissemination can result in insecurity and ineffective crisis response. In 2001, researchers Hinds and Mortensen asserted that "geographically dispersed crews may also find it more challenging to resolve disagreements and resolve complications." As a result, the likelihood of such issues escalating into full-fledged conflict within distributed teams is increased (Morrison-Smith and Ruiz, 2020).

Table 1. Summary of the benefits and challenges of visual communication technologies

Benefits	Challenges
Visual communication are more attention-catching and appealing.	Participation Barriers
Visual aids can provide information more clearly.	Command, Control, Coordination (C-3) Inefficiencies
Visual communication has a high flexibility.	Information Quality
Research investigations has been able to prove that visual communication makes an influence on the audience.	Collaboration Issues

VLC AND CRISIS MANAGEMENT

Symbols were already used to facilitate communication in the Middle Ages, for example, to designate systems of horoscopic markers. It could be argued that ancient Egypt's hieroglyphics were used as a symbolic communication language. In recent years, we have been surrounded by symbolic communication, which ranges from machine controls and icons used in commuter traffic to symbolic communication systems used to assist people with speech impairment. Naturally, even if they are intended to represent the same concept, such symbols are visually distinct across languages. Additionally, systems play a critical role in the majority of GUI-based computer functions as a small graphic representation of a system, source, choice, or display (Kumar & Mallick, 2018).

Recent efforts have been made to evolve computer-based symbolic communication, for example: (a) the Motel Reservation System, which enables communication within a limited domain (Pei et al., 2019); (b) the CD–I symbol, which was developed as a natural individual-to-individual communication system (Beardon, 2020); (c) Sanyog, which was developed for India's incapacitated individuals (Sinha & Dasgupta, 2021); and (d) (Bertenghi, 2021). Nonetheless, the majority of these systems are incomprehensible. They are either incorrect or are based on excessively complicated grammatical hypotheses. Leemans (Holdenmajer, 2019) conducted a thorough investigation into the use of symbolic language as a common language. Visual Inter Language emphasised its portability and simplicity of use. It has enabled individuals to communicate with one another despite the lack of a common language.

Information on the use of symbols in crisis management was not immediately available. The majority of symbols used were already accessible through visual software systems used by organisations or societies. Dymon conducted a thorough investigation of the policies and principles governing the project of danger and disaster maps (Zhou et al., 2017). The investigation examined the application of existing symbols, as well as the traditional military and NATO map symbols of the United States of America (Wong & Gerras, 2015). The following symbols are argued to be ascendable and adaptable across a variety of fields and social contexts. According to the findings of this investigation, the United States government supports the use of universal map iconic symbols for emergency response purposes on a federal level (Givens et al., 2018). The symbols were examined throughout the country with the assistance of contributors from private and public domains. They are used by emergency managers and individuals responding to tragedies to share information during critical emergency situations. The governments of the Commonwealth of Australia and New Zealand also use this collection of symbols.

Following September 11, 2001, interest has shifted toward cutting-edge technologies based on multi-beam communications (Yastikli & Uzar, 2013), three-dimensional geospatial information (Estrella et al., 2012), and three-dimensional (3D) visualisation on cell phone gadgets (Botta et al., 2016). Information serves as the foundation for decision-making, and it is critical in times of crisis. It is possible to aim for the delivery of a communication port for data sharing, while the report does not place a premium on the decision-making mechanisms for applying the information. The critical nature of emergency response structures that incorporate phases of human reflection has never been more apparent. WHISPER (Gunawan et al., 2012) is a web-based application that enables emergency responders to share information during emergency response events. Based on the data collected, the structure provides a coherent view of an emergency response activity. Additionally, this design incorporates pertinent data from all emergency facilities in order to bolster their decision-making process. With their testbed CAMAS (Yastikli & Uzar, 2013), the RESCUE scheme (Kirby et al., 2016) enables operators to transmit reports via a web interface utilising natural language communications. This structure enables the description and analysis of operator input, the categorization of crisis incidents, and the generation of situation awareness. Additionally, the VCMC prototype features a web interface (Netten et al., 2016). It enables its operators to share and review information about crisis conditions in real time.

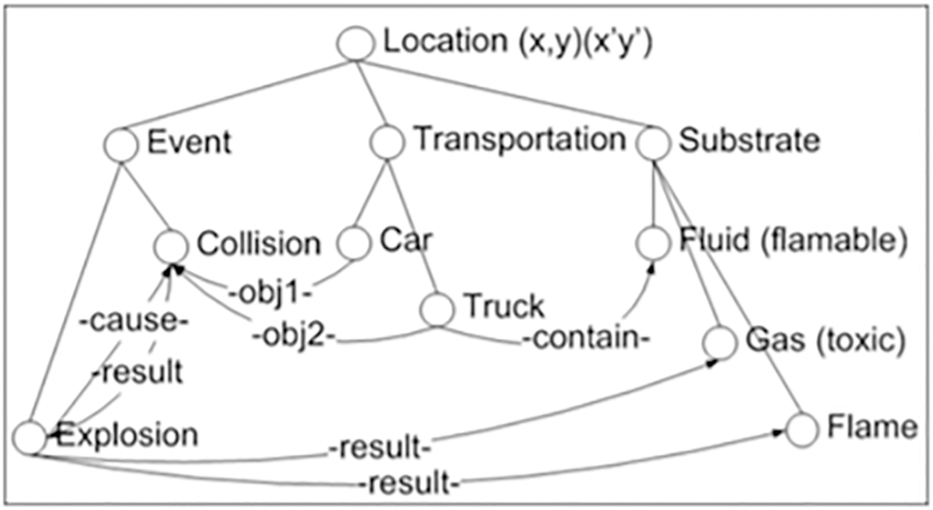
Tatomir and Rothkrantz developed a symbolic interface for reporting interpretations in a Mobile Ad-hoc Network (MANET) (Seba et al., 2019). The system enables its operators to share and unify topologic maps in damaged buildings by relying on interpretations provided by people present in an infrastructure-less system. Apart from indicating emergency situations such as fires and explosions, a collection of symbols is used to create a map that represents characteristics such as intersection types and road stops. Thus, the demonstrated understanding can be used to provide assistance to specific locations, locate the nearest exit, match rescue activities of individuals and businesses, gather information about crisis markers, and reason about the building's status.

According to Robinson and Brown, modelling and virtual reality are critical for evaluating a new technology in a disaster situation (Mourtzis et al., 2014). DRIFTS, an agent-based model, was created to illustrate the information flow between agents in a crisis situation. The simulation demonstrates the effect of an agent's outcomes and actions on other agents. It enables human operators to modify both the tragedy data and the attributes of the agents. Loper and Presnell, for example, have developed an agent-based simulator that replicates the data stream in a crisis facility (Anagnostou et al., 2013). A few attempts have been made to integrate real-world user interfaces and virtual reality. Jain and McLean, for example, combined gaming and virtual reality structures for emergency response coaching (Haas et al., 2011). A combination of computer and virtual reality is required to evaluate the serviceability of a user interface. As a result, communication between individual users and the interface can be captured.

Recommended VLC Typology and Innovations to Manage Crisis Situations: Multiagent Disaster and Rescue Simulation

The VLC crisis management typology is based on Fitrianie and Rothkrantz's (2007) work on geospatial knowledge of crisis situations, and graphs are used to model data in the VLC typology. The graph depicted in Figure 1 is made up of nodes that are connected based on their approximated spatial coordinates in the real world. Lower nodes correspond to objects, actions, and events that occur in the real world. They

Figure 1. Graph-based symbolic representation of a crisis event on a certain location (Fitrianie & Rothkrantz, 2007)



contain much more than data about particular events and objects. Additionally, they contain information about their current state (such as living condition and dynamic spatial state), as well as information about their temporal (such as frequency and time point) and spatial relationships (for example current location, origin, destination and path). The arcs illustrate how people are classified or how concepts are related (for example result, cause and contain). A node at the root of the tree provides a different perspective on the crisis event. A collision between a car and a truck resulted in an explosion that released toxic gas and ignited a fire. Figure 2 illustrates several of these occurrences:

Figure 2 illustrates how the interface allows people to communicate with one another. The Local World Model Generation process converts user input into a symbolic representation in this manner. It enlists the help of the domain ontology. A MANET transmits this image to the blackboard. Finally, the Global World Model Decomposition changes the user's screen based on the newly built global world model. Because the world model contains information about where its objects and events are in the world,

Figure 2. Schematic architecture of the communication interface (Fitrianie & Rothkrantz, 2007)

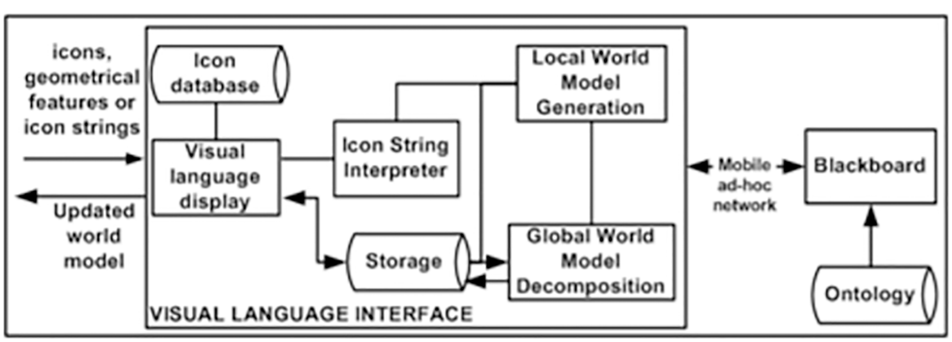
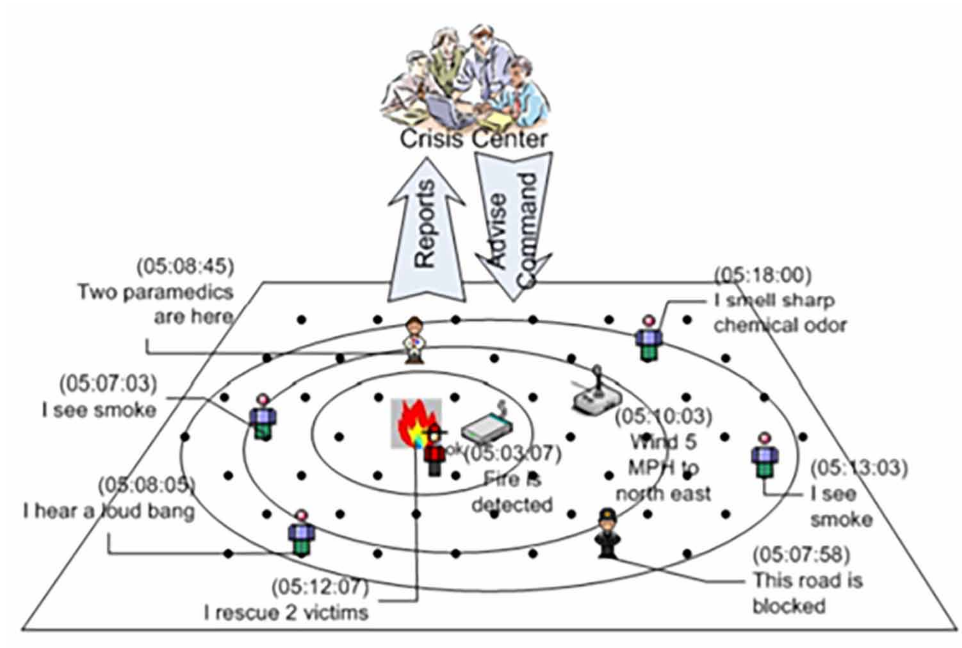


Figure 3. Overview of the multiagent disaster and rescue simulator. On a world with waypoints, disaster dispersion (represented by ellipses) occurs (dots). Agents on the ground report their findings (Fitrianie & Rothkrantz, 2007)



this process is almost as simple as it sounds. The interface only checks to see if the knowledge has been saved as icon strings in this case. If not, it will appear as icons on the map. If there is any uncertainty, the interface will try to resolve it. A few users submit the same report from a different location than the one in the global world model. These coordinates will be chosen by the reasoning engine, and the new information will be displayed to these users.

After that, a simulation environment can be used to assist in testing the new interface. The simulation enables you to combine real-world crisis observations with a MANET interface. Individuals who observe the real world can help to calibrate and update disaster simulations. This will be accomplished by utilising individual reports. Figure 3 depicts the simulator. We use grids and waypoints to model the crisis simulation world's geospatial knowledge. Waypoints are vectors that depict information about the environment in close proximity to a particular location on the globe. They include data about the physical world (for example, the current temperature outside, the wind speed and direction, and the direction of the wind), as well as reports from individuals who have seen or heard something. This illustration is straightforward but detailed enough to depict a variety of situations.

An "agent in the field" is someone who contributes to the crisis simulation by reporting what they observe. It could be a genuine individual, a fictitious individual, or a fictitious sensor device (for example a smoke detector and a wind meter). An agent is always associated with a single location on the globe. This is the point at which the disaster occurs. They will compile them all to create a global model of reported crises. In this case, it has an expert system that uses the world model to determine what happened and what to do next. If an explosion is reported and the temperature rises, the likelihood of a fire increases, and firemen are dispatched and residents may be forced to evacuate.

In this crisis simulator, you can observe how fire spreads, how gas spreads, and how a dangerous substance spreads. It depicts how the crisis affects other people (such as the intensity of the fire, the pressure of the gas, and so on) at any given time and location based on the information in the way points. A crisis simulation's events are scripted. Each time a new time unit arrives, a photograph of the scene is taken. Each snapshot is composed of a large number of waypoints extracted from a grid cell. It is carried out on a minute-by-minute basis. The typological innovation can also simulate how toxic gas spreads and how quickly a fire spreads. The simulator is used by a sensing infrastructure that monitors and extracts data from real people, such as the location of an agent, in order to capture real people in a virtual world. Additionally, information is provided about the virtual world to a real-world actor, allowing him or her to take part in a simulated reality. In a test scenario, this could be real people moving around and using their mobile phones to report on events. Thus, the current version of the simulator can display an image of a situation relevant to the current scenario based on the location of an agent at the time. This could potentially help mitigate future real-life crisis situations, which in turn could save millions of lives.

CONCLUSION

When verbal communication is impossible, VLC has been found to be an effective mode of communication for humans. To gain a better understanding of the crisis, the proposed communication paradigm is not intended to replace any of the primary modes of communication used by humans, such as talking. Rather than that, it wishes to establish new channels for obtaining information. The use of icons to represent concepts or ideas enhances the interface's usability for users of various languages and backgrounds. Naturally, this comes at a cost. There is a need to process all of this data and make prudent use of it. Multiple sources must be analysed and combined in order to comprehend how the crisis fits into the larger picture. On this basis, the necessary decisions must be made and communicated to all parties involved. By enabling this feature, future work can be done to make communication between people easier. Such a system must be multimodal in order to support people collaborating and coordinating in non-deterministic environments to solve crisis problems. It should be capable of switching between modes to ensure that the appropriate mode is used for the task and environment. As a result, humans are able to use all of their senses concurrently, with each complementing and enhancing the others.

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Chapter 11
A Systematic Literature Review of Contingency Distance Teaching and Learning in the Time of Crisis:
COVID-19 Context

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ABSTRACT

The purpose of this chapter is to examine the transition from traditional teaching and learning methods that rely heavily on face-to-face interaction inside lecture rooms to online distance learning in the context of the pandemic. The existing literature is systematically reviewed using the guidelines for conducting systematic information system (IS) literature reviews, with the assistance of NVivo. Diverse experiences navigating the contingency transition to distance learning in the midst of the COVID-19 pandemic. The review's findings are presented in the form of various figures, tables, and graphs. It makes comparisons between the included studies' objectives, methodology, theory application, findings, perspective, and context. Additionally, the analysis compares the findings from prepared (in terms of infrastructure and training) and unprepared implementation cases. This chapter is expected to guide decision-makers in developing strategic action plans to enhance the online learning experience for instructors, students, and institutions as a whole during a crisis situation.

INTRODUCTION

The Covid-19 pandemic is the unprecedented health crisis that has intricate effect on how different activi-

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ties are being undertaken across the globe (Ayittey et al., 2020). This severe acute respiratory syndrome discovered during December 2019 in the Chinese city of Wuhan has driven the fastest changes to education sector necessitated by social distancing and self-isolation policies strongly recommended by the World Health Organization (WHO), forcing all learning and teaching activities to confront an unexpected transition to wholly online learning contexts in order to avoid future expected waves (Toquero, 2020).

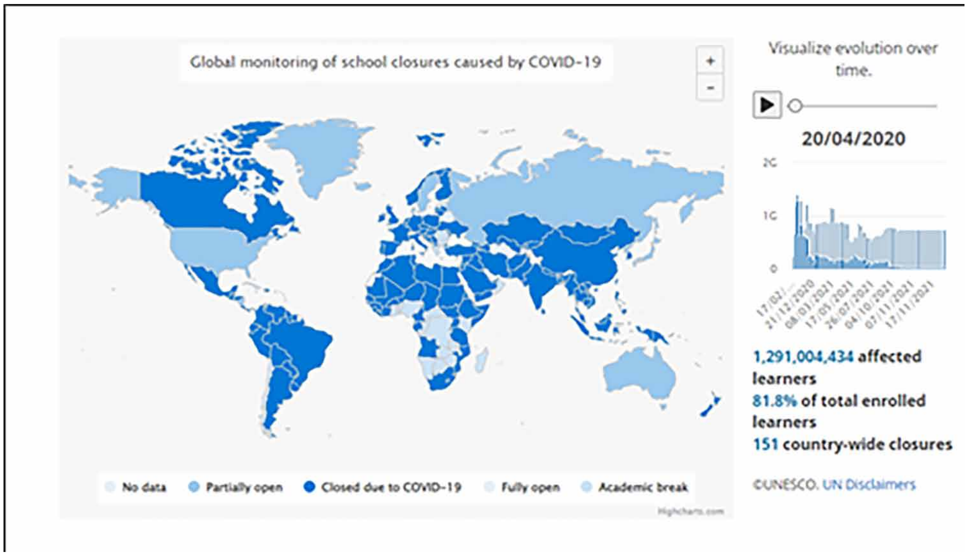
Consequently, countries worldwide have introduced diverse solutions to carry on teaching and learning activities. TV broadcasts, video lectures, online channels and online libraries support have been initiated in at least 96 countries (Basilaia & Kvavadze, 2020). While the educational institutions are still struggling with digital transformation challenges in order to find out optimal adaptation ways, the pandemic has principally affected their core: instructors and students (Adedoyin & Soykan, 2020). The period for the shift is undoubtedly very stressful as all learning and teaching activities, namely classes, meetings, exams, supervisions and seminars were forced to move online within very short notice, in order to adapt the challenges of the rapidly changing educational environments (Nikou & Maslov, 2021; Van Nuland et al., 2020). This sudden impact, as well as the future possible influence on education sector stresses on the need for careful study for the advantages as well as the drawbacks of online distance learning (Calonge et al., 2021).

The concept of Contingency/Emergency Remote Teaching and Learning is normally used in the literature depict the prompt and unplanned need to switch form the conventional FtoF teaching to online learning. This is different from the normal online learning, which is distinguished from the emergency online learning by having an established pedagogy, in addition to being planned, premeditated in courses design and always prepared to be delivered online (Bozkurt & Sharma, 2020; Calonge et al., 2021). Thus, the contingency Remote Teaching represents the unexpected shift and swift adaptation of remote online course delivery, which is basically planned to be delivered FtoF, inside classrooms and lecture halls, and this happen as a consequence of a sudden event, such as natural disasters or during a global pandemic. Thereafter, when that sudden event is over, it is expected that all the teaching and learning activities to revert back to the planned FtoF mode. Thus, the Covid-19 pandemic requested rapid and necessary action form educational institutions and teaching staff to switch to distance online learning, in order to avoid indefinite study suspension, because students can no longer be inside classrooms (Basilaia & Kvavadze, 2020). It is important to mention here that although social distance rules and regulations may be relaxed worldwide when the virus wave recede, especially after vaccination, however, the threat of future lockdowns still exist, specifically with the new Coronavirus variants and mutations.

This incidental and unforeseen move to contingency remote learning has affected educational institutions, instructors as well as students. The unpreparedness and lack of required infrastructure have been reported as main challenges for educational institutions to suddenly switch to remote online learning and teaching. The unprepared teaching staff strived to device how to efficiently, promptly and fluently use educational technology, such as online resources, digital tools and Learning Management Systems to teach, assess and engage students in novel, predominantly with initial minimal support (Watermayer et al., 2020).

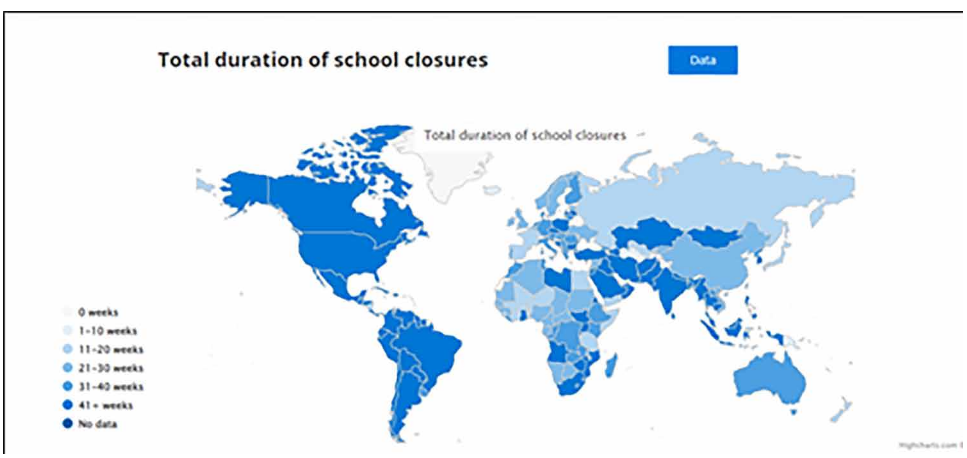
Students also have affected by this sudden transformation across the globe. It has been reported that more than 1.5 billion students had been prohibited from attending physical classes because of Covid-19 pandemic restrictions and lockdowns (Strauss, 2020; Unicef, 2020). Figure 1 illustrates a screenshot of a worldwide monitoring of school closures caused by Covid-19 at the pandemic peak on April 2020. Figure 2 represents the total duration of school closure in weeks for each country since the onset of the pandemic (UNESCO, 2020).

Figure 1. Global monitoring of school closure caused by COVID-19 (UNESCO, 2020)



This emergency shift from FtoF teaching and learning to distance online educational activities started as a transient shift, however, it is evident that this pandemic will have a lasting influence on the future of educational activities worldwide. The instantaneous need for contactless teaching and learning environment, in addition to off-campus experience with tolerable strengths and weaknesses, may extend both opportunities and threats to students, teaching staff as well as the entire educational institution (Calonge et al., 2021).

Figure 2. Total duration of school closure around the globe. (UNESCO, 2020)



This study aims to explore influence of the sudden shift from conventional education methods to emergency online distance education methods on educational institutions, instructors and students. It conducts a systematic review for the literature addressing issues relevant to the application of contingency Remote Teaching and Learning. This systematic review follows the guidelines from Bandara et. al. (2011).

The chapter is organized as follows. In Section 2, we present background information on distance learning (DL) and DL during crisis. In Section 3, we describe the methodology we followed to select and analyse the publications. In Section 4, we present the results, discuss patterns that emerged from the analysis. Finally, in Section 5, we present opportunities for future researchers and conclude the paper.

Background

Distance Learning and Distance Learning System

The American Association for Distance Learning defines (USDLA) Distance Learning as "the process of acquiring knowledge and skills through a variety of media for the transfer of education and information, including all types of technology and various forms of education level for distance learning" (USDLA, 2020). Online distance education utilization has increased in many universities around the world during the Covid-19 pandemic, trying to adapt the new situation (Bashitialshaaer et al., 2021). It is achieved without direct contact between instructors and students. Alternatively, students learn at their convenience, i.e., in any place and according to what their time allows. Consequently, technology is a crucial element when adopting distance learning (Liguori & Winkler, 2020).

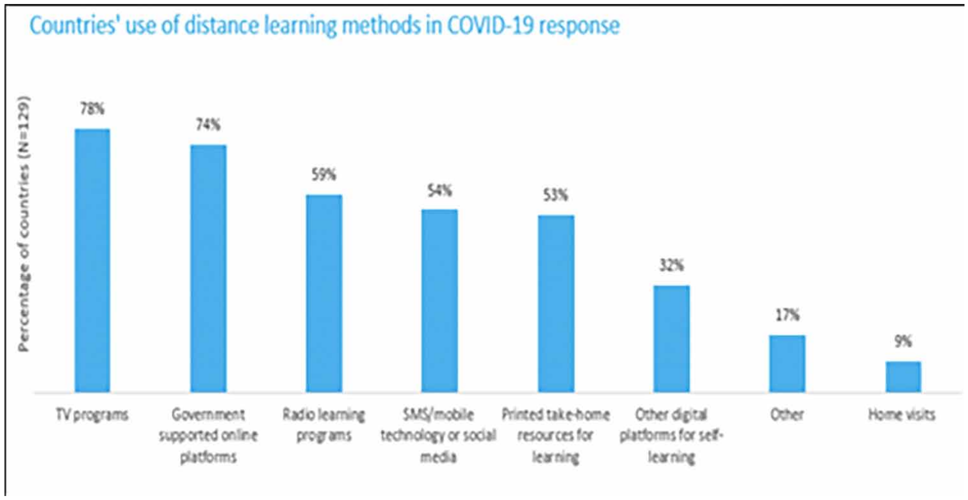
Accordingly, distance learning demands the utilization of various types of modern audio-video technologies, for example laptops, mobile phones and tablets to exchange information between instructors and students (Liguori & Winkler, 2020). The first Distance Learning system was established in the mid-nineteenth century as a form of continuous higher education, and in 1858, the University of London granted degrees to students through distance learning, without attending any classes, then other universities around the globe followed. It has been introduced basically to handle the need of adult learners who cannot enrol in full and part-time studies at university level for many years, because of their professional life commitments. Moreover distance learning has been adopted as an option to facilitate teaching and learning for distant rural, as well as poor areas (Lassoued et al., 2020a). Figure 3 depicts the global countries' utilization of distance learning methods in Covid-19 response. It can be noticed that TV education programming and Government-supported online platforms are the most common platforms employed (Memon et al., 2020).

Despite the benefits attained by introducing distance learning, many barriers to achieving quality in distance learning during Covid-19 pandemic have been reported by both students and instructors, which affected the quality of the educational learning process as a whole. Lack on direct interaction between instructors and students is one of the major disadvantages of online distance learning. Additionally, the need for training and experience of using internet for both instructors and students, and preparing materials properly to be delivered remotely. The lack of technological infrastructure was also among the main weaknesses of online distance learning (Bashitialshaaer et al., 2021; Lassoued et al., 2020a).

Online Distance Learning as a Necessity Not an Option

As previously mentioned, at some point of time the major part of the world was on quarantine due to the significant outbreak of the novel Covid-10 virus. Hence, emergency online teaching and learning has been the panacea during this crisis, as an alternative for the traditional mode of pedagogy. This pandemic

Figure 3. Distance learning methods utilization during the Covid-19 pandemic worldwide. (Memon et al., 2020)



forced educational institutions which were earlier resistant to change to accept modern technology. Many educational institutions around the globe have fully digitised their teaching and learning processes to adapt that massive situation. The main concern was how educational institutions will be able to adopt distance online learning unexpectedly, rather than thinking about whether online teaching and learning can provide quality education (Carey, 2020; Dhawan, 2020).

Educational institutions are now required to face the reality that online distance learning is no longer an option, it is rather a necessity posed by the massive changes caused by the Covid-19 pandemic. Hence, those institutions should always be prepared for a sudden shift to emergency remote distance learning system, with quality maintained. Such prompt response from educational institutions is now shaping their reputation and showing their adapting capabilities. Indeed, not all curricula can be transformed into online resources overnight, however, innovative solutions by institutions can assist in dealing with this crisis (Liguori & Winkler, 2020).

Consequently, there is an evidence for a need to explore and understand the previous experiences of educational institutions worldwide. Our exploration to these experiences will focus on studying the reported feedback about the encountered challenges and the innovative solutions recommended by institution, instructors and students. This understanding shall guide the future efforts to enhance the quality of emergency distance online learning. Therefore, this study aims to contribute to the ongoing literature about distance online learning during Covid-19 pandemic by achieving the following objective:

RO1: To explore the different experiences for emergency transition to distance learning amidst Covid-19 Pandemic with focus on context conditions and the used perspective.

RO 2: To explore the different alternative approached used to enable instantaneous emergency distance learning implementation during the COVID-19 pandemic.

RESEARCH METHOD

This research is geared toward conducting a literature survey. The idea is inspired by the growing plethora of emerging literature in the contingency distance online learning, particularly amidst the Covid-19 pandemic. To realize the main aim of this research about "understanding how emergency distance online learning (EDL) was implemented during the covid-19 outbreak as an alternative to the traditional teaching and learning system, a Systematic Literature Review (SLR) was chosen as research methodology. SLR is a process of identifying, assessing and interpreting all available and appropriate literature to answer specific research questions (Tranfield et al., 2003). It is regarded as the ideal method for this type of research problem. SLR is characterized by a clearly formulated research target, its transparency, reproducibility as well as systematic evaluation and synthesis of the relevant study context (Rousseau et al., 2008)(Fink, 2014)(Breuer et al., 2018). It also helps to obtain trustworthy results that assist in building the foundation for drawing meaningful conclusions (Soltani and Navimipour, 2016).

By developing a SLR, the research identifies the current research focus, observes on the progress of the research on the EDL during COVID-19, and highlight areas that require more investigation. The specific set of research questions that this SLR answers are the following:

- RQ-1: How EDL was implemented during the COVID-19 outbreak? (Existing experiences/implementations)
    - RQ1-1: What are the context's conditions of these implementations?
    - RQ1-2: What perspectives was focused on during these implementations?
- RQ-2: What are the different innovative approaches and technologies used to enable instantaneous emergency distance learning implementation during the COVID-19 pandemic?

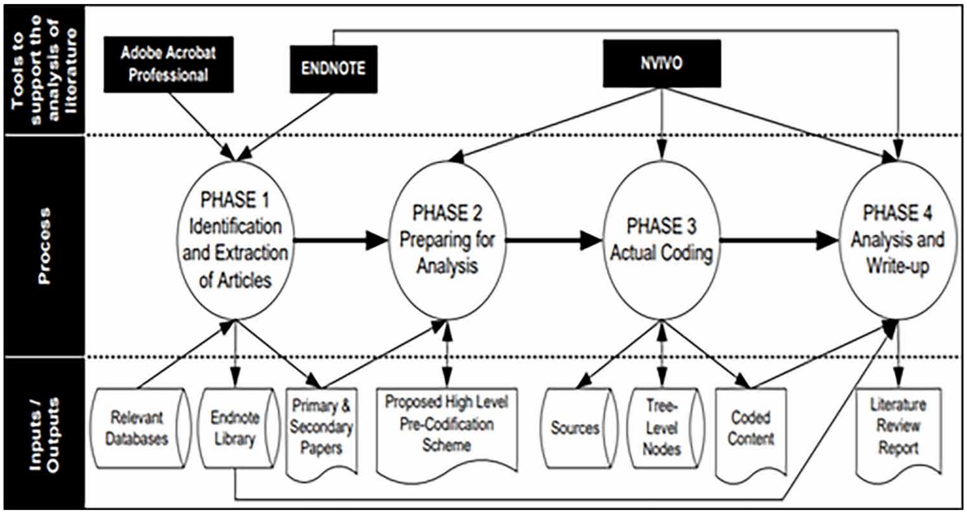
By answering these set of research questions, the research contributes to the information systems research field by summarizing on the current existing implementations to the EDL and highlights the research existing gaps in this research stream. Thus, the research builds a foundation for future research by reporting on the details of the existing implementation cases and methods.

Research Protocol

This research followed the recommendations of Bandara et. al. (2011) in conducting systematic literature reviews. Figure 4 below illustrates the steps involved in the proposed approach to conduct systematic literature review.

According to Bandara et. al. (2011), two main steps are important in conducting SLR: source selection and search strategy. The source selection process refers to which publications should be targeted, for example, journals papers and conferences proceedings (Brocke et al., 2009; Vom Brocke et al., 2015). While search strategy refers to defining search terms and search fields as well as the duration of time to be covered (Bandara et al., 2011; Brocke et al., 2009). The following subsections will report on how these steps was applied in this research.

Figure 4. Summary overview of the proposed literature review approach (Bandara, Wasana, Miskon, Suraya, & Fielt, 2011)



Phase 1: Identification and Extraction of Articles

Information Sources and Search Strategy

By following Bandara et. al. (2011) guidelines, the research first identifies the relevant sources to be included in the literature review. To identify those sources, a pre-search plan was prepared to answer the following set of questions such as: where to search? (information sources) What to search? (keywords) How long the period of focus? (search duration) How to select the targeted set of articles to be included? (selection criteria). Details of the pre-search plan and the actual search strategy and process are described in the following paragraphs.

As the scope of this study is information systems research, the researchers surveyed 8 highly respected IS journals –the selected most reputable IS basket of eight journals - following the recommendations of Association of Information system research (AIS). Also, selected AIS affiliated journals that is relevant to “learning and learning technologies” were considered as selected search source. Furthermore, a systematic search was conducted in selected e-libraries and academic search engines. Namely, e-libraries such as Elsevier, Springer, Routledge, Wiley, IEEE Explore digital library, ACM Digital Library were reviewed. Moreover, reputable academic research search engines such as: Scopus, Web of science and Google Scholar were used to broaden the scope of the search.

The article extraction was conducted in multiple iterations. In terms of the search strategy, the search focused on journals papers, conferences proceedings and book chapters that published between (Dec 2019- Nov 2021). Different keywords were used such as “emergency distance learning”, “Emergency remote teaching”, “experience COVID- 19”, “global crisis emergency distance learning”, “global crisis emergency remote teaching”, “distance learning during pandemics”, “teaching during pandemics”, “off-campus experience COVID-19,” Distance Education COVID-19”, “emergency transition COVID-19” and “contact-less learning/teaching”. These keywords were searched in the title, abstract, keywords of the searched publications. The search process with these keywords was documented using a log table that containing the following items: Number, search date, the used keyword, search location, no. of the initial search results returned, no. of the included articles and remarks. This log table were shared between researcher to document the search details.

To decide on which publications should be targeted, set of sources selection criteria were formulated. The selection criteria that were used are: empirical case study that describe discuss on emergency e-learning/ distance learning/teaching application during the COVID-19 outbreak. Data extraction process of those selected articles was conducted by one author and then double checked by the second author. The required data was extracted using a form containing the following items: No. , citation, title, year, number of citations, date, type of study, method (data collection method, data analysis method, sample size), findings, level (micro, meso, macro), perspective (student, educator, administrator), context (country, institute, specialization), the used theory (if any), SWOT analysis (yes or no), the used distance learning approaches (LMS, radio, social media, ZOOM etc.), ready infrastructure –IT equipment + training - ? (yes/no), challenges, success factors, limitations, future research and remarks. This form later used to feed an MS Excel Sheet with the full details of the included publications. At the data preparation phase this Excel sheet were used to import the details of the data sources as classification sheets in NVivo 10. Finally, a quality assessments were performed to resolve duplication and incompleteness of the data. Disagreements were resolved through discussion and consultation between the authors.

Phase 2: Preparing for the Analysis

When describing the preparatory phase for the analysis, two key aspects are of importance, the pre-coding scheme and the tool(s) used. Initially, a coding scheme was designed in a way that match the previously mentioned study objectives and help in answering its research questions. Details about the used coding schema and its mapping to the research objectives and questions are summarize in Table below. Next, the tools for that will be used to conduct the analysis was chosen. Mainly, the used tools were: Mendeley software, NVivo 10 and MS Excel. Mendeley software were used as reference manager and initial e-reader to skim, classify and comment on the downloaded publications. NVIVO 10 was used as a qualitative data management and data analysis tool. It was used to systematically code and analyze the prior literature within one repository. Additionally, it was used to conduct the qualitative thematic analysis and generate the analysis querying results. MS Excel were used to transform the publication details from Mendeley to NVivo and create the final results charts and figures.

The pre-analysis phase also involves preparing the NVivo software by translating the identified coding schema introduced in Table 1 below into sources and nodes with their corresponding classification sheets.

Phase 3 and 4: Actual Coding Process and Analysis and Interpretation

After finishing the pre-analysis phase, the third phase involves applying the pre-coding scheme defined in the previous phase to conduct the actual coding process. The final analysis and interpretation phase consists of synthesizing the coded details and analyzing the literature to respond to the research objectives of this study. In the following, a brief description to these phases is provided.

The process of coding using NVivo started by placing the key areas of interest (the identified main themes in the pre-coding schema), in this case; ‘EDL Experiences’ and ‘EDL Methods’ (amongst others) were placed as main tree-level nodes within the NVIVO data-base that was created for this project. A tree-level node is a physical location, where user can store the set of related ideas that would be coded.

Table 1. Summary to the used pre-coding schema

<table>
<tr><th colspan="4">RO 1: To explore and evaluate the different experiences for emergency transition to distance learning amidst Covid-19 Pandemic with focus on context conditions and the used perspective.</th></tr>
<tr><th>Main Theme</th><th>Subtheme/
Attribute</th><th>Supported RQ</th><th>Remarks</th></tr>
<tr><td rowspan="2">Existing experiences</td><td>Context
Country
Level
Learning domain</td><td>RQ1-1</td><td>Classification sheet were developed for this sub-theme with more describing attributes.</td></tr>
<tr><td>Perspective
Student (S)
Instructor(I)
Administration(A)</td><td>RQ1-2</td><td>Classification sheet were developed for this sub-theme with more describing attributes.</td></tr>
<tr><td colspan="4">RO 2: To explore the different alternative approached used to enable instantaneous emergency distance learning implementation during the COVID-19 pandemic.</td></tr>
<tr><td rowspan="2">Implementation approach</td><td>LMS</td><td rowspan="2">RQ2</td><td rowspan="2">Classification sheet were developed for this sub-theme with more describing attributes.</td></tr>
<tr><td>Others</td></tr>
</table>

All the set of the extracted articles were imported and saved within NVIVO as ‘documents’. Documents are the sources of data that can be analysed in the study. The coding process was conducted in two levels. The goal of the first-level-coding was to capture the main details that related to each main theme – at a high level. In the second-level-coding, the extracted details were analysed deeper to derive the intended findings. A detailed coding-protocol was devised by the researchers, to confirm the coding plan and scheme.

Interpretation phase involved using different NVivo capabilities such as framework matrix and queries execution results to generate rich insight about the coded data that provides answers to the research questions. The overall research findings and the analytical activities that supported these findings are presented in detail in the next section.

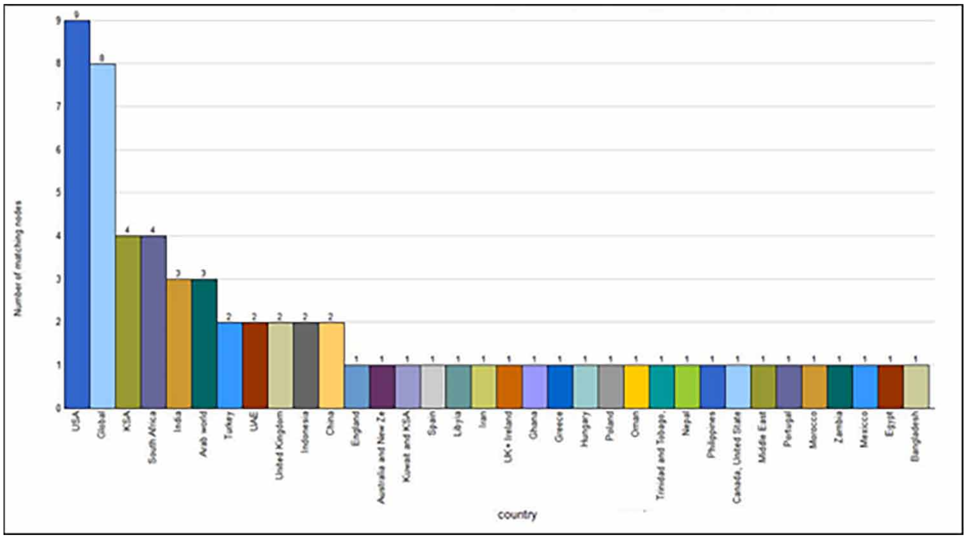
Findings and Discussions

After database screening and removal of duplicates, 321 articles were considered relevant. A total of 201 studies were excluded after their assessment based on the predefined eligibility criteria. Of the 201 eliminated studies, 157 articles were excluded because the title, keywords, or abstract did not contain the themes relevant to this study. While the another 44 were excluded due to “no full text being available”. 120 articles have been read in details and finally, 66 articles were included as eligible data sources. Detail about the selected studies are provided in in the appendix of this chapter (Table 2). In the following subsections the finding will be presented and discussed according to its corresponding research questions.

RQ-1 How EDL was Implemented During the COVID-19 Outbreak? (Existing Experiences/Implementations Context and Perspective)

To answer first research question of this research (RQ-1), the identified EDL implementation case studies where reviewed with focus on the context of these implementations as well as the adapted perspective.

Figure 5. Distribution of the included EDL implementations by country



The context of these implementations was characterized based on three different dimensions: country/ countries, level of analysis, specialization/learning domain. The following paragraphs discuss on the finding of each of these dimensions.

The Context Dimensions

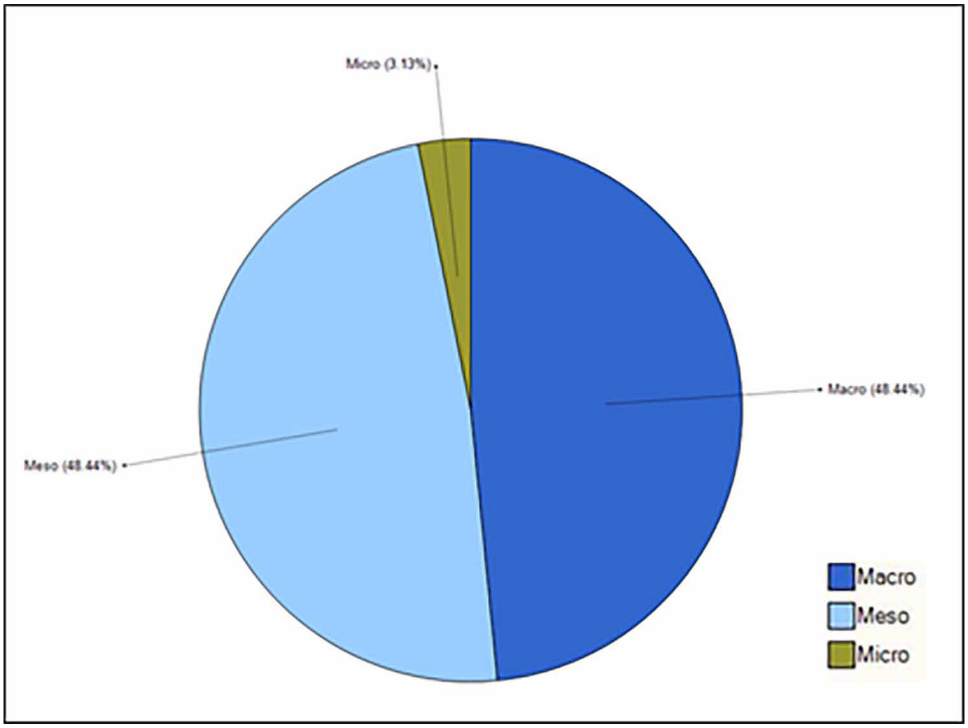
The Country Dimension

Figure 5 below categorizes the included EDL implementations by its country/countries that the study was reported from. As mentioned previously, NVivo 10 was used to analyse and report on the thematic analysis of the included resources. The figure shows the countries its X-Axis and its corresponding no. of nodes in the Y-Axis. In NVivo, each node represents specific EDL implementation case study. The different included data sources report about specific implementations case study either in single country, more than one country, region or global. Figure 5 shows that the biggest number of study cases in single country is USA with 9 cases. Followed by total of 8 case studies that focus on global (multiple countries). Four case studies are introduced from KSA and South Africa each. 3 cases were reported from India. Likewise, the Arab region was covered by 3 different case studies. Finally, all the other mentioned countries have 2 or less cases.

The Level of Analysis Dimension

Figure 6 below classify the included EDL implementations by its level of analysis. All the included cases were studied at three different levels: Macro (many institutions in one or more country), Meso (single institute) or Micro (single individuals). The figure shows that most of the studied cases was either Macro (48.44%) or Meso (48.44%). The Micro level was less likely used (3.13%).

Figure 6. Distribution of the included EDL implementations by the selected case study level of analysis



The Learning Domain Dimension

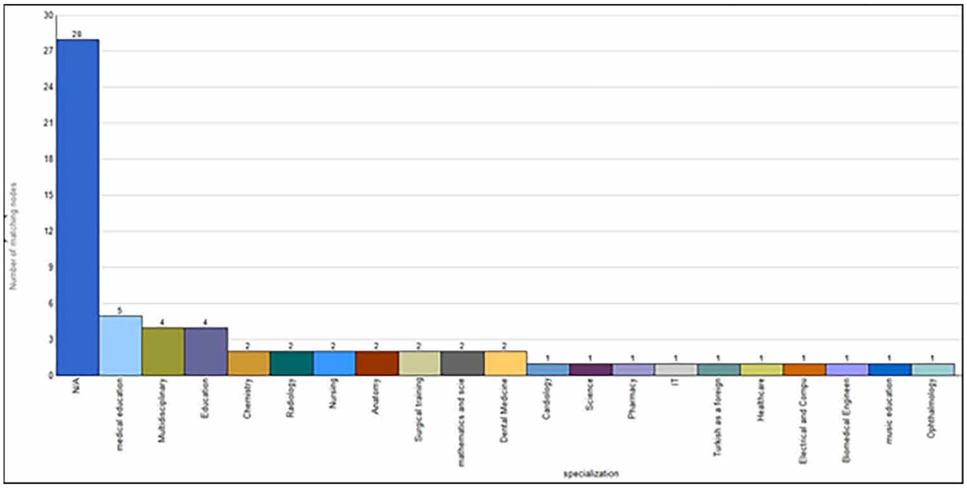
Figure 7 below classify the included EDL implementations based on its learning domain (specialization). Many studies do not mention on its case studies learning domains (28 studies). The figure shows that most of the cases were presented from a medical or medical related fields (Total of 19 studies). Other domains of study are Science (5 studies), education (4 studies), Engineering and IT (3 studies). Single study was presented from other domains such as music and language. Additionally, 4 multidisciplinary studies were reported.

The Adapted Perspective

Finally, the adapted perspective of the included case studies was overviewed in figure 8 below. The analysis identified three different main perspectives: Student (S), Instructor (I), institution Administration (A). A combination of these perspectives also reported. The figure shows that most of the included studies (24 studies) are taking both the students and the instructor perspective (S+I). Similarly, the second dominant perspective is the Student perspective (S) (19 studies). Furthermore, 7 studies were reported adapting al the three perspective (S+I+A). Single instructor perspective (I) and Administration perspective are reported by 6 and 4 studies respectively. Finally, combined Administration and Student or instructor (S+A or I+A) were also reported by 3 and single study respectively.

The discussion about those three perspectives on the chosen studies was about the challenges experiences, and the opportunities created by such unforeseen and unexpected switch to Emergency Remote

Figure 7. Distribution of the included EDL implementations by the selected case study adapted learning domain



Teaching and Learning on those perspectives mentioned above. Both instructors and students found the experience of emergency distance learning during the Covid-19 pandemic beneficial and satisfactory in achieving its objective of resuming the teaching and learning processes, and avoid indefinite study suspension indefinitely. This is because of its convenience, flexibility and low cost.(O. B. Adedoyin & Soykan, 2020; Agarwal & Dewan, 2020; Ali et al., 2020; Huang, 2020; Khalaf et al., 2020; Rodriguez-Segura et al., 2020; Sharma et al., 2020). In fact, some studies concluded that this sudden transition had no significant influence on studies, depending on the nature of materials delivered (Agarwal & Dewan, 2020; Huang, 2020; Jes et al., 2020; Rizun & Strzelecki, 2020; Zhang et al., 2020).

However, there are number of challenges reported by both students and instructors. The technological infrastructure, specially access to internet was a dominant challenge that made it difficult to handle such sudden transition smoothly (Assunção Flores & Gago, 2020; Crawford et al., 2020; Pather et al., 2020; Soria et al., 2020). Moreover, some instructors and students expressed their feelings of anxiety and concerns about the efficacy of emergency online distance learning, the long-term ramifications of this technological transformation on security health and security, as well as the uncertainty about the future while they are trying to adapt to the new learning scheme (Agarwal & Dewan, 2020; Ali et al., 2020; Hasan & Bao, 2020; Kidd & Murray, 2020; Pather et al., 2020). In addition, while emergency online learning gave the students flexibility with work/families responsibilities, and adaptability to their routines (new timings and schedules plus being able to watch the learning material several times) (Crawford et al., 2020; Mohmmed et al., 2020; Vielma & Brey, 2021); instructors reported difficulties adapting this sudden transition, because it resulted in increase in their workload, obstacles to adapt lab sessions in some specialities to online environments, necessity to devise new students performance assessment methods, in addition to the main concern of unfamiliarity with online pedagogy, and emergency remote teaching and learning methods (Al Lily et al., 2020; Assunção Flores & Gago, 2020; Aucejo et al., 2020; Johnson et al., 2020; Pather et al., 2020; Vielma & Brey, 2021).

Regarding this sudden transition impact on the academic institutions' administration, it is considered an unprecedented stimulant to launch professionally designed online materials and to upskill their staff.

It is now a must for educational institutions administrators worldwide to think strategically about the design and implementation of professional and successful Emergency Online Remote Learning system and become ready for such unforeseen transitions. It would be prudent for those administrators to invest in online learning infrastructure and check their acceptance with students in order to preclude such frustration experienced in the onset of the pandemic (Crawford et al., 2020; Soria et al., 2020; Vielma & Brey, 2021; Wotto, 2020).

Nevertheless, looking at the holistic picture of Contingency Remote Teaching and Learning experience during Covid-19 pandemic, there is evidence that such experience presented opportunity for innovation for all perspectives (Assunção Flores & Gago, 2020; Calonge et al., 2021; Crawford et al., 2020; George, 2020; Huang, 2020; Khalaf et al., 2020; McRoy et al., 2020; Pather et al., 2020; Wotto, 2020; Wyres & Taylor, 2020). There are number of "lessons learned" form the past period since the onset of the novel Corona Virus pandemic that can be absolutely beneficial in the development of "best practices" in online pedagogy (Calonge et al., 2021; Crawford et al., 2020; Huang, 2020; Kidd & Murray, 2020). Educational institutions have the opportunity as well to develop their online teaching capacities (Al Lily et al., 2020; Crawford et al., 2020; Johnson et al., 2020; Wotto, 2020), and instructors and students have a good opportunity for capacity building and upskilling (Bozkurt & Sharma, 2020; Gallagher et al., 2020; Vielma & Brey, 2021).

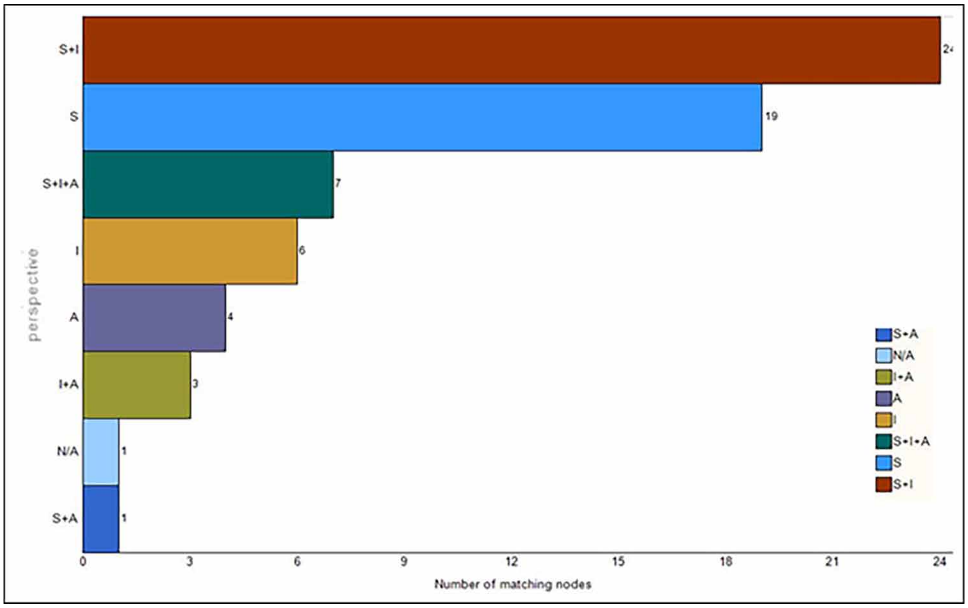
Such extensive discussion about the advantages, challenges and opportunities reported in considerable number of the selected studies encouraged the authors to undertake another extensive research in the near future about the strengths, weaknesses, opportunities and challenges reported in the literature about Emergency Remote Teaching and Learning during Covid-19 pandemic form the perspectives of students, instructors and academic institutions administration, in order to define set of success factors those can guide the decision making process about the successful online learning strategies.

RQ-2 What are the Different Alternative and Innovative Approaches and Technologies Used to Enable Instantaneous Emergency Distance Learning Implementation During the COVID-19 Pandemic.

To answer the second research question (RQ-2), the identified EDL implementation case studies where reviewed with focus on the implementations approaches and technologies used. The researchers try to answer this question but faced by the lake of information about the details of those implementation. Only 14 case study mentioned about their used implementation approaches or technologies. The context of these implementations was characterized based on four different dimensions: country/countries, level, specialization/learning domain and the adapted perspective. The following paragraphs discuss more on the used technologies.

Reviewing the chosen studies, it can be clearly noticed that there is a forced migration of educational institutions form conventional teaching and learning methods to electronic distance learning worldwide, regardless of the educational level or speciality, however, not all papers designated the particular platforms of methods adopted and implemented. Social Media (SM) platforms, especially WhatsApp was one of the mostly used platforms to facilitate electronic distance learning during the Covid-19 lockdown (Azhari & Fajri, 2021; Kara et al., 2020; Nel & Marais, 2020). Blackboard, Powerpoint slides, Microsoft Teams, Moodle, Zoom, teleconferencing and specialized Learning Management Systems (LMS) were also reported to be adapted during the crisis (Ali et al., 2020; Chatziralli et al., 2021; Chick et al., 2020; Rodriguez-Segura et al., 2020). Some educational institutions have utilized more than on one platform

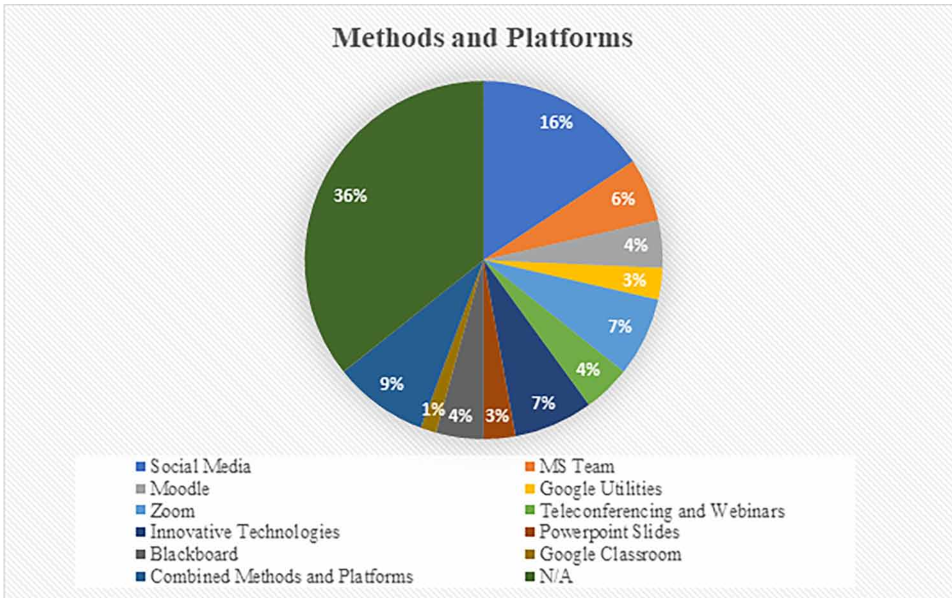
Figure 8. Distribution of the included EDL implementations by the selected case study adapted perspective



or method for emergency distance learning. For example, (Kim, 2020) mentioned the use of Google Hangouts, Zoom and Blackboard Collaborate as a mean of teaching and learning for early childhood. (Mohmmed et al., 2020) also mentioned that the Middle College of Oman used the combination of Microsoft Teams and Moodle as their contingency plan methods for undertaking teaching and learning activities during the pandemic. WhatsApp, Zoom Meeting applications and Google Classroom with Webex were also adopted in Indonesia during the Covid-19 pandemic school closure to teach mathematics and science (Azhari & Fajri, 2021).

On the other hand, some institutions developed their own innovative methods and platforms to switch from traditional teaching and learning processes to online distance ones, and it can be clearly noticed from the selected studies that the medical field dominated other specialties in innovations and adaptation of emergency distance learning methods. For instance, the Department of Diagnostic Radiology and Nuclear Medicine, University of Maryland School of Medicine, United States designed their own novel cloud-based Health Insurance Portability and Accountability Act (HIPAA) compliant and accessible education platform that imitates a live radiology workstation for first year radiology residents, in order to maintain a continued education during the pandemic lockdown, focusing on call preparation and peer to peer resident learning (McRoy et al., 2020). Three tools were used in this innovative model, namely: Pacsbin, Zoom and Google Classroom. This platform has been tested for acceptance, and has been reported that hundred percent of first year residents felt comfortable and confident to use the novel model, moreover, they reported that the model improved their confidence and knowledge to undertake independent call. 78% of the respondents to the acceptance survey form first year resident students demonstrated keen interest to continue using the model for learning, even after the pandemic restrictions are lifted. It has been recommended as suitable for other institutions to teach residents.

Figure 9. The reported EDL implementations approaches



The Brooke Army Medical Center along with the University of California, also in the United States proposed several innovative solutions, in an attempt to continue surgical resident education, while maintaining the safety of educators, residents as well as patients. Those novel solutions encompass the flipped classroom model, online practice questions, teleconferencing (using the commercial online software GoToMeeting) in place of in-person lectures, procedural simulation and the facilitated use of surgical videos (Chick et al., 2020). It has been reported that, after undertaking a small pilot study that those techniques enhanced knowledge acquisition without increasing the preparation time. It also provides the trainees with a repository of video lectures, available for them at their convenience (place and time). Additionally, they created an innovative social media-based platform, which is a closed Facebook group named "ABSITE Daily", for posting daily practice questions for residents, as preparation for the American Board of Surgery In-Training Examination (ABSITE).

Another interesting and innovative solutions for online distance learning during the Covid-19 pandemic has been discussed by Al-Taweel et al. (Al-Taweel et al., 2020) in their study about the shared experiences od academics form Kuwait and Saudi Arabia in multiple disciplines. For example, and in an effort to restore and maintain the social connection between students and their professors during the lockdown, an activity at Mohammed Al-Mana College for Medical Sciences (MACHs) in Saudi Arabia was piloted. An Online Coffee Break (OCB) initiative was trailed at MACHS midst the spring semester to virtually join students with each other into causal and informative sessions.

A comparable initiative was launched at Kuwait University called "Virtual Recharge Hour". The primary purpose of these casual but structured sessions was to share teaching innovations to boost students' engagement, however, when the lockdown imposed, these sessions were converted to virtual meetings to provide peer support, in order to face the disruptions and challenged experienced because of Covid-19.

In the United Kingdom (UK), a website called SIM SHARE (Simulation Share) was written, published and launched permit healthcare staff to support learners across the sector in a better way (Wyres

& Taylor, 2020). It is a basic WordPress framework, which avails an open access platform for learner's development, when the face-to-face learning is prohibited. Those resources include embedded videos, documents, webinars, links to videos on sharing websites and podcasts.

Khalaf et al. (Khalaf et al., 2020) presented on their study a successful implementation of high-stake online exam for final-year dental students during the covid-19 pandemic at College of Dental Medicine, University of Sharjah, Sharjah, United Arab Emirates (UAE). The exam consisted of various types of questions, including Modified Essay Questions (MEQs), Multiple Choice Questions (MCQs), Objective Structured Clinical Examination (OSCE) and an oral exam. Both exam and invigilation were conducted using Blackboard and MS Teams program. Then, the views of stakeholders were assessed using two tailored surveys for students and faculty. It has been reported that the exam session went very successfully without any unfavorable events. Both staff and students reported satisfied with the online exam experience.

Furthermore, Effective teaching and examination strategies for undergraduate learning during COVID-19 school restrictions have been presented and discussed by George (George, 2020). Those strategies and platforms have been implemented at the University of the West Indies, Department of Electrical and Computer Engineering, Trinidad and Tobago. An online platform called MyElearning has been developed to access all courses materials including lectures and lab materials, in addition to examination activities by students. Other beneficial learning resource called Visual Tutor and was made available for students for download via the MyElearning platform. It provided an interactive experience of all topics in the specific module of Digital Electronics.

Thus, it is obvious from the above discussion that all educational educations, around the globe are forced to adapt their teaching and learning methods to the novel and unprecedented situation after the pandemic, regardless of the field of specialty or educational level. It is now a necessity not an option to adapt the new circumstances, either by utilizing available platforms and methods or by devising special platforms to tailor their needs on them.

CONCLUSION AND FUTURE AVENUES

The unprecedented pandemic of Covid-19 is the health crisis that has intricate effect on how different activities are being undertaken across the globe. It has driven the fastest changes to all sectors, and education is not an exception. The social distancing and self-isolation policies strongly recommended by the World Health Organization (WHO), forced all learning and teaching activities to confront an unexpected transition to wholly online learning contexts in order to avoid future expected wave.

This study explored the literature about the transition to Emergency Remote Distance Learning from conventional teaching and learning methods responding to the restrictions imposed by the spread of Covid-19, focusing on how EDL was implemented during the covid-19 outbreak (implementation contexts and perspectives), in addition to the different innovative approaches and technologies used to enable instantaneous emergency distance learning implementation.

To do so, the authors systematically reviewed 65 articles from high impact journals that touched on the topic of education amidst the Covid-19 pandemic.

It has been found that educational institutions around the globe moved to EDL. Selected studies covered contexts from America, Asia, Europe, Africa and Australia. Various disciplinaries have been studies as well, ranging from different medical fields like Anatomy and Radiology, to science and mathematics studies. Moreover, three main perspectives were focused on in the selected studies, namely, students, instructors and institutions administrators. Some papers discussed a sole perspective, and other examined a combination of two or the three perspectives. From the discussion of those perspectives, it is evident that there is a good level of satisfaction and acceptance of EDL among students and instructors, and this is because of its flexibility, convenience and low cost. In addition, it creates from them opportunities for upskilling and capacity building. However, number of challenges faced students and instructors when utilizing EDL have also been highlighted. The major challenges were lack of adequate technology infrastructure, technology literacy and increased workloads for instructors.

Regarding the educational institutions' administration dimension, It is obvious that many institutions around the world were unprepared for such sudden immigration to EDL, which resulted in issues of lack of access and lack of skills to make this type of learning beneficial and easy, among other reported challenges, however, it created a chance for innovation for those institutions. Consequently, institutions are now requested to have preparedness plans and contingency planning procedure to follow in case of unforeseen interruptions. Moreover, it is essential to create a sustainable and reliable educational ecosystem, in addition to risk management architecture with robust support.

To adequately analyze, synthesize and discuss those challenges reported on the literature, the authors shall undertake a comprehensive, more in-depth study of literature about the strengths, weaknesses, opportunities and challenges from the perspectives of students, instructors and educational administrators. Such study shall assist decision makers to develop successful strategic plans toward smooth and efficient transition to online distance learning in case of contingencies.

The second question that is addressed in this study was about different and the innovative methods and platforms utilized by different institutions to facilitate EDL. Social media platforms, especially WhatsApp were heavily utilized as an alternative method for teaching and learning during the Covid-19 lockdown. Other reported methods are MS Teams, Zoom, Moodle, Blackboard and specific Learning Management Systems. Some institutions combined more than one method to efficiently deliver the online material. Respectively, other institutions innovated their own EDL models and methods, like MyElearning and SIM SHARE. For futther reading about distance learning technologies across different domains, please refer to the following authors: (Ali, 2019, 2020; M. Ali, 2019; Ali M et al., 2018; Ali & Abdel-Haq, 2021; Ali & Edghiem, 2021; Ali et al., 2017; Ali, 2021; Ali et al., 2020a, 2020b)

Limitations

The limitation of this presented study basically lies in its nature as literature review study. The authors assume that the research approach used might exclude pertinent literature within other themes, languages, and scope and publication type. However, it shed some light on how EDL has been implemented as a response to the outbreak of Covid-19, in addition to the review of various and innovative methods, models and platforms adopted, which contributed to the ongoing research about EDL by reviewing the most recent articles in this regard. Furthermore,

the findings presented in this study highlights the existence of some gaps. Mainly, the research has discovered a pronounced need for more research on innovative digital/business models to implement EDL because considerable number of the selected studies didn't give details the implemented methods and majority of reviewed studies about the utilized methods and platforms were on the medical or medical related fields, without proper coverage of other disciplines. This may be because this field of study is still emerging. Additionally, the authors were planning to conduct more in-depth thematic analysis about the used theories and research methods in EDL research, but due to time constraints, it has not been included in this study.

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APPENDIX

Table 2. Details of the included publications

		No.	EDL Case Study	Title	Date	Type-of-Study	Country	Level
Perspective	**Domain**	1.	(Adedoyin & Soykan, 2020)	"Covid-19 pandemic and online learning: the challenges and opportunities"	2020	Qualitative	Global	Macro
S+I+A	N/A	2.	(Agarwal & Dewan, 2020)	An Analysis of the Effectiveness of Online Learning in Colleges of Uttar Pradesh during the COVID 19 Lockdown	2020	Quantitative	India	Meso
S+I	N/A	3.	(Ahmed et al., 2020)	Model for utilizing distance learning post COVID-19 using (PACT)™ a cross sectional qualitative study	2020	Qualitative	Middle East	Macro
I+A	Medical education	4.	(Al Lily et al., 2020)	Distance education as a response to pandemics: Coronavirus and Arab culture	2020	N/A	Arab world	Macro
N/A	N/A	5.	(Ali et al., 2020)	Impacts of Online Remote Education on the Learning Process among Nursing Students	2020	Quantitative	Egypt	Meso
S	Nursing	6.	(Almaiah et al., 2020)	Exploring the critical challenges and factors influencing the E-learning system usage during COVID-19 pandemic	2020	Qualitative	Arab world	Macro
S+A	N/A	7.	(Almarzooq et al., 2020)	Virtual Learning During the COVID-19 Pandemic: A Disruptive Technology in Graduate Medical Education	2020	Design	USA	Meso
S+I	Cardiology	8.	(Alqahtani & Rajkhan, 2020)	E-Learning Critical Success Factors during the COVID-19 Pandemic: A Comprehensive Analysis of E-Learning Managerial Perspectives	2020	Mixed	KSA	Macro
A	Multidisciplinary	9.	(Al-Taweel et al., 2020)	"Multidisciplinary academic perspectives during the COVID-19 pandemic"	2020	Qualitative	Kuwait and KSA	Macro
I	Multidisciplinary	10.	(Altwaijry et al., 2021)	Distance education during covid-19 pandemic: A college of pharmacy experience	2020	Mixed	KSA	Meso
S+I	Pharmacy	11.	(Alvarez, 2020)	"The phenomenon of learning at a distance through emergency remote teaching amidst the pandemic crisis"	2020	Qualitative	Philippines	Micro
S	N/A	12.	(Amir et al., 2020)	Student perspective of classroom and distance learning during COVID-19 pandemic in the undergraduate dental study program Universitas Indonesia	2020	Quantitative	Indonesia	Meso
S	Dental Medicine	13.	(Assunção Flores & Gago, 2020)	Teacher education in times of COVID-19 pandemic in Portugal: National, institutional and pedagogical responses	2020	Descriptive Study	Portugal	Macro
S+I+A	N/A	14.	(Aucejo et al., 2020) et al.,(2020)	"The impact of COVID-19 on student experiences and expectations: Evidence from a survey"	2020	Quantitative	USA	Meso
S	Multidisciplinary	15.	(Awuzie et al., 2021)	Facilitating Successful Smart Campus Transitions: A Systems Thinking-SWOT Analysis Approach		Quantitative	South Africa	Meso
A	N/A	16.	(Azhari & Fajri, 2021)	Distance learning during the COVID-19 pandemic: School closure in Indonesia	2020	Mixed	Indonesia	Macro
I	mathematics and science	17.	(Bozkurt & Sharma, 2020)	"Emergency remote teaching in a time of global crisis due to Corona Virus pandemic"	2020	Descriptive Study	Global	Macro
S+I	N/A	18.	(Chatziralli et al., 2021)	Transforming ophthalmic education into virtual learning during COVID-19 pandemic: global perspective	2020	Quantitative	Global	Macro
I	Ophthalmology	19.	(Chick et al., 2020)	Using Technology to Maintain the Education of Residents During the COVID-19 Pandemic	2020	Design	USA	Meso
I	Surgical training	20.	(Crawford et al., 2020)	"COVID-19: 20 countries' higher education intraperiod digital pedagogy"	2020	Qualitative	Global	Macro
A	N/A	21.	(Dampson et al., 2020)	COVID-19 and Online Learning: A SWOT Analysis of Users' Perspectives on Learning Management System of University of Education, Winneba, Ghana	2020	Mixed	Ghana	Meso
S+I	Education	22.	(Darras et al., 2021)	"Undergraduate Radiology Education During the COVID-19 Pandemic: A Review of Teaching and Learning Strategies"	2020	Exploratory	Global	Macro
S+I	Radiology	23.	(Dhawan, 2020)	Online Learning: A Panacea in the Time of COVID-19 Crisis	2020	Qualitative	Global	Macro
S+I+A	N/A	24.	(Dutta, 2020)	Impact of Digital Social Media on Indian Higher Education: Alternative Approaches of Online Learning during COVID-19 Pandemic Crisis	2020	Qualitative	India	Macro
S+I	N/A	25.	(El Firdoussi et al., 2020)	Assessing Distance Learning in Higher Education during the COVID-19 Pandemic	2020	Mixed	Morocco	Macro
S+I	Multidisciplinary	26.	(Elzainy et al., 2020)	Experience of e-learning and online assessment during the COVID-19 pandemic at the College of Medicine, Qassim University	2020	Mixed	KSA	Meso
S+I	medical education	27.	(George, 2020)	"Effective teaching and examination strategies for undergraduate learning during COVID-19 school restrictions"	2020	Descriptive study	Trinidad and Tobago,	Meso
S	Electrical and Computer Engineering	28.	(Hasan & Bao, 2020)	"Impact of e-Learning crack-up perception on psychological distress among college students during COVID-19 pandemic: A mediating role of "fear of academic year loss"	2020	Mixed	Bangladesh	Macro
S	N/A	29.	(Hayat et al., 2021)	Challenges and opportunities from the COVID-19 pandemic in medical education: a qualitative study	2020	Qualitative	Iran	Meso

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Table 2. Continued

		No.	EDL Case Study	Title	Date	Type-of-Study	Country	Level
S+I	medical education	30.	(Huang, 2020)	"Successes and Challenges: Online Teaching and Learning of Chemistry in Higher Education in China in the Time of COVID-19"	2020	Quantitative	China	Macro
S+I	Chemistry	31.	(Hudson et al., 2020)	The potential of a simulated workplace environment for emergency remote teaching	2020	Qualitative	South Africa	Meso
S+I	Radiology	32.	(Almansour & Al-Ahdal, 2020)	University Education in KSA in COVID Times: Status, Challenges and Prospects	2021	Quantitative	KSA	Macro
S+I	N/A	33.	(Ismaili, 2020)	Evaluation of students' attitude toward distance learning during the pandemic (Covid-19): a case study of ELTE university	2020	Quantitative	Hungary	Meso
S	N/A	34.	(Jes et al., 2020)	"Experiences of Nursing Students during the Abrupt Change from Face-to-Face to e-Learning Education during the First Month of Confinement Due to COVID-19 in Spain"	2020	Qualitative	Spain	Micro
S	N/A	35.	(Johnson et al., 2020)	"US faculty and administrators' experiences and approaches in the early weeks of the COVID-19 pandemic"	2020	Quantitative	USA	Macro
I+A	N/A	36.	(Kara et al., 2020)	"Using social media to support teaching and learning in higher education: an analysis of personal narratives"	2020	Qualitative	Turkey	Meso
S+I	N/A	37.	(Khalaf et al., 2020)	"Introducing a comprehensive high-stake online exam to final-year dental students during the COVID-19 pandemic and evaluation of its effectiveness"	2020	Quantitative	UAE	Meso
S+I	Dental Medicine	38.	(Kidd & Murray, 2020)	The Covid-19 pandemic and its effects on teacher education in England: how teacher educators moved practicum learning online	2020	Qualitative	England	Meso
S+I	Education	39.	(Kim, 2020)	"Learning and Teaching Online During Covid- 19: Experiences of Student Teachers in an Early Childhood Education Practicum	2020	Quantitative	USA	Meso
S+I	music education	40.	(Lassoued et al., 2020b)	An Exploratory Study of the Obstacles for Achieving Quality in Distance Learning during the COVID-19 Pandemic	2020	Quantitative	Arab world	Macro
S+I	N/A	41.	(Lemay et al., 2021)	Transition to online learning during the COVID-19 pandemic	2020	Quantitative	USA	Meso
S	Science	42.	(Longhurst et al., 2020)	Strength, Weakness, Opportunity, Threat (SWOT) Analysis of the Adaptations to Anatomical Education in the United Kingdom and Republic of Ireland in Response to the Covid-19 Pandemic	2020	Qualitative	UK+ Ireland	Macro
S+I+A	Anatomy	43.	(Maatuk et al., 2021)	The COVID-19 pandemic and E-learning~ challenges and opportunities from the perspective of students and instructors	2020	Quantitative	Libyia	Meso
S+I	IT	44.	(Mohmmed et al., 2020)	Emergency remote teaching during coronavirus pandemic: the current trend and future directive at Middle College Oman	2020	Qualitative	Oman	Meso
S+I+A	N/A	45.	(Mulenga & Marbán, 2020)	"Prospective Teachers' Online Learning Mathematics Activities in The Age of COVID-19: A Cluster Analysis Approach"	2020	Mixed	Zambia	Meso
I	mathematics and science	46.	(Novikov, 2020)	"Impact of COVID-19 Emergency Transition to On-line learning on International Students' Perceptions of Educational Process at Russian University"	2020	Mixed	Global	Macro
S	N/A	47.	(Otaki et al., 2021)	Introducing the 4Ps model of transitioning to distance learning~ A convergent mixed methods study conducted during the COVID-19 pandemic	2020	Qualitative	UAE	Meso
S+I	medical education	48.	(Sokhulu, 2020)	The use of digital technology at home during the COVID-19 outbreak: views of social work students in Greece	2020	Quantitative	Greece	Macro
S	Nursing	49.	(Patel et al., 2020)	Utility of a webinar to educate trainees on UK core surgical training (CST) selection – A cross sectional study and future implications amidst the COVID-19 pandemic	2020	Quantitative	United Kingdom	Macro
S	Surgical training	50.	(Pather et al., 2020)	"Forced Disruption of Anatomy Education in Australia and New Zealand: An Acute Response to the Covid-19 Pandemic"	2020	Qualitative	Australia and New Zealand	Macro
S+I+A	Anatomy	51.	(Nel & Marais, 2020)	"Preservice teachers use of WhatsApp to explain subject content to school children during the COVID-19 pandemic"	2020	Qualitative	South Africa	Meso
S+I	Education	52.	(Sathishkumar et al., 2020)	E-Learning during Lockdown of Covid-19 Pandemic: A Global Perspective	2020	Qualitative	India	Macro
S	N/A	53.	(Rizun & Strzelecki, 2020)	Students' Acceptance of the COVID-19 Impact on Shifting Higher Education to Distance Learning in Poland	2020	Quantitative	Poland	Macro
S	N/A	54.	(Rodriguez-Segura et al., 2020)	" Teaching Challenges in COVID-19 Scenery: Teams Platform-Based Student Satisfaction Approach"	2020	Quantitative	Mexicco	Meso
S+I	N/A	55.	(Sandi-Urena, 2020)	"Experimentation Skills Away from the Chemistry Laboratory: Emergency Remote Teaching of Multimodal Laboratories"	2020	Quantitative	USA	Meso
S	Chemistry	56.	(Calonge et al., 2022)	Contactless Higher Education: A SWOT Analysis of Emergency Remote Teaching and Learning during COVID-19	2020	Qualitative	Unassigned	N/A
I+A	N/A	57.	(Sharma et al., 2020)	Online Learning in the Face of COVID-19 Pandemic: Assessment of Students' Satisfaction at Chitwan Medical College of Nepal	2020	Quantitative	Nepal	Meso
S	medical education	58.	(Sokhulu, 2020)	Students' experiences of using digital technologies to address their personal research needs during the COVID-19 lockdown	2020	Qualitative	South Africa	Meso
S	Education	59.	(Soria et al., 2020)	"First-generation students' experiences during the COVID-19 pandemic"	2020	Quantitative	USA	Macro
S	N/A	60.	(Ustabulut, 2021)	SWOT Analysis for the Distance Education Process of Lecturers Teaching Turkish as a Foreign Language	N/A	Qualitative	Turkey	Macro
I	Turkish as a foreign language	61.	(Vielma & Brey, 2021)	Using evaluative data to assess virtual learning experiences for students during COVID-19	2020	Quantitative	USA	Meso

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Table 2. Continued

		No.	EDL Case Study	Title	Date	Type-of-Study	Country	Level
S	Biomedical Engineering and Chemical Engineering	62.	(Whittle et al., 2020)	"Emergency remote teaching environment: A conceptual framework for responsive online teaching in crises"	2020	Design	Global	Meso
S+I	N/A	63.	(Wotto, 2020)	The future high education distance learning in Canada, the United States, and France: Insights from before COVID-19 secondary data analysis	2020	Descriptive study	Canada, United States , France	Macro
A	N/A	64.	(Wyres & Taylor, 2020)	Covid-19: using simulation and technology enhanced learning to negotiate and adapt to the ongoing challenges in UK healthcare education	2020	Descriptive Study	United Kingdom	Meso
S+I	Healthcare	65.	(Zhang et al., 2020)	"Suspending Classes Without Stopping Learning: China's Education Emergency Management Policy in the COVID-19 Outbreak"	2020	Descriptive Study	China	Macro

S+I+A
N/A

Chapter 12
A Multidimensional Experience Perspective of Remote Online Education During the COVID-19 Pandemic

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ABSTRACT

The UK's higher education sector continues to be one of the most dynamic in the world, attracting 2,697,380 students by March 2021. The population of UK higher education students as a whole is extremely diverse and reflects a globalised version of contemporary higher education. Globalization, high-quality education, and increased competition for HE degrees have re-energized student migration, resulting in the formation of cross-cultural student environments at educational institutions worldwide. In essence, this culturally diverse higher education sector in the United Kingdom was expected to experience a range of effects from the COVID-19 pandemic crisis on students with asymmetric cultural backgrounds. This chapter provides a multidimensional experience of remote online education during the COVID-19 crisis.

INTRODUCTION

The United Kingdom's higher education HE sector remains to be amongst the most pulsating world-wide education sectors that attracted 2,697,380 students by March 2021 (HESA, 2021). The general characteristic of the UK's HE students' population is vastly diverse and represents a globalised version

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of contemporary HE. Globalization, high-quality education and the intensified competition for HE degrees have invigorated the relocation of students from one country to another which contributed to the formation of cross-cultural students' environments across educational institutions worldwide (Altbach, 2015). In essence, this culturally diversified HE sector of the UK expectedly received a variant impact of the Covid-19 pandemic crisis on students of asymmetric cultural backgrounds.

It is vital for HE students to remain motivated during education experience to focus on gaining subject knowledge and perform well in their coursework (Banks, 2009) which will pave the way for their planned career routes. The motivation of HE students is also important to help them retain information and participate in classroom activities. However, the Covid-19 pandemic caused a huge impact on HE institutions' operations, including the mode of sessions' delivery and engagement practices. This chapter sheds light on the unprecedented transition in the UK's HE sector, that was brought on by the Covid-19 pandemic crisis, and the factors of culture and intrinsic motivation are likely to shape up students' experiences. This transition was marked by the heavy reliance on remote online education facilitated by information technology applications.

CULTURAL DIVERSITY IN HIGHER EDUCATION

Culture is a complex construct and is defined extensively in the literature. According to Hofstede (2011) culture is the collective programming of the mind that distinct different groups of people one from another. However, within each group there may exist subgroups of distinctive conventions and behaviour. Cultural diversity, from another perspective, is featured by differences among individuals of varied backgrounds and ethnicities that are connected homogeneously (Banks, 2015). Cultural diversity has been highlighted as a positive factor and to play a vital role in organisations but the tendency in the literature is to focus on managing cultural diversity in business to drive growth rather than education institutions.

The understanding of the different values and beliefs of individuals and the way of interaction between them is essential for inter-cultural openness (Meer and Modood, 2012). According to Schwarzenthal *et al.* (2020), cultural diversity entices students to understand the values of other cultures and might help for improving their cross-cultural interaction. At the same time, cultural diversity can entail that crisis developments such as the Covid-19 pandemic are tolerated differently. The study of (Koul and Fisher, 2005) indicated a relationship between the cultural background of students and their differentiated perceptions of their surrounding environment. In relevance to the Covid-19 pandemic, the study of (Morris *et al.,* 2020) revealed that international students were enjoying their stay in another country during the pandemic but they were also experiencing financial difficulties.

Cultural background is advocated by Morera (2019) as an important factor that has a significant influence on students' views on learning. The cultural contexts of individuals and their educational backgrounds play an essential role, not only in their assignment preferences, but also in their adaptation and performance. The students within international educational institutions possess different learning experiences shaped by their cultural assumptions and expectations.

Cultural Experience

Alsubaie (2015) highlights the relationship between culture and education and presents some cultural issues that may appear in the classroom such as social communication and group activities. Although the study (2015) has highlighted the importance of flexibility and social support when dealing with students in multinational classrooms, it overlooked the importance of the influence of cultural issues on the motivation of students. As has been previously proposed by Wu *et al.* (2015), the transition from one country to another takes time and endeavour for adapting to the new environment as the length of time is different for distinct individuals. The research points out some of the problems encountered in the adjustment of higher education students but it is not focused on more specific variables like the educational and cultural background that may affect students' behaviour. The transitional experiences vary, depending on the ability of student to adapt and cope with the challenges when joining into a new cultural environment. The different groups respond to the cultural changes in different ways as some might feel typically enthusiastic when others can experience language difficulties and boredom. The cultural issues of HE students have also been explored by Parr *et al.* (1992) where concerns on cultural differences between the students in culturally diverse universities were noticed and the study explored cultural dimensions like individualism, competitiveness, and assertiveness. Jamaludin (2018) emphasized that both cultural orientation and sociocultural adaptation are the most significant variables that had an impact on students, their experiences as well as their future intentions. Moreover, this depends on the external stimuli that emerge such as Covid19, and the social restrictions that caused a significant change to the educational process.

STUDENTS' INTRINSIC MOTIVATION

Motivation is a complex psychological conception. It has been largely identified by DA and AR (2016) as the element that guides goal-oriented behaviour. Hallam *et al.* (2011) concluded that motivation and learning are deeply connected, and the lack of motivation hinders academic achievement. According to Henning *et al.* (2014), motivation to learn is deemed as the student's willingness to comprehend academic content and participate in academic activities.

There may be a range of different elements to impact students' motivation to learn and affect their engagement in-class activities. As stated by Ginsberg (2005) the levels of extrinsic motivation might have a negative impact on the performance and intrinsic motivation is considered as much more significant when it comes to achieving better academic results. For instance, international students are more likely to be externally motivated when they decide to study abroad as they are influenced by the poor quality of education and circumstances in their home countries (Henning *et al.,* 2014). However, extrinsic rewards like money and better conditions are not always an effective motivator for many students. Other factors such as social group behaviour and ethical and moral beliefs can impact the student's decision to participate in class.

The study of Lutfi *et al.* (2016) identified factors as family background, appreciation of completed studies, and gender stereotypes to result in poor performance and challenges in-class activities and discussions. The lack of cultural knowledge may be another barrier to motivation to learn according to the study of Hengyu (2016). Self-belief has been determined as vital for students' motivation and a link between self-belief and academic performance has been identified when students who possess a reduced level of self-belief achieved worse academic results (Edgar *et al.,* 2019).

Coutts *et al.* (2011) concluded that assessments might impact students' intrinsic motivation and mood and increases their tension and levels of stress. The formation of social groups for common learning and support may positively affect students' mood and decrease levels of stress. Nevertheless, each student has different assessment preferences which also affects their perceptions (Van de Watering *et al.,* 2008).

REMOTE ONLINE EDUCATION DURING COVID-19 DEVELOPMENTS

The Covid-19 pandemic brought dramatic changes across many sectors in the entire world where the higher education sector is no exemption; It has had a substantial impact on education systems and caused the closure of institutions worldwide (Daniel, 2020). From another perspective, the learning experience of higher education transformed in line with the Covid-19 pandemic developments. For example, Gopal *et al.* (2021) proposed a number of factors that shaped up students' experiences during online delivery implied by the pandemic such as the efficiency of tutors, sessions' content and tutors' feedback. Empirical evidence, such as in Holzer *et al.* (2021), revealed that academic competence during the Covid-19 pandemic's transition may be influenced by self-regulated learning that may also have an influence on students' psychological fulfilment and emotions.

Online learning is a multifaceted concept that could be commonly described as access to learning through online technology (Moore *et al.,* 2011). There are significant differences between the online learning satisfaction of students who have better technological skills based on the students with a lack of previous skills who are more likely to experience any kind of challenges during the online learning.

In view of the Covid-19 pandemic developments, higher education institutions have moved to remote learning and started using educational technologies to avoid difficulties and strains. The majority of studies on the Covid-19 impact on the higher education learning environment were focused on using video-platforms like Zoom and Teams and how it was used by students and lecturers. For instance, the study of Vandenberg and Magnuson (2021) indicated different Zoom opinions between faculty and students; the students were found to have experienced more technological and psychological barriers and were not satisfied at all. Scull *et al.* (2020), indicated that learning in online classes is slower than in on-campus learning. De Oliveira Dias *et al.* (2020) additionally revealed that most of students are not actively attending the online classes due to worse communication experiences.

The online participation of students has been investigated in Dascalu *et al.* (2021) where the monitored behaviour of the students before and after the Covid-19 pandemic indicated an increment in online participation. Further research has provided evidence that the levels of stress among students are significantly increasing due to the inability to afford the technology, such as the internet and computers, needed to fully receive the most of online education (Akpınar, 2021).The study (2021) concludes that even online learning is facilitating the education system during the Covid-19 pandemic, it is a primary element causing mental health issues. Other factors affecting students' learning experiences during the Covid-19 pandemic included unstable internet connection and repeated interruptions by family members (Salman *et al.* 2021).

A recent study by Middleton (2020) found that most of the students have been struggling to adapt with online learning and the changes caused by the pandemic. The study shows the importance of distance learning as it is the best solution in the current situation and this statement has been supported by many students.

DISCUSSION

Cultural differences are the distinct values and beliefs of individuals belonging to a specific ethnicity or a country that sets them apart from others. According to Stromquist and Monkman (2014), cross-cultural diversity provides valuable exposure to the students and enables them to understand the values and ideas of other cultures in addition to improving their cross-cultural communication. Cultural background is an important factor that has a significant influence on students because it guides their behaviour and learning (Chuenjitwongsa *et al.,* 2018). In relevance to their cultural background, students may appear to have different views on assignments and learning preferences (van de Watering *et al.,* 2008).The cultural diversity of students can be assessed by using the cross-cultural model of Hofstede as it incorporates the five dimensions of national culture (Foskett and Lumby, 2003; Dimmock and Walker, 2005; Banks, 2015; Velten and Lashley, 2018). Hofstede's model enables the identification of differences in beliefs and values of students belonging to different cultures and providing useful insight for managing such differences.

From another perspective and as per (Kourova and Modianos, 2010), motivation determines the willingness of an individual to perform a specific task with attentiveness. The motivation to learn is viewed by Brophy (2004) as a student's ability to enjoy and understand academic activities and to gain its learning outcomes. The motivation to learn can be classified into two kinds that are intrinsic and extrinsic (Brophy, 2004; Arpan and Santoso, 2016). Intrinsic motivation for learning can be simply denoted as the situation when the students are already interested in learning a particular subject driven by an internal driving force. Extrinsic motivation occurs when factors like recognition, in the form of a reward, encourage the students to participate in learning activities. External regulated motivation factors may not always encourage students' engagement, such as when Stirling (2014) found out that despite external motivation some students dedicated less effort and interest (Stirling, 2014)

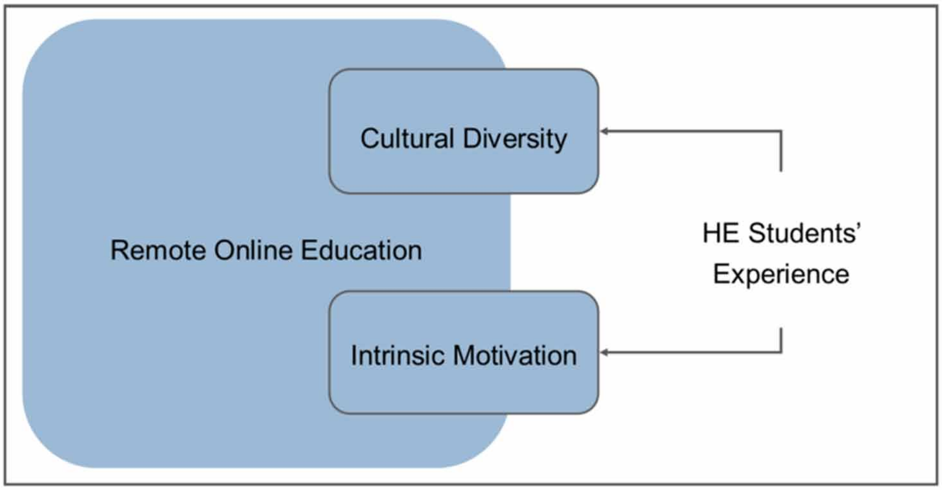
The Covid-19 outbreak is a worldwide challenge that has impacted the everyday life of the entire population (Fox *et al.,* 2021) and has caused significant strains to the UK's HE system that have resulted in dramatic changes. Since UK universities were not able to deliver the casual on-campus education, they were forced to urgently move to remote online education throughout two periods of lock-down. Universities had to make difficult decisions to adapt to this major transition (Ewing, 2021). Similarly, UK HE students faced multiple challenges such as transitioning and being accustomed to new remote online education models of learning, lack of in-person communication and the uncertainty of future developments. Such problems, to some extent, may still persist during the post Covid-19 transition that is marked by a hybrid delivery model combining both on-campus and remote online education.

There has been substantial research on HE students' motivation in view of the impact of their exposure to a cross-cultural environment but there is a recognisable paucity in the research looking into how these factors affected HE students during experience during remote online learning implied by the Covid-19 pandemic.

CONCLUSION

There have been multiple studies to investigate the students' experiences during the Covid-19 pandemic. However, these previous studies don't explore the UK HE students' experiences by adopting a multidimensional approach. In relation to coping with remote online education, most studies focus on traditional aspects of how students and educators cope with remote online learning technology but overlook the

Figure 1. Multidimensional factors affecting remote online education



diversity amongst HE students and how this would affect their experiences of online education. For instance and in a highly diverse HE sector such as in the UK, international students may respond differently to the remote online education model that was pushed forward by the Covid-19 developments. Cultural differences between home and international HE students has been proven to impact students' experiences differently Hari (2021).

Individual factors may also have variable impact on students' experiences of remote online education. Differences in technological skills (Salman *et al.,* 2021) along with varied perceptions self-belief and confidence (Chue *et al.,* 2016) shaped up students' learning experiences at an individual level. In essence, different factors that have an impact on students' motivation during the Covid-19 pandemic have been considered by several authors but limited focus has been given to how these factors might influence different ways of learning, behaving, and communication of students within the remote online education model.

Due to its infancy, the current literature on how students experienced remote online education during Covid-19, and now post Covid-19, developments adopts a generic viewpoint and does not sufficiently recognise the impact of cultural and individual peculiarities. We propose adopting a synthetic approach to investigate the implications of culture and intrinsic motivation factors; in our conceptual framework, depicted in Figure 1, we propose that the remote online learning experience of HE students in diverse educational environments is likely determined by cultural and intrinsic motivation factors. For further reading of similar innovations applied in this domain, please refer to the following studies (Ali, 2019, 2020; M. Ali, 2019; Ali M et al., 2018; Ali & Abdel-Haq, 2021; Ali & Edghiem, 2021; Ali et al., 2017; Ali, 2021; Ali et al., 2020a, 2020b).

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Chapter 13
Mobbing and Word-of-Mouth Communication (WOM) in the Digital Age:
An Application of Crisis Situations in Maritime Organisations

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ABSTRACT

Businesses today face more intense competition than in the past as a result of advancements in information and communication technologies. Supporting employees and developing positive relationships with their managers are critical for the organization's and employees' performance. Mobbing behaviour, which is prevalent in the workplace, has a detrimental effect on employees' performance and motivation. The purpose of this chapter was to assess an organization's mobbing behaviour from a management and marketing perspective and within the context of crisis management. The chapter also aimed to determine whether employee exposure to mobbing results in a significant difference in word-of-mouth communication (WOM). The research concluded that employee exposure to mobbing resulted in a significant difference in WOM.

INTRODUCTION

"In today's world, "an effective crisis management" takes its ship to safe harbors."

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Workplaces are areas where employees socialize, interact, develop their potential, work in teams and be happy. In peaceful and healthy organizations, a climate of enthusiasm, joy, sharing, effective communication, freedom of thought, feedback and suggestion systems and a high level of synergy prevails (Kılıç, 2019). However, in some organizations, contrary to this mentioned climate, employees are exposed to emotional violence, namely *mobbing*. The phenomenon of "emotional violence (mobbing)" has recently emerged globally for the last 30 years as one of the primary problems of many businesses in many fields. The outcomes of the exposure to mobbing, not only affects their social lives and families, but also their societies and businesses interests. It was only in the early 1980s that mobbing in the workplace began to be defined and systematically analyzed by Heinz Leymann, who used the term "mobbing" to describe workplace terror (Leymann & Gustafsson 1984). However, although the phenomenon of mobbing in the workplace is very old in all societies, it is well hidden due to its inconspicuous nature and there are great problems in determining its characteristics and dimensions (Brodsky, 1976; Olweus, 1978). The process of mobbing in the workplace has dramatic effects on workers, employees, their families, the organization, but also looking from the general overview mobbing has permanent effects on society (Chappell & Di Martino, 2006).

The concept of mobbing in organizational literature was used by Leymann (1996) in the 1980s. Leymann researched people who were reported to him as "difficult people" at work. He determined that these were not difficult people in the beginning, that the structure and culture of the workplace branded these people as "difficult" and created reasons to fire them. Mobbing is defined as the systematic exposing of one or more people in the workplace to emotionally damaging behaviors by one or more people every day and for several months (Leymann, 1996). Tutar (2004), on the other hand, defines mobbing as "all kinds of ill-treatment, threats, violence and humiliation behaviors systematically applied to employees by their superiors, subordinates or those at an equal level". In addition, according to Leymann (1996), in order for a behavior to be described as mobbing, that behavior must be repeated at least once a week for six months (Leymann, 1990; Davenport et al., 2003; Zapf et al., 1996; Çobanoğlu, 2005). In this regard, Leymann defined 45 different mobbing behaviors and grouped them into five groups. These groups are as follows: 1) Behavior threatening communication: The victim (who is exposed to mobbing) is limited in his ability to show himself by his superior, he is constantly interrupted, he is shouted at in the face in front of other employees, he is scolded publicly, and his work is constantly criticized. 2) Behavior threatening social contacts: The people around the victim do not talk to him anymore, the victim is prevented from reaching others, he is treated as if he did not exist in the environment. 3) Behavior threatening personal reputation: People talk badly behind the victim's back, false rumors circulate, ridicule, and sexual innuendo. 4) Behavior threatening occupational situation: There are no special duties for the victim, previously given jobs are taken back, meaningless jobs are given to work, his job is constantly changed, his personal belongings are damaged. 5) Behavior threatening physical health: The victim is physically forced to do hard work, is subjected to threats of physical violence, physical harm, and direct sexual harassment. Mobbing is divided into two as horizontal or vertical (bottom-up-top-down). This situation is related to the culture and hierarchical structure of the organization. If the hierarchy is high, mobbing usually occurs vertically, if low, horizontal mobbing occurs (Davenport et al., 2003). *Top-down Mobbing:* In top-down mobbing, there is a mobbing phenomenon that a supervisor or manager applies towards his subordinates with behaviors that can be associated with excessive use of his power by taking advantage of the position brought by his professional role (Tınaz, 2011). *Bottom-up Mobbing:* It is a type of mobbing more likely to occur in highly competitive organizations. It is realized by behaviors such as not fulfilling or delaying the tasks given by the manager, questioning the decisions he has taken, and searching for his faults by large groups (Şimşek, 2009). It is a type of mobbing used to dismiss senior managers who are disliked by subordinates or to pacify them in the working environment. Mobbing is usually carried out by groups of people as opposed to single individuals. Those who apply mobbing use the exclusion strategy in order to put the person in a difficult situation against the senior management of the institution. *Horizontal Mobbing:* It is the type of mobbing that occurs between employees in the same position. The perpetrators and the victims of mobbing are usually colleagues in the same position with similar duties and similar opportunities (Atman, 2012). As it is understood from the factors mentioned above, "mobbing" briefly; it is a systematic psycho-terrorism that starts with any kind of ill-treatment and disturbs the victim for any reason, regardless of age, race, gender, belief, or nationality. Therefore, the risk of being exposed to "mobbing" applies to everyone. A person who has achieved significant success, earned the appreciation of superior or direct management, or the praise of a client can easily be envied by their co-workers. All kinds of games are played behind the individual's back, rumors are spread, and his work can be sabotaged (Mimaroğlu & Özgen, 2007).

It is seen that there are many different definitions of word of mouth communication (Goyette et al., 2010; Dellarocas, 2003), which is one of the oldest ways of information transfer. Word of mouth communication, which is generally explained by communication and relationship factors, is expressed in terms such as personal suggestions according to Arndt (1967), interpersonal communication according to Godes and Mayzlin (2004) and Keller (2007), and informal communication according to Silverman (2001). Word of mouth communication, which is perhaps one of the oldest forms of marketing communication, is used to describe positive or negative verbal communication between groups such as experts, family and friends, potential consumers (Ennew et al., 2000: 75). WOM is a low-cost and reliable source of information for the exchange of ideas (Harrison-Walker, 2001; Mazzarol et al., 2007). Since WOM is not under the direct control of the organization, it can provide positive or negative information (Sun et al., 2013). It can also provide more reliable information as it is an independent source from the company (Van Hoye, 2008). In this context, studies examining the relationship between mobbing (Tınaz, 2006) and WOM, which can occur in all workplaces regardless of cultural differences, and which can be exposed to everyone, studies examining the relationship between mobbing and WOM have not been found in the literature. The concept of mobbing is a multidimensional process. For this reason, the relationship between the concept of mobbing and WOM in general was examined in order to give a perspective to the literature. This study was carried out for the employees of a maritime organization in an important international port and port city in Turkey.

MOBBING, BULLYING AND HARASSMENT AT WORKPLACE

In these terms, '*bullying at work'* comes forward from power struggle across different levels. Frankly, *bullying at work* has emerged through competition over entitlements in a globalized business world. (McCarthy, 2003). Bullying in any form, regardless of whereabouts it is undergone, is not acceptable in respect of its effects on mental and physical well-being, work-life balance, productivity, pride and dignity. Employees try to stay ahead of their competitors by developing many different tactics such as slandering their colleagues to their superiors, claiming false recognition for the work that others have accomplished, and pretending to be working to show themselves. Established good business relations, commitment to the job and the company are replaced by new trends and the newest of these movements is the policy of emotional pressure and intimidation applied to the employee in the workplace, which is referred to as "mobbing" in the literature (Mimaroğlu & Özgen, 2007). The aim of the "mobbing" behavior is to force the victim to leave their employment by creating systematic pressure on the person or persons in a workplace, destroying the work performance and endurance with an unethical approach.

Factors Causing "Mobbing" in Organizations

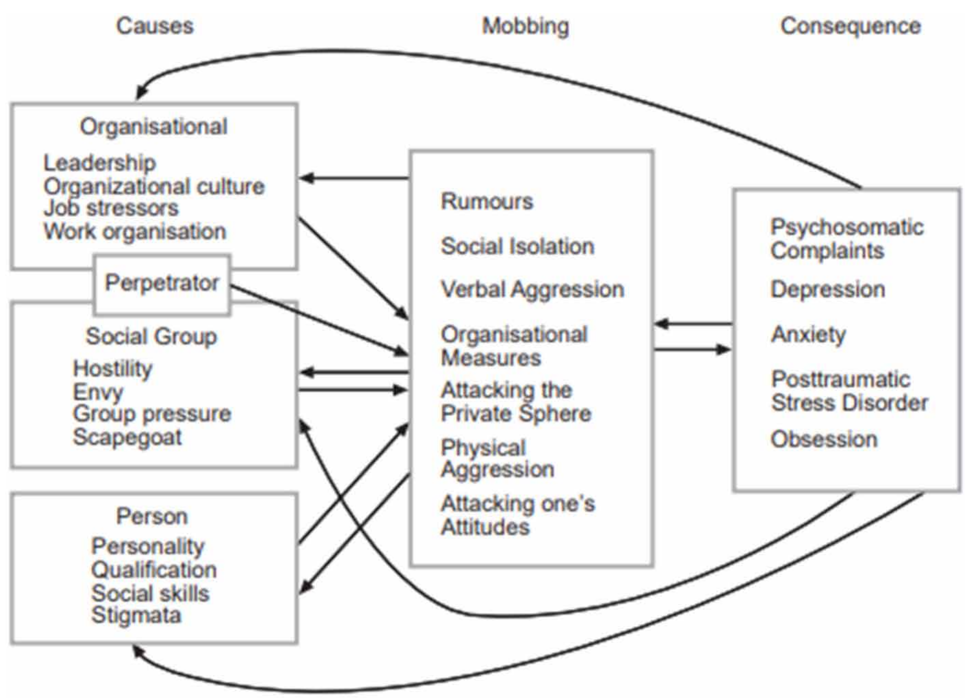
Leymann (1993), based on his interviews with the victims, mentions the ambiguity of the job design, the inadequacy of the leader, the social inadequacy of the victim, and the low ethical values in the organization as the four distinctive features that cause "mobbing" in organizations. In general, in organizations, it is possible to list the main reasons that push employees to group against individuals as follows (www.insankaynaklari.com/cn/ContentBody.asp?BodyID= 3489; www.canaktan.org/yonetim/psikolojik-siddet/kaynaklari.htm): **Loss of ethical values:** Organizations where unethical behaviors are accepted as normal, and some values have already been lost are ideal environments for "mobbing" to occur. **Radical changes in the organizational structure:** Unexpected changes in the managerial structure of the organization create new status differences among the employees, some dismissals and new hires create unpleasantness among the employees. In such cases, it is possible to encounter "mobbing". **Operational and functional commitment:** There is a functional commitment between some organizational jobs and the people who do these jobs. For example, the Human Resources department has a functional advantage over the employee, while the accounting department has a functional advantage in financial matters. This operational and functional superiority and dominance may cause disagreements and even conflicts between other units and employees from time to time. **Sharing of resources:** The competition of the employees of the organization with each other in resource sharing can cause conflicts, which paves the way for "mobbing". **Goal differences:** Individuals, groups and units in the organization have different goals and have different goals, causing organizational conflict, thus accelerating the formation of "mobbing". **Perception and interpretation differences:** Individuals, groups and interpretation of organizational issues, events and problems with different perceptions by the departments creates conflict and increases the possibility of "mobbing". **Communication barriers:** Factors that prevent communication may cause differentiation in goals and groupings and conflicts of employees who share similar goals. **Managerial uncertainties:** The fact that the command-command line, duties, authorities and responsibilities are not clearly defined in writing can cause conflicts between employees, groups and departments. **Management styles:** The authoritarian management style applied by the executives may lead to vertical "mobbing", and an exaggerated democratic management style can lead to horizontal "mobbing". **Lack of emotional intelligence:** Especially the failure of the people who have assumed the leadership task to behave towards their employees escalates the tensions in the organization, prevent the formation of a peaceful environment and invite "mobbing". **High degree of stress in the workplace:** The work environment and the work itself causes stress, which can lead to strained relations between employees. An employee who disrupts his/her work may be reacted to by others or be taken against him because of a superior success. **Monotony in the workplace:** It can also be seen that people who are bored of going to the same place every day and doing the same things apply "mobbing" just to add a little color to their routine life, to make gossip material and to keep themselves busy. **General characteristics of organizational members:** When looking at the profile of "mobbing" in organizations, it is seen that women are generally exposed to more "mobbing" than men and experience the psychological effects of "mobbing" more (Björkqvist, Österman, & Hjelt-Back, 1994). When examined in terms of age distribution, it is seen that older employees are more exposed to mobbing than younger employees

(Einarsen & Skogstad, 1996). "*Mobbing*" victims draw attention as employees who do their job very well, who do not compromise on their working principles and values, who are honest, reliable and who identify with their work (Zapf et al., 1996). The basic personality traits of "mobbing" perpetrators are defined by Davenport, Schwartz, and Elliott (2003), as over-controlling, irritable, always wanting to be strong, antipathic, narcissistic, self-centered, prejudiced and trying to make their own norms an organizational policy.

Causes and Consequences of Mobbing

Briefly, the factors that cause "*mobbing*" in organizations as shown in Figure 1, it is possible to divide them into three: *organizational reasons* such as inadequate leadership, poorly structured organizational culture, problems in organization and stressful work, *reasons originating from the social group* such as hostility, jealousy, being under the influence of the group, and *personal reasons* such as personality, characteristics, skills and physical defects. Mobbing can lead to various health problems such as depression, anxiety, obsession, stress disorder etc. On the other hand mobbing can also follow comportments such as rumors, social isolation, verbal and physical aggression, attacking one's attitude.

Figure 1. Causes and consequences of mobbing
Source: Zapf, 1999



Organizational Policies of Coping with Psychological Violence

Organizational response has a significant place in the organization between workplace mobbing and depressive symptoms among the victims (Kim et al, 2019). Undoubtedly, the most important responsibility in dealing with "mobbing" falls on organizations. In order to prevent and/or prevent psychological harassment in the workplace, the following measures should be implemented first. The policies that organizations are advised to follow regarding mobbing are as follows: 1) Workplaces need to employ "*real leaders*" in order to prevent mobbing 2) Top management and Human Resources Management department of organizations need to seek for policies to head off *psychological harassment* 3) Written rules, notice of information and brochures informing the outcomes of mobbing in the organizations should be circulated 4) Training and information activities should be conducted for employees, white and blue-collar workers 5) The executives should develop methods for the investigation of mobbing incidents in accordance with its own business structure, disciplinary sanctions and rehabilitation measures must be taken for those who attempt mobbing in the workplace 6) Complaints of psychological harassment in workplaces should be taken into account and fair solutions should be developed 7) Employees exposed to mobbing need to be felt as important as the mobbing actors regardless their title 8) In the measures to be taken to prevent psychological harassment in the workplace, in order to establish environment of trust special attention should be paid to the "protection of confidentiality" in the investigation 9) It is necessary to frequently conduct satisfaction surveys to managers and their subordinates and question whether they are exposed to mobbing or not 10) Undoubtedly, one of the most effective ways to deal with mobbing is to enable the mobbing actor to look at the event from the eyes of the victim, in other words, to establish "*empathy*" 11) One of the important functions of organizational leadership is to create a shared vision that guide the employees of the organization. Thanks to the shared vision, it is clearly stated that attitudes and behaviors that do not coincide with the basic goals and values of the institution have no place in the organizational climate and culture. It is the leader's duty to establish an understanding that condemns attitudes and behaviors that disrupt organizational health and do not contribute to organizational synergy.

MOBBING AND CRISIS MANAGEMENT

"Crisis" is a tension situation that is unexpected and unpredictable, requires a quick response, and threatens the goals, objectives, plans, strategies, and assumptions of the organization by rendering the prevention and adaptation mechanisms ineffective (Tutar, 2011). In order to minimize the negative effects caused by a crisis situation and even to turn the negativity created into an opportunity, an important responsibility falls on the business leaders, managers, human resources and top management both in the pre-crisis period when the crisis signals are received, during and after the crisis. If the risks are not managed and minimized correctly, the emergence of a crisis is inevitable. For this reason, organization managers' need to manage the crisis phenomenon with the right strategies (Kılıç, 2019). In this context, in the event of a possible situation that may result in a crisis, managers should implement a planned and programmed crisis management, without jeopardizing the existence of the business and by overcoming this process with the least loss, or if possible, by turning the crisis into an opportunity Otherwise, the crisis may damage the structure of the enterprises or collapse the organization (Güney, 2020). Weick (1988) defines crises as low-probability high-consequence events that threaten an organization's most

Table 1. An array of organizational crises

An Array of Organizational Crises
Extortion Bribery
Hostile takeover Information sabotage
Product tampering Workplace bombing
Vehicular fatality Plant explosion
Copyright infringement ***Sexual harassment***
Environmental spill Escape of hazardous materials
Computer tampering ***Mobbing***
Security breach Personnel assault
Executive kidnaping Assault of customers
Work-related homicide Product recall
Malicious rumor Counterfeiting
Natural disaster that disrupts a Natural disaster that destroys corporate headquarters
major product or service Natural disaster that eliminates key stakeholders
Natural disaster that destroys
organizational information base

Source: Pearson, C. M. and Clair, J. A.,1998.

fundamental goals. Pearson and Clair (1998), on the other hand, presented the various types of crises that can affect organizations in the table below:

As it is seen in Table 1, mobbing, malicious rumor and sexual harassment are some of the consequences of organizational crises. According to Demirtaş (2000), if the signals of the impending crisis could not be taken, evaluated and healthy reactions could not be given, entering the crisis period has become inevitable. The crisis period consists of the emergence of the crisis, the attack and the rescue phases. In this period, the effects of the crisis cannot be ignored. During the crisis, previously used methods and applications cannot be used and the crisis creates its own characteristics and dynamics (Pira & Sohodol, 2015).

Gigliotti and Ronald (1991) defined crisis management as an organization's ability to deal with emergency operations quickly, efficiently and effectively to reduce the threat to human health and safety, loss of public or corporate property, and adverse impact on normal business or operations (Pheng et al., 1999). An effective Business Continuity Management framework is also recommended to include an up-to-date and detailed Crisis. This approach includes the threat scenarios to be determined specifically for any sector and organization and the preparation, response and evaluation steps against them. In these uncertain times of crisis, it is very important for organizations to understand the potential impact of this threat for employees, customers and business partners and to take action quickly. Crisis management, on the other hand, is a systematic process that the business maintains within the framework of minimizing the losses of all its stakeholders by ensuring that it continues its daily activities (Pearson and Clair, 1998). The difficulties, stress and challenges posed by the crises contain more wisdom, and the difficult conditions created by the crisis play an important role in the emergence of leaders (Bennis, 2003).

Financial and any type of distress, which occurs especially during crisis periods, may also play a triggering role in conflicts between people as an individual stress factor, and consequently it can turn into a mobbing factor. Mobbing, which is sometimes caused by the crisis management experienced by the employees, may not be ended without the intervention of the law. However, legal decisions can be made based on evidence. In order to resolve the issue of psychological violence, it is first necessary to determine whether the conflict arises from personal reasons or from the workplace environment or management style (Hirigoyen, 1998). It is very important to have a human resources department in organizations and to implement effective policies during crisis management by developing sensitivity about psychological violence as well as the department's effort to fulfill its human resources management function effectively. It is important to establish a crisis management system and to create a crisis management team among the preventive practices in the way of crisis resolution.

MOBBING AND WOM

Supporting the employees by the organization and establishing good relations with their managers are vitally important for the performance of both the organization and the employees. It is stated that large or small companies need to pay more attention to mobbing in the workplace because it significantly affects the performance of the employee (Divincová & Siváková, 2014). Therefore, it is clear that mobbing behavior, which is common in working life, will cause negative effects on the performance and motivation of employees. In the marketing literature, employees are seen as internal customers. External customer satisfaction depends on internal customer performance (Çoban & Nakip, 2007). When evaluated in terms of service profit chain, internal customer satisfaction is also necessary for the success of businesses (Heskett et al., 1994). In addition, the negative experiences of customers motivate them to share this situation with others (Anderson 1998; Philip & Ashworth, 2013). Considering that people interact and communicate more with each other in the digital age, exposure to mobbing has negative physical or psychological consequences on employees (Layman, 1996; De Pedro et. al., 2008) and in terms of organizations, it can cause negativities and loss of image (Veinhardt & Sroka, 2020). WOM studies, which are generally conducted in the field of consumer behavior, have also been conducted in the context of organizational attractiveness for employees (Uen et al., 2013; Van Hoye et al., 2013; King et al., 2014). However, studies in this area are also limited. Collins and Stevens (2002) found that WOM has a strong influence on intentions and decisions. Van Hoye and Lievens (2007) concluded that negative WOM has a greater effect on organizational attractiveness than positive WOM. It is also stated that negative WOM may have a stronger effect on self-development than positive WOM (Chawdhary & Riley, 2015). Potential employees are able to process negative WOM more strongly and further strengthen negative impressions about the organization (Sun et al., 2013). However, it is stated that WOM referrals can be managed by strengthening the perceived corporate prestige of the employees (Uen et al., 2013). In addition, in the context of signal theory and brand equity, it is stated that the negative signal strength with negative WOM may vary depending on the employer's image and reputation, which is conceptualized as brand equity (Stockman et al., 2019). In this context, the necessity of investigating the relationship between the exposure of employees to mobbing and WOM becomes evident.

MATERIAL AND METHOD

Purpose, Model and Hypothesis of the Research

In the study, mobbing behavior was evaluated from the perspective of management and marketing. For this reason, it is aimed to determine whether the exposure of employees to mobbing causes a significant difference on WOM. The research model is shown in Figure 2.

Figure 2. Crises research model
Source: Authors

In the study, the following hypothesis is suggested within the scope of the literature mentioned in the mobbing and WOM section.

H: Mobbing exposure of employees causes a significant difference on WOM.

METHOD

The sample of the research consists of 409 people working in the Turkish branch of an international maritime business. Research data were collected between the dates of 01/02/2021 –01/05/2021 with convenience sampling method. The questionnaire form consists of two parts. In the first part of the questionnaire, 5-point Likert type was prepared as: 1: Strongly disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree. These questions consist of statements that measure WOM for the participants. In the second part, questions prepared to determine the demographic characteristics of the participants and their exposure to mobbing are listed. Frequency and percentage distributions were determined in the questions prepared for the demographic characteristics of the participants. The demographic characteristics of the participants in the study are shown in Table 1.

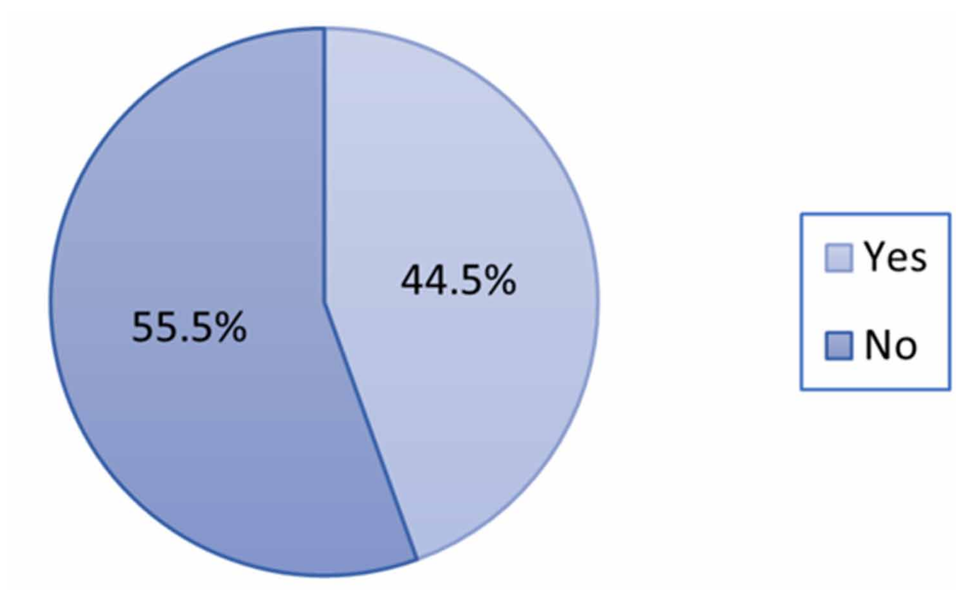
In Table 2, it is seen that the distribution of the number of women (108) and men (301) participating in the research within the sample is not close to each other. This situation can be explained by the rate of female employment in the sector. 49.6% of the participants are single and 50.4% are married. When the educational status of the maritime sector employees participating in the research is examined, the majority of the participants are university graduates with a rate of 54.8%. It is seen that 64.8% of the participants are 26-40 years old, 22.2% are 18-25 years old and 13% are over 40 years old. Considering the income levels, 36.4% of the participants have an income of 301-500$, 34.7% of them 150$-300$,

Table 2. Frequency and percentage distributions of the participants' demographic characteristics

Age	N	%	Gender	N	%
18-25	91	22.2	Female	108	26.4
26-40	265	64.8	Male	301	73.6
40 +	53	13.0	**Marital status**	**N**	**%**
Experience (Years)	**N**	**%**	Married	206	50.4
0-1	118	28.9	Single	203	49.6
2-5	209	51.1	**Education**	**N**	**%**
6-10	60	14.7	High school	139	34.0
10 +	22	5.3	College	224	54.8
Position	**N**	**%**	Graduate	46	11.2
Staff	205	50.1	**Income (Monthly-$)**	**N**	**%**
Head	65	15.9	150-300	142	34.7
Specialist	74	18.1	301-500	149	36.4
Engineer	65	15.9	501-1000	78	19.1
			1000+	40	9.8
Total				409	100

Source: Authors

Figure 3. Mobbing exposure status
Source: Authors



19.1% of them 501-1000 and 9.8% of them have an income of 1000$. 50.1% of the participants work as staff/personnel, 18.1% as specialists and 15.9% as heads and engineers. 51.1% of the employees have work experience of 2-5 years, 28.9% of them 0-1 years, 14.7% of them 6-10 years and 5.3% of them have work experience over 10 years. In summary, the majority of the maritime business employees participating in the research are male and consist of university graduates. The majority of them have 2-5 years of work experience in their organization. In addition, it can be said that the majority of them are people aged 26-40 and have an income of 150-500. Figure 3 shows the percentage distributions related to the mobbing exposure of the participants in the research.

In Figure 3, approximately 45% of the respondents think that they have been exposed to mobbing in the organization they work for. In the study, only the general exposure to mobbing was examined. In this sense, no information was requested from the participants about the type of mobbing they were exposed to.

RESULTS

The data obtained within the scope of the research were analyzed with the IBM SPSS Statistics 24 package program and a reliability analysis was applied. In order to ensure the validity of the scales, factor analysis was applied and factor values of 0.50 and above were taken into account (Yaşlıoğlu, 2017). Table 3 shows the frequency, percentage distributions, arithmetic averages and the general alpha value obtained as a result of the reliability analysis of the responses to the WOM scale.

Table 3. Responses to the WOM scale

	1		2		3		4		5		Mean	Alpha
	F	%	F	%	F	%	F	%	F	%		
WOM1	75	18.3	46	11.2	131	32.0	114	27.9	43	10.5	3.01	0.857
WOM2	76	18.6	68	16.6	97	23.7	105	25.7	63	15.4	3.03	
WOM3	70	17.1	60	14.7	125	30.6	99	24.2	55	13.4	3.02	
WOM4	78	19.1	44	10.8	98	24.0	117	28.6	72	17.6	3.15	

Source: Authors
1: Strongly disagree 2: Disagree 3: Neutral 4: Agree 5: Strongly Agree
F: Frequency

In Table 3, it is seen that the arithmetic averages of the scale items are 3.01, 3.03, 3.02 and 3.15, respectively, and the general alpha value is 0.857. Within the scope of the research, t-test was applied to discover whether the exposure of employees to mobbing causes a significant difference on WOM. The results are given in Table 3.

The p value showing whether there is a significant at the 0.05 level significant difference between the mobbing exposure of the maritime organization employees participating in the research and the WOM, was found 0.002. In Table 4, it was determined that there was a significant difference between the mobbing exposure of the participants and the WOM. Therefore, the research hypothesis was supported.

Table 4. Hypothesis test result

Exposure to Mobbing	N	Mean	t	p
Yes	182	3.2404	3.163	.002
No	227	2.9009		

Source: Authors

FUTURE RESEARCH DIRECTIONS

Future studies need to be carried out considering that mobbing and organizational silence are intertwined and in order to eliminate business blindness, specific training should be given to concerned parties. Furthermore, efforts need to be made to minimize employee's exposure to mobbing, to treat feelings of personal failure as well as to eliminate low job satisfaction. Regardless of the level of an organization in shipping industry, to benefit from highly effective human resources, serious consideration of the thoughts, opinions and concerns of the employees need to be considered at management level. Otherwise, employees would tend to share their negative experiences (WOM) with others. Considering that people interact and communicate with each other on a global scale, especially as a result of developments in information and communication technologies, the concept of mobbing and WOM emerges as a subject that needs to be emphasized more. Considering the effectiveness of today's interaction of people on digital platforms, organizations need to pay attention to their approach towards their employees in order to prevent them from having a bad image and reputation. Therefore, it is expected that the study will present an idea to both the sector and the literature in this context.

CONCLUSION

As a result, in order to prevent mobbing from happening, it would be appropriate for managers to keep communication channels open and create platforms such as employees' listening room and so on where employees can express themselves. In addition, instead of an approach that prioritizes discipline in which authoritarian, rude & solid comportments and emotional violence is experienced; it is appropriate to create a soft organizational climate that is open to positive new ideas. A crucial act in the prevention of workplace mobbing is the sustainable education and training of managers, supervisors, management executives and bosses in human resources, crisis management and conflict at work. It is also essential to advise employees of the organization through seminars and lectures therefore employees can notice work harassment behavior "*mobbing*" at the right time. It is recommended to establish internal rules and procedures regarding mobbing and to continue these regulations under the control of executive management. Although it is seen in the literature that WOM studies for employees are conducted in the context of organizational attractiveness, it is noteworthy that studies on this subject are limited. In addition, mobbing is a multidimensional concept. For this reason, the study aims to contribute to the literature by examining the relationship between mobbing and WOM in general. In this context, it is important to remember that internal customers - employees who are exposed to mobbing - share their negative thoughts about the organization with their environment. In particular, as a result of the opportunities provided by information and communication technologies, employees spend more time in digital environments and interact and communicate with each other through digital applications. For this reason, it is thought that businesses need to pay more attention to the phenomenon of mobbing.

"If the crisis is managed correctly, it becomes the springboard of development."

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KEY TERMS AND DEFINITIONS

Digitalization: The digitalization of different areas of production and service sector means that the work that was previously done manually or by people is done entirely or to a certain extent by programmed machines. It is also called Capitalism or the fourth industrial revolution. Digitization is the transfer of accessible information to any computer, smartphone, tablet, etc. It can be defined as the name given to the process of transferring it to digital media so that it can be read by technological tools, edited in those environments, and included in workflows.

Maritime Organization: Maritime businesses management section covers maritime-related management and administrative activities. The maritime business management department is an academic department that aims to train individuals who are competent in ship management, maritime law, logistics, ship-related finance, or supply chain management. Maritime businesses include many subjects and businesses from maritime businesses to maritime activities, from ship financing to human resources management.

Mobbing: "Mobbing," which is referred to as "bullying, emotional harassment or intimidation" applied in the workplace, long-term systematic pressure exerted by the person or group in power on others, especially in hierarchically structured groups and in organizations where control is weak, is defined as creating emotional attack and attrition. False accusation is defined as malicious attempts to discredit, humiliate, and force a person to quit their job, by direct or indirect violence, through hearsay.

Word-of-Mouth Communication: Word-of-mouth communication is defined as positive or negative verbal communication between groups such as experts, employees, family members, friends and current or potential customers, independent of the forwarding. The literature underlines that word-of-mouth communication is a very effective factor in the decision of employees' positive or negative thoughts about their organization.

Chapter 14
Exploring How Artificial Intelligence (AI) Can Support Start-Ups to Manage Crisis Situations for Future Sustainable Business in the Agri-Food Industry

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ABSTRACT

The agri-food industry is in the midst of a massive crisis due to low economic growth and production. Recently, the adoption of several AI technologies has aided farmers in producing thousands, thereby reducing human intervention in food production. The components of artificial intelligence, which include learning, perception, problem solving, and reasoning, have aided the agri-food business industry in identifying sustainable models for crisis management. In this chapter, the author proposes a four-stage strategic roadmap for addressing the challenges associated with implementing artificial intelligence to manage crises in the agri-food business.

INTRODUCTION

The implementation of AI technology within the agri-food industry is not a common element across the globe. Hence, the implementation of AI technology within the agri-food industry can be identified as an exception (Di Viao, 2020). However, implementing this advanced technology can be helpful for different tasks such as analysing the weather forecast, business analytics and establishing effective supply chain management (Ibáñez and Blázquez, 2021).

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According to recent research, it can be understood that the use and popularity of AI within the Agri-food business has been increasing day by day as it has the potential to provide comparatively higher profitability (Maté-Sánchez-Val and Harris, 2018). AI can improve the overall accuracy and quality of the agricultural process of agri-food businesses (Rabadán *et al.,* 2019). AI is helpful to detect and automate major crises in the agri-food business industry, including over-dependency on climate, rainfall, and the rampant usage of pesticides, which over time causes environmental degradation (Yadav, 2020).

The implementation of technology is not only sufficient in this industry. It is crucial to provide proper training to each handling the agricultural activities on a day-to-day basis. It is the most important challenge faced by the decision-makers of this industry as providing training to everyone is comparatively a time and cost taking approach. Therefore, it is essential to identify specific and simplified processes for training the individuals and discussing the importance of the system within this industry (Rabadán *et al.,* 2019).

LITERATURE REVIEW

Models for Artificial Intelligence in Business (Service and Implications)

The component of Artificial Intelligence includes Learning, Perception, Problem Solving, and Reasoning (see Table 1), which can be used in business and analysed through different service models and implementation models. As the current era is fast-paced and adopting the advancements of Artificial Intelligence in various business industries, the business processes are running with accuracy and acceleration of growth (Monteiro and Barata, 2021). The agri-food industry is currently initiating Artificial intelligence innovation processes to make the business secure and make the process faster. The agri-food business is implementing the “Business Model Canvas Framework” for the e-models of agribusiness.

The models have highlighted the innovative technologies already incorporated in the agri-food industry to maintain sustainability in the supply chain management system. Machine Learning Models helps to use the algorithms for the known data set to execute the desired input and output for enhancing the business process in the agri-food industry so that the business can produce more desired and required products. The approach helps to store the data and utilise the data to understand the current market trends. AI can store farmers, suppliers, stakeholders’ information and their desired products and services will be delivered through the algorithm-based approach (Monteiro and Barata, 2021). The process can be run successfully with the techniques of clustering, forecasting, and regression to complete every step of the process with full accuracy (Monteiro and Barata, 2021).

The deductive reasoning approach helps to run a process in a very specific as well as in a more detailed way. The approach provides more specific data regarding any business procedures. The approach gives specific data regarding the agri-food business process so that precise agriculture’s cross agricultural technology and data analytics can be processed smoothly (Bačiulienė and Petrokė, 2020). The inductive Reasoning Approach refers to the generalisation of the different specific data. The approach helps to create the generalisation of the search and specific data obtained from the Deductive Research Approach.

The Pain Perception Model helps to understand different factors like social, cultural dimensions and analyse the impacts of the factors on the growth of the business. The perception model helps analyse the population’s data related to the agri-food business industry (Bačiulienė and Petrokė, 2020). The Evolutionary Computation Model helps to understand the basic functional implementations in terms

Table 1. Components of artificial intelligence

Components of Artificial Intelligence		
Traits	**Models for service**	**Implementations model**
● Learnings	● Machine Learning ● Pattern Recognition (Di Vaio *et al.* 2018) ● Natural Language Processing	● Understand Artificial Intelligence as well as organisational capabilities
● Reasonings	● Deductive Reasoning ● Inductive Reasoning ● Monotonic Reasoning (Lezoche *et al.* 2020)	● Understanding the current potential for the Business model for the BMI (Business Model Innovation)
● Problem Solving	● *"Heuristics"* ● Searching Algorithm (Monteiro and Barata, 2021) ● Evolutionary Computation	● Identifying the problem ● Analysing the problem ● Finding the leading cause of the problem ● Thinking solutions for the problems ● Implementing the solution process ● Measuring the result of the solution
● Perception	● Visual Perceptions ● Olfactory Perceptions ● Haptic Perception	● Pain Perception Model ● Hybrid Log Gamma

of the technology-based applications process. Thus, the advanced software implementation can help in utilising the data of the agri-food business supply management chain.

Impact on the Innovation of Agri-Food Food Businesses Concerning the Adoption of AI

BMI (Business Model Innovation) analyses the business's role and allocates the tasks to improve the business strategy as per the demand of the market. Moreover, the model helps in assessing the performance of progress of the agri-food industry. The model analyses the business's requirements and develops the innovative technology for the implementation process of the innovative technology process. Besides, the model analyses the resources for managing the supply management chain and maintains the business procurement process for running a business smoothly (Sharma *et al.,* 2020). The logistic operations and ethical issues are to be checked and analysed by implementing the model for innovative artificial technology. The model focuses on the tracking of the progress on productivity and the satisfaction of the needs of the consumers to maintain a better procurement process.

Issues

The supply management chain in the agri-food industry often faces difficulties in managing the innovative technologies of the artificial intelligence revolution. Moreover, the supply management system focuses on meeting the requirements of the consumers and maintaining sustainability. The business faces lack of proper resources due to the limited resources in the agri-food business. The process cannot run smoothly to maintain sustainability in the ness management. Several e-business models in the agri-food business industry often led to difficulty in managing the business process (Sharma *et al.,* 2020). Different models have different goals that hinder managing several operational activities in the business industry, which disrupts the digitisation process. Besides, the new adoption of innovative technologies in running the agri-food business sometimes becomes a great challenge to the stakeholders to relate and implement the technologies for better services. Though the approaches have so many benefits to accelerate the growth of the business, it is a time-consuming innovation process for the growth of the industry.

Benefits

The innovative business models help the business industry to get a more focused approach in the progression of the business. The e-marketplace models help to accumulate the stakeholders of the agri-food business so that the stakeholders can exchange the partnerships and onboarding the business procedures of the agri-food business industry (Sharma *et al.,* 2020). The B2B model (Business to Business Model), Consumer to Consumer (C2C) Model allows the understanding of the requirements of the resources of the business and consumers and suggests effective strategies to meet the satisfaction level of the consumers.

APPLICATION OF AI IN BUSINESS MODEL

Identifications of Challenges with the Implementation of AI in Business

The management of the business industry faces severe challenges regarding the implementation of the business process in the agricultural industry. The lack of proper technical knowledge creates a hindrance in the implementation process of the approaches regarding artificial intelligence. The industry needs proper infrastructure for implementing the process of software networking regarding artificial intelligence. Privacy issues are one of the most serious concerns regarding the management of the business through various online modes of business (Khrais, 2020). The cost factor matters a lot for implementing the processes as the implementation of artificial intelligence in the business sectors (Di Vaio *et al.,* 2020). Therefore, start-up businesses often face difficulties implementing artificial intelligence technology.

Innovation Related Challenges

The agri-food business industry mostly focuses on the conventional methods of food processing as well as the procurement process. Moreover, the process of artificial intelligence has a great issue regarding the application of the e-commerce marketplace, which ensures the communication process among the agriculture stakeholders. As the business industries often face the lack of proper knowledge regarding the innovation process of the technology process, the business faces retardation. Moreover, many start-up business industries face the cost issue of implementing the proper infrastructure to advance the technologies of artificial intelligence (Di Vaio *et al.,* 2020). Besides, the business industries lack proper developers and technical heads to adopt the utilisation of the innovative technology process. The process of investment regarding the improvement of the business procedures helps the acceleration of the business. Therefore, the agri-food business industry needs to focus on more strategic approaches for the advancements of artificial intelligence to maintain the resources and deliver the proper food and procurement process to manage the advancement of artificial intelligence to meet the satisfaction level of the customers.

Table 2. Predictive analytics deployment model in business

Models for service using AI	Models for deployment of AI	Reported outcome
Predictive analytics	● Accessing the external data ● Training of the automated tools	● The business process can be smoother through the access of the data of the third-party assessors (Khrais, 2020) ● Training the automated tools helps to understand the machine learning process so that the business growth can be accelerated.
Saas	Cloud Delivery Model (Khrais, 2020)	The model helps to understand the delivery process of the business procedures to the customers.
IaaS	Cloud Computing Model	The model helps to store the data of the stakeholders as well as of the business
MlaaS	Out of the box of algorithms	The algorithm helps to maintain the accuracy of the business as well as the speed of the business.

Adoption related Challenges in Business Context

The challenges regarding the business need to overcome the strategic approaches for the improvement of the current market strategy. The business industry needs to appoint some employees who have good skills and good knowledge regarding the models and approaches of artificial intelligence. Moreover, the proper infrastructure needs to be established to accelerate business growth (Di Vaio *et al.* 2020). Therefore, the business entity needs to strengthen the process of artificial intelligence with proper application service and implementation models so that the acceleration of growth of the agri-food business industry can be possible.

Measuring Issues Related to the Real-Time Application of AI in Agri-Food Business

Conceptual Model of Business for Successful Implementation of AI in Agri-Food Business

Model Concept

As per the above discussion, the focus can be given on sustainable BMI (Business Model Innovation) that can help agri-food start-ups to achieve sustainable growth effectively. According to Barth *et al.* (2017), BMI helps create a link between sustainability and business models in the agri-food sector. BMI can encourage agri-food entrepreneurs to develop more strategic perspectives regarding applying advanced AI technologies in the business. Food SMEs that aim to achieve business sustainability are more likely to determine their business activities with a diversified approach (Barth *et al.,* 2017). In this context, the importance of BMI can be considered, including both practical and theoretical perspectives.

Table 3. Core issues of implementing AI in agri-food business (Source: Nascimento et al. 2021, Di Vaio et al. 2020, Gardeazabal et al. 202, Duckett et al. 2018, Tharatipyakul and Pongnumkul, 2021, Cillo et al. 2019, Shet and Pereira, 2021)

Core issues	Underlying significance and description
Operational process management	Due to the lack of appropriate data regarding the small agri-food business, it becomes difficult to plan operations. Since the small business has to deal with the scarcity of data related to the business operations, the companies face challenges while implementing AI technology for the growth of the business (Nascimento *et al.,* 2021).
Space economy	Since the space economy is a new concept, there is a lack of knowledge about this economic system. Moreover, the agri-food market is evolving continuously owing to the uncertainty of events like the COVID-19 pandemic. Besides, it becomes more challenging for the companies and agri-food companies to make the stakeholders aware of the new concept of the space economy and its importance for increasing the effectiveness of AI (Di Vaio *et al.* 2020).
Stakeholder issues	The AIS (Agri-food Innovation System) framework is closely associated with a diverse stakeholder network. Therefore, it is quite challenging to understand the needs and expectations of diverse stakeholders regarding the implementation of AI technology. It is also true that all the stakeholders do not have equal knowledge on the use of AI for the business (Gardeazabal *et al.,* 2021).
Ethical issues	The concern with the ownership of data leads to developing ethical issues in the agri-food sector in terms of integrating AI technology with the business process. Moreover, the increased use of AI technology can have a negative impact on employment in the agri-food sector as it has the potential to cut off the jobs of manual labourers (Duckett *et al.,* 2018).
Usability issues	Due to the lack of knowledge about AI technology, small and medium agri-food companies are less likely to consider user interfaces integrated with AI. In turn, it leads to increasing usability issues significantly (Tharatipyakul and Pongnumkul, 2021).
Competency issues	A large number of employees have a lack of digital skills that increase competencies issues in the agri-food sector in terms of applying AI technology. The workers need to develop their digital skills to overcome this issue (Cillo *et al.,* 2019).
Managerial issues	Managerial competencies are crucial for developing the ground for a successful implication of AI technology in the agri-food sector. However, some managers are not skilled enough to handle the large data required for AI applications (Shet and Pereira, 2021).

Moreover, it is important to consider the major factors like traceability, sustainability-oriented skills and AI algorithms while determining the BMI for implementing AI technology in the agri-food business.

From the comments of Barth *et al.* (2017), it is quite evident that BMI can be considered as a process of achieving the desired business outcomes. Therefore, the food SMEs can focus on identifying the core issues related to digital transformation to develop the business models effectively. As per the view of Rachinger *et al.* (2019), digitalisation has a significant impact on BMI in terms of increasing the model's effectiveness. Thus, it can be stated that agri-food companies need to consider the importance of digitalisation while developing the business model for implementing AI to secure sustainable growth for the business. It can help the companies to make proper use of the digital opportunities, which, in turn, is also effective for developing the e-Business models for agri-food start-ups. As opined by Rachinger *et al.* (2019), business models depend more on context than the technologies, which is why the models

Table 4. Key concepts for implementing AI technology in agri-food business successfully

Concepts	Source	Element for the successful implication of AI
Business model for overcoming sustainability issues incorporated with AI implementation		
It is important to define various indicators related to the application of AI technology which, in turn, contributes to facilitating the decision-making process for the Agri-food companies. Determining the procurement process is also necessary for increasing the effectiveness of procurement technologies.	Jahani *et al.* (2021)	Technology Acceptance Model (TAM)
Digital transformation has taken place in the Agri-food industry in this recent time. The companies are more likely to adopt advanced digital technologies like AI to maintain national competitiveness, enhance regional development and deal with uncertain conditions. It is essential to determine the trends related to the Agri-food ecosystem for the growth of the business.	Vlachopoulou *et al.* (2021)	e-business model
The impact of climate change and loss of biodiversity on the agri-food sector needs to be considered. It is vital to reduce the impact of climate change on the supply chain system of agri-food companies. Advanced digital technologies also need to be integrated with the agri-food supply chain system for better development.	Esposito *et al.* (2020)	Circular economy model
Models for overcoming *Stakeholders' issues, ethical issues, Usability issues Competency issues and Managerial issues*		
To accelerate the sustainable development of agri-food companies, it is required to enhance the digital skills and competencies of the workers so that they can easily adapt to the application of advanced technology. In turn, it can help to improve sustainability-oriented innovation in the organisation.	McCarthy and Eagle (2021)	Sustainability-oriented skills
The managers need to improve their digital skills to make effective decisions for developing the business in the agri-food sector. Intelligence-based production and manufacturing are also essential for securing the growth of agri-food companies.	Shet and Pereira (2021)	Algorithm-based decision making
Increasing usability of the AI applications is important in maximising the use of AI technologies in the Agri-food sector. It can contribute to increasing traceability of the agri-food applications according to the requirements of different domains.	Tharatipyakul and Pongnumkul (2021)	Blockchain-based application for agri-food traceability
It is important to enhance the liability of the agri-food business and develop an open system for the stakeholders to choose and use the advanced technologies according to their convenience.	Gardeazabal *et al.* (2021) Duckett *et al.* (2018)	Autonomous agricultural robot

vary from company to company. Accordingly, agri-food companies need to focus on the business context for sustainable BMI related to AI implementation.

Moreover, it can help the companies to develop a data-driven business process to increase the efficiency of the business for making more effective decisions. Data-driven technologies like AI are always helpful to enhance the skills and competencies of the workers so that the companies can achieve their sustainable goals effectively. Therefore, this conceptual model focuses on the importance of including data-driven technology in the business models of agri-food start-up companies. According to Sorescu (2017) view, data-driven BMIs help the commis develop radical innovation in a significant way. Thus, it can be stated that the sustainable BMI for agri-food start-ups need to consider the data-driven model for making better business decisions.

Model Description

The main purpose of this section is to explore and explain the major variables associated with the conceptual model. Thus, it can be said that by developing an innovative business model, it becomes easier to increase organisational performance effectively. Furthermore, it helps to overcome the barriers related to applying advanced AI technology in agri-food business companies. As per the opinion of Barth *et al.* (2017), BMI can be observed as a framework that emphasises business innovation and business management. In this regard, it can be said that the model focuses more on digitalisation to promote digital transformation in a significant way. It will help the companies to adopt TAM for identifying the key factors associated with digital transformation. As a result, it can be easier to determine how to make effective strategies for enhancing the effectiveness of AI implementation in agri-food companies.

In addition, BMI is also effective for introducing a circular economy in the business process (Pieroni *et al.,* 2019). Implementation of the circular economy model can be very helpful for reducing the impact of climate change on food SMEs. With the help of integrated AI applications, agri-food companies can collect essential data required for applying the circular economy model in the business. The sustainability of a company depends on several important factors like environmental resilience, social inclusiveness, and economic performance. Thus, the Circular economy can help increase the competitive advantage of the agri-food start-ups, which, in turn, can contribute to ensuring the growth of the business in an effective manner (Pieroni *et al.* 2019).

According to the key themes discussed in the literature review section, this study elaborates on the following research question about the proposed conceptual model:

RQ1: How does AI technology impact agri-food start-ups dealing with the crisis for ensuring sustainable growth?
SRQ1: What are the major issues related to applying AI technology in the agri-food business industry?
SRQ2: What are the major components of AI affecting the sustainable growth of the agri-food business?

METHODOLOGY

Research Design

Research design highlights the overall outline of research, and it helps develop the outline based on the identified objectives. There are different research designs such as descriptive research design, experimental research design and correlational research design. The implementation of experimental research design is dependent on developing new hypotheses and focusing on a completely new research topic. Descriptive Research Design has been applied in this research as the information for completing this research has been collected from secondary sources. The primary motive of this research is to develop an effective application model of AI technology within the Agri-food business industry. The concept of descriptive research design is essential for collecting and analysing descriptive information from the existing literature resources (Schoonenboom and Johnson 2017). Thus, the implementation of a descriptive research design is suitable for this research.

Research Strategy

Research strategy is an integral part of a research life cycle as it determines the data collection process and data analysis process for research. Widdersheim (2018) stated that there are two kinds of research strategies: qualitative research strategy and quantitative research strategy. The basic characteristics of quantitative research strategy are essential for collecting statistical information. A qualitative research strategy is crucial for extracting information based on the quality and relevance to the topic. In this research process, the information has been identified from secondary sources, and the basic characteristics of qualitative research strategy have been applied in this research. The effectiveness of different models for applying artificial intelligence within the Agri-food industry is the primary motive of this research. Quantitative research strategy effectively collects detailed information regarding the relevance of different models for applying artificial intelligence.

Data Collection

Data collection defines the data extracting technique from the identified sources. It has been highlighted by Johnston (2017), data can be collected from two sources as secondary sources and primary sources. Collecting information from primary sources during the period is a comparatively challenging and time-taking approach. However, the primary motive of this research is to identify effective and suitable models for applying AI technology for supporting start-ups to manage crisis situations in the "agri-food industry" According to the basic objectives of this topic, it can be determined that the implementation of the survey is not suitable for collecting relevant information. Interviews can be an effective tool for collecting relief and information regarding this topic. Still, it is essential to interview industry experts, and it is not an easy task to perform.

On the other hand, secondary qualitative information is easily available in different databases. Peer-reviewed journals and recent journals can provide authentic and up to date information on the encountered topic. Thus, a secondary data collection method is suitable for this research.

Sampling Technique and Sample Size

The sampling technique highlights the method for selecting the sample size for the data collection process. According to the opinion of Sharma (2017), random probability sampling and non-probability sampling are two common methods. The random probability sampling method is essential for selecting a huge number of participants for samples for research. This method is suitable for selecting the participants in a survey process. On the other hand, the basic characteristics of non-probability sampling methods are suitable for selecting a comparatively lower number of participants or samples. The utilisation of non-probability sampling methods is dependent on the basic skills and knowledge of the concerned researchers. The non-probability sampling method has been used in this research, and the researcher has selected the secondary journal articles based on personal knowledge and conception regarding the implementation of AI technology within the Agri-food business industry. Four peer-reviewed journals have been selected from authentic sources such as Google Scholar and Mdpi.com.

FINDINGS AND ANALYSIS (SECONDARY)

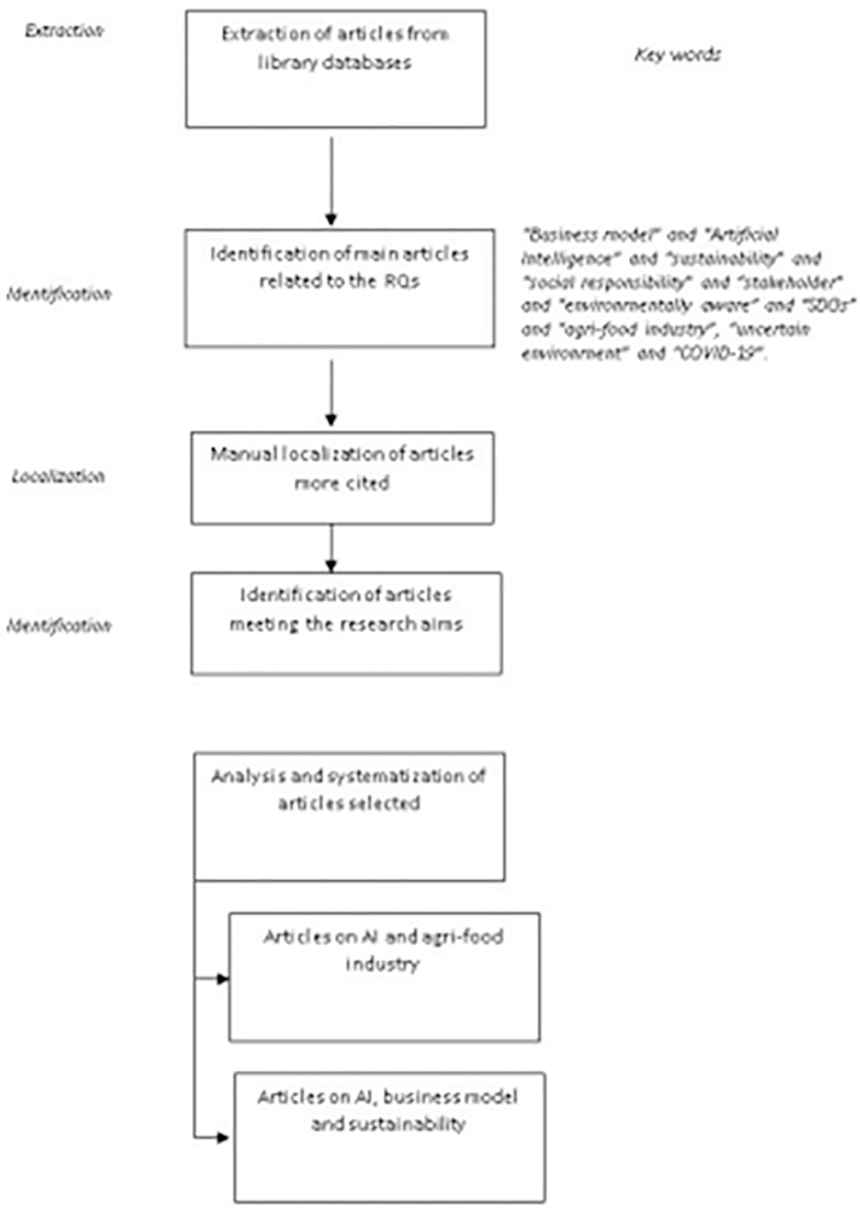
Development of the Use of AI Can Help in Supporting Future Sustainable Business in the Agri-Food Industry

Agri-Food Tech Model

In recent times the emergence of the use of AI systems within different business sectors and mainly in the Agri-food industry supports to reduce the crisis. As per the view of Rowan and Galanakis (2020), the development of AI technologies among Agri-food businesses is also essential to ensure their sustainable development. On the other hand, the application of Agri-Food tech models helps the companies and Agri-food businesses trying to improve the scope of innovation by utilisation AI systems in recent times. It can be stated that the development and application of AI technologies in Agri-food business support to ensure essential operations management processes effectively develop various internal planning (Zhao *et al.* 2020). In addition, this model helps in analysing the essential use of AI technologies and incorporates other benefits like it provides the advantage to increase profit margin and the resolve of managerial issues. The agriculture business is at the very centre of the overall procedure that is related to a profound kind of renewal by the development and application of AI technologies (Mendling *et al.* 2018). Accordingly, based on the BMC framework and Agri-food Tech model, it can be stated that the application of AI systems and other technologies like machine learning, IoT (Internet of Things), Blockchain, and the cloud helps to realise the efficient traceability of the overall supply chains.

In the Agri-food industry, adopting these essential AI technologies helps protect customers and improve agricultural production quality (Zhao *et al.,* 2019). On the other hand, the greatest aspect of this is the application of AI in the Agri-food business with the computer processing ability, which helps in reducing human intervention and consumes less time in the production of food.

Figure 1. Agri-food tech model (Source: Mendling et al., 2018)

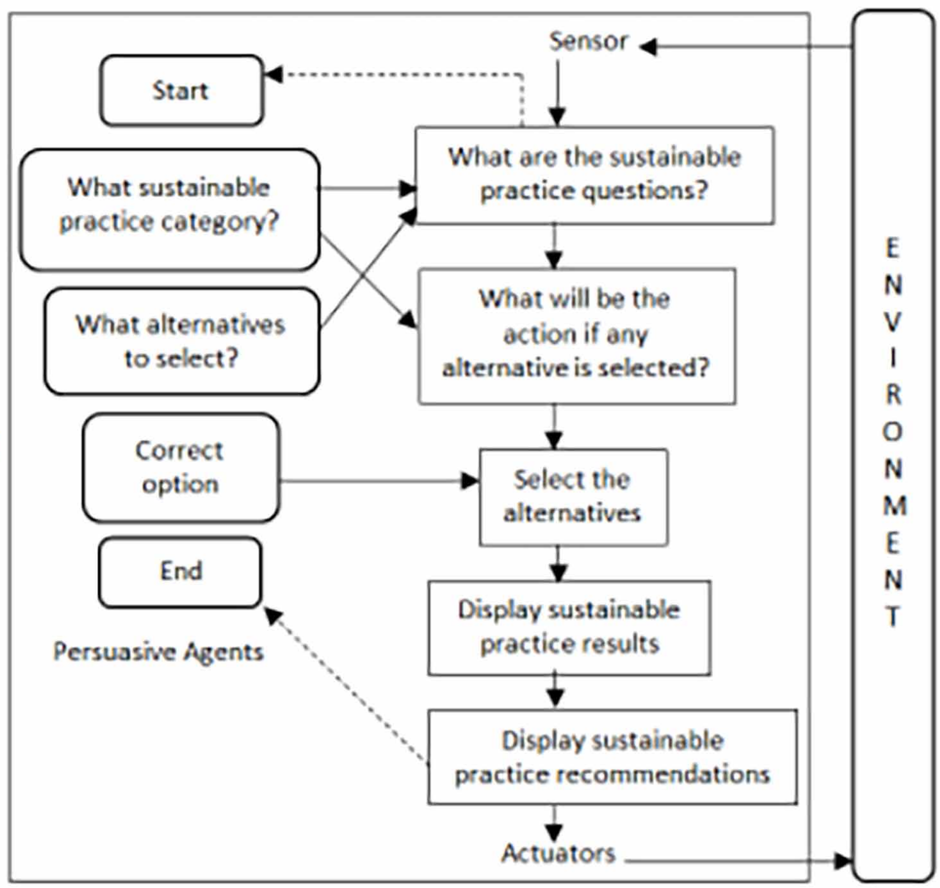


Digitalisation to Reduce the Crisis in the Agri-Food Business by Unlocking Opportunities

Application of Sustainable Practices Business Model

Digital technologies or the adoption of AI technologies in the context of business provide potential solutions to effectively improve sustainability among businesses. It also provides an advantage in the Agri-

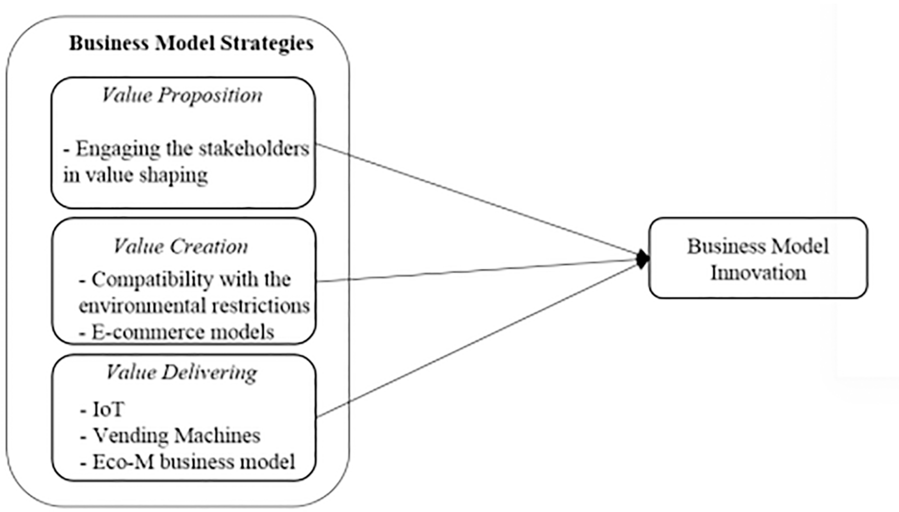
Figure 2. Application of sustainable practices business model (Source: Bahn et al. 2021)



food business to provide benefits regarding social, economic and environmental concerns. It has been highlighted by Bahn *et al*. (2021), application of several AI systems like machine learning, IoT (Internet of Things), Blockchain in this Industry helps to resolve the crisis and make improvements upon supply chain, production and by ensuring its logistics performance (Bahn *et al*. 2021). On the other hand, based on the aspect of rethinking, the sustainable business model considers that the adoption of AI technologies among the Agri-food business also supports the optimisation of the use of natural resources to maintain sustainability in business and its operations.

It can be stated that the application of AI systems is also essential as it helps in reducing some of the issues to ensure business growth. These issues are related to managerial, ethical, usability and others. However, Arruda *et al*. (2021) stated that the concept of digitalisation and adoption of AI systems generally refers to social-technical applications to make the Agri-food food business innovative and more efficient. Moreover, this helps ensure improvement within agri-food related primary production, development of the supply chain to resolve the issues of this crisis.

Figure 3. Transformation of business model: Source: Upendra et al. (2019)



Social Agriculture and Food Start-Ups Can Transform the Food System by the Application of AI Systems

Transformation of Business Model

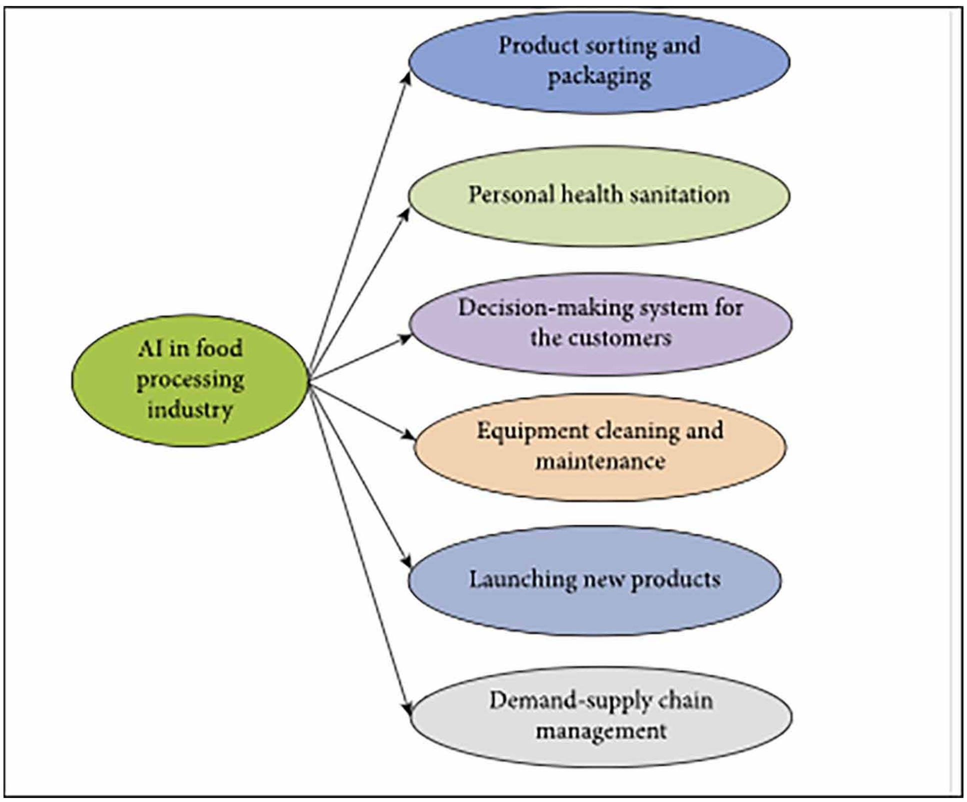
The agri-Food business is one of the most important and oldest professions globally, which faces a huge crisis in this pandemic situation. In recent times, the adoption of several AI technologies has helped farmers produce thousands of data points upon the ground daily and in less time. It can be stated on the aspect of the transformation of the business model, as the application of these effective AI systems drives economic growth and development within the Agri-food business. On the other hand, Upendra *et al.* (2019) stated that AI systems and their utilisation within the Agri-food business also helps in improving harvest accuracy and mitigating quality issues regarding the business model of transformation. In addition, the application of this transformation business model also helps reduce the sustainability issues in the business context of Agri-food. Moreover, the application of AI systems also works for ensuring tackling the challenges of the labour faced by the company by reducing human intervention in production (Omar *et al.,* 2017). Therefore, applying these transformation business models ensures the essential application of AI systems in this pandemic situation to ensure the reduction of crisis and economic growth.

Implementation of Artificial Intelligence Technologies to Reduce Crisis in the Agri-Food Industry

Process Management Needs Business Models

Artificial Intelligence systems and related technologies mainly work for helping the farmers and other employees ensure the yielding of healthier crops (Germscheid, 2020). On the other hand, based on the aspect of process management needs related to business models, AI systems help ensure growth conditions in this pandemic situation. In addition, this helps the farmers to ensure essential process management by reducing workload and human intervention in food production. As per the view of Germscheid (2020), AI technologies are essential to improve the accuracy and quality of the harvest known as precision culture by developing through process management business models. On the other hand, the application of essential AI sensors on this business model helps ensure high-quality agriculture production (Dhanabalan and Sathish 2018). Therefore, it can be stated that the implementation of artificial intelligence technologies helps reduce the agri-food industry crisis.

Figure 4. Process management needs business models (Source: Germscheid, 2020)



ANALYSIS

The above research study explores the idea of implementing an AI system that can support start-ups to manage crises for future sustainable business in the agri-food industry. As per the view of Barcaccia *et al.* (2020), the Agri-Food business is the oldest profession globally, which faces a massive crisis in this pandemic situation on the aspect of low economic growth and production. In recent times, the adoption of several AI technologies has helped farmers produce thousands of data points upon the ground daily and in less time and reduce human intervention in the production of food. On the other hand, the components related to Artificial Intelligence include learning, perception, problem-solving and reasoning, which helps the agri-food business from different implementation and service models (Riahi *et al.* 2021).

However, the agri-food industry is currently regarding this pandemic and crisis, initiating the Artificial intelligence innovation procedure to do the business and develop the processes and operations faster.

DISCUSSION

Innovative business models are essential for increasing the overall potential and core value of business organisations. Mendling *et al.* (2018) stated that there could be different similarities between the business models identified by different business organisations. Still, differences within the implementation process can provide competitive advantages to business organisations. The implementation of e-Marketplace models can effectively connect partners, farmers and consumers through a platform, and it helps to exchange essential information. This model is one of the most essential tools for establishing effective communication between the different stakeholders, and it can increase trust among the different stakeholders. It also helps to empower the stakeholders for enabling the matching between buyers and sellers. Implementing this business model through AI technology is essential to reduce the costs of reading commission rates in B2B and B2C activities. This information can be utilised as a proper explanation regarding the comparatively higher cost at the initial stage for implementing AI technology. According to the literature review section of this research, the implementation of technology is comparatively a cost taking approach at the initial stage. However, long term strategies and long-term vision are required for implementing AI technology (Zhao *et al.,* 2019). The collected information from this article justifies the discussed information in the literature review section.

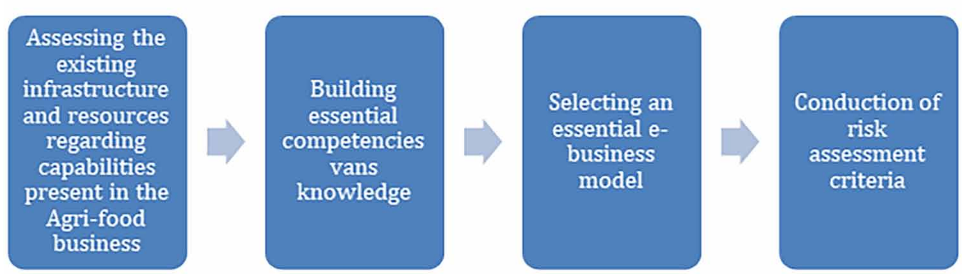
Implementing the digital marketplace model can be an effective tool for developing the matching between different buyers and sellers in the digital platform. Search agents and robots effectively find out essential information regarding the price and availability of specific products (Bahn *et al*., 2021). It is one of the most authentic ways to reduce the complications regarding middlemen, and this method is also crucial for establishing a two-sided market. There can be different ways to reduce the actual cost and increase the satisfaction rate among the associated stakeholders. The implementation of this specific model is effective for both farmers and business organisations. Farmers can sell their products at a comparatively higher rate as there will be no middleman, and the organisations will get the product at a relatively lesser price. The literature review section of this research has discussed the efficiency of AI implementation in the Agri-food sector. Implementing the subscription model is another effective tool for enhancing the overall experience in the Agri-food business sector. The basic characteristic of this model is to use a periodically charged fee for providing membership. It might be difficult for start-up organisations to utilise the paid membership strategy initially as lack of brand loyalty and customer loyalty can be the significant issue for this reason. Providing trial facilities at the initial stage might be an effective method for showcasing the effectiveness of the artificial intelligence that is implemented in the business model. On the other hand, the primary purpose of this model is to reduce the process of supply chain management. The literature review section of this research indicates that the implementation of AI Technology can reduce supply chain-related issues. Thus, the finding section of this research justifies the discussed literature of this research.

The implementation of process management needs business models is an effective tool for reducing the errors and prices within the agri-food industry. According to the findings of Arruda *et al*. (2021), this process is crucial for improving the overall quality and accuracy of the harvesting process. It is helpful to reduce the risks associated with a budget overrun and other factors. This method is comparatively more efficient than the other two methods in terms of risk management. The literature review section of this research provides a clear conception regarding the risks associated with the agri-food industry. Reducing the risks is an important task for new business organisations (Upendra *et al.,* 2019). It is the responsibility of each new business venture to mitigate the rising issues and provide proper attention towards financial sustainability. However, the application of this mode is not as practical as establishing effective digitalisation between the customers and sellers. It is essential to identify a suitable model covering digitalisation and risk management as it will provide sustainable growth and stability within the operational activities.

PROPOSED FRAMEWORK

The design of the proposed model has been developed based on the conceptual model of the existing literature. The findings of this research have also helped to establish the outline of the strategic framework. It is essential to provide equal importance in multiple sectors such as risk management, cost efficiency, and the different tools' utility. Omar *et al.* (2017) stated that risk management is an integral part of a business organisation as it helps provide proper stability to the business entity. The proposed strategic framework is essential to identify the requirements and issues within the agri-food industry. It also helps to develop an appropriate knowledge regarding the infrastructure and resources as it is directly linked with the suppliers. Subsequently, it will also help select a sustainable model for establishing adequate communication and collaboration between the sellers and buyers. This method allows develop effective communication between the stakeholders and effectively reduce the excessive cost associated with the middleman. Both business organisations and the farmers will be faced with the facilities of this framework.

Figure 5. Proposed framework



CONCLUSION AND REFLECTION

This entire research study is based on the aspect of Artificial Intelligence and its effectiveness to provide the Agri-food business in the reduction of this crisis. This study is mainly developed by applying various business models related to the Agri-food business to analyse the issues and ensure business growth. In recent times, the application of essential AI systems and technologies in the Agri-food business context has helped ensure economic growth and increase the production level. On the other hand, there is a need for an essential understanding of the practical application of AI technologies within the business context of Agri-food. Subsequently, this can help reduce several managerial, stakeholder, ethical, usability, competency, and other issues. This comprehensive research study based on this topic will help the business of Agri-food determine its significant aspect to develop business and manage a crisis.

Figure 6. Adapted model of conceptual to address the implementation issues of AI

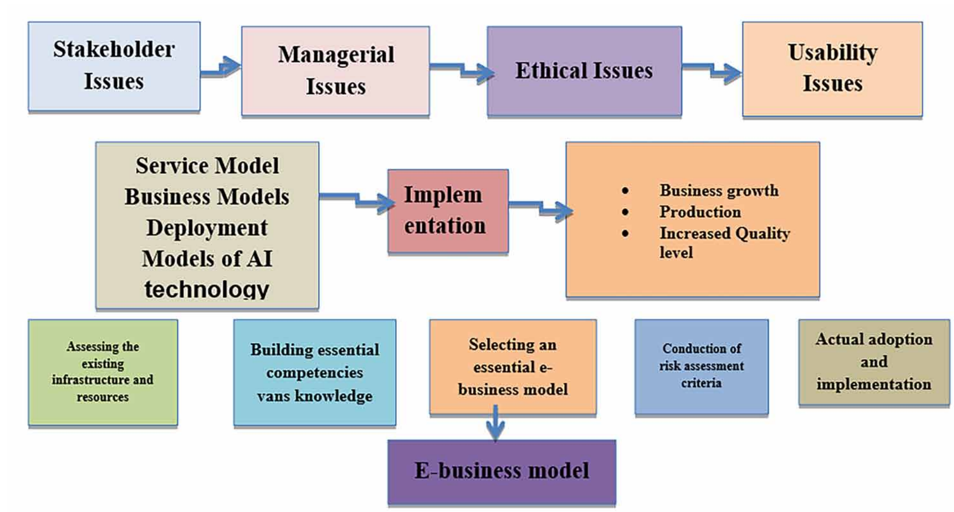


Table 5. Summary of the essential roadmap stages to overcome the issue in AI implementation

Roadmap Stages	Description
Assessing the existing infrastructure and resources regarding capabilities present in the Agri-food business	This helps in determining the primary requirement of AI technologies in the development of the agri-food business.
Building essential competencies vans knowledge	This study reflects AI systems and technologies' essential use and application to ensure business growth and production among the Agri-foods industry.
Selecting an essential e-business model	This model involves essential components such as business intelligence, supply chain management and others to ensure the business growth of agri-food businesses.
Conduction of risk assessment criteria	This study faces some issues to identify the problems related to the application of AI systems in the Agri-food industry and adequately manage to reduce the effect of a crisis.
Actual adoption and implementation of business models	This e-business model helps adopt advanced digital technologies like AI to maintain national competitiveness, enhance regional development and deal with the uncertain conditions within the Agri-food business.

The secondary data and based on its analysis, it can be said that regarding the aspect of essential business models, implementation of AI systems requires proper management to get successful outcomes. On the other hand, AI technologies provide an advantage in the Agri-food business by ensuring the development of social, economic, and environmental concerns and increased food production. This research study also helps in understanding the essential requirements of the business as well as develops the innovative technology for the implementation process of the creative AI technology process in the Agri-food business. Therefore, the concern is that the agri-food industry needs to implement AI systems for reducing human intervention and to produce high-quality food and ensure business growth.

Limitation

This research study consisted of limitations based on analysing only secondary data. Subsequently, it can be stated that primary research conduction and analysis helps to know the perception of employees and managers of the business by conducting surveys and interviews (Nabi and Dip, 2017). This can reflect based on the aspect of AI technologies and their application to the Agri-food business. On the other hand, the conduction of quantitative data on any country of concern might be essential to collect more critical data. In addition, the development of questionnaires also helps to get an in-depth insight into this research topic (Nyumba *et al.,* 2018).

Future Studies

Future studies can effectively explore or gather information by researching the issues companies face during the application of AI technologies. According to Di Vaio et al. (2020), focusing on the implementation process and issues regarding AI technologies can help the Agri-food business perform efficiently. However, exploring the challenges companies face applying AI technologies and systems will be effective in considering some management decision-making for the Agri-food industry. For further reading into similar innovations that can be applied in the industry, please refer to the following studies (Ali, 2019, 2020; M. Ali, 2019; Ali M et al., 2018; Ali & Abdel-Haq, 2021; Ali & Edghiem, 2021; Ali et al., 2017; Ali, 2021; Ali et al., 2020a, 2020b).

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Chapter 15
NextGen Smart Healthcare Systems:
Solution for Mitigating Crisis

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ABSTRACT

Citizens' health is a barometer of society's health, and thus healthcare is a primary focus of all governments/societies. Precaution is preferable to cure. It is critical to monitor patients on a regular basis and to treat them proactively. Despite being proactive, there is a possibility that patients will require reactive treatment. Over the last century, the healthcare industry has made tremendous strides. Technology has been critical to these advancements. This has aided doctors in diagnosing patients more accurately, resulting in more effective treatment. Healthcare costs have increased, as has the incidence of chronic lifestyle diseases and the ageing population. These factors are compelling healthcare stakeholders worldwide to pursue round-the-clock activity tracking and continuous monitoring of health parameters. Hospitals are critical for monitoring and treating patients. The purpose of this chapter is to discuss how hospitals are implementing newer technologies to monitor and treat their patients through the development of next generation affordable healthcare systems.

INTRODUCTION

Innovation in healthcare is inevitable to meet the demand in the healthcare industry and improve the citizens quality of life. This paper focuses on how hospitals are adopting newer technologies to monitor

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and treat its patients by building Next Generation affordable Healthcare systems.

The Next Generation Healthcare systems are convergence of technology. It transforms the healthcare from

- Reactive to preventive
- hospital-centered to proactive and person-centric

Instead of focusing on disease, it focuses on well-being. The Next Generation Healthcare health solutions (Islam, M.M et al. 2020) involves

- Capturing patient health data from various sensors in a secured manner
- Applying complex algorithms to analyze the data
- Sharing the data in a secured manner, using wireless technologies, with Medical professionals for them make appropriate recommendations.

Thus promoting

- Patient's independence,
- Focuses on prevention,
- Improves outcome.

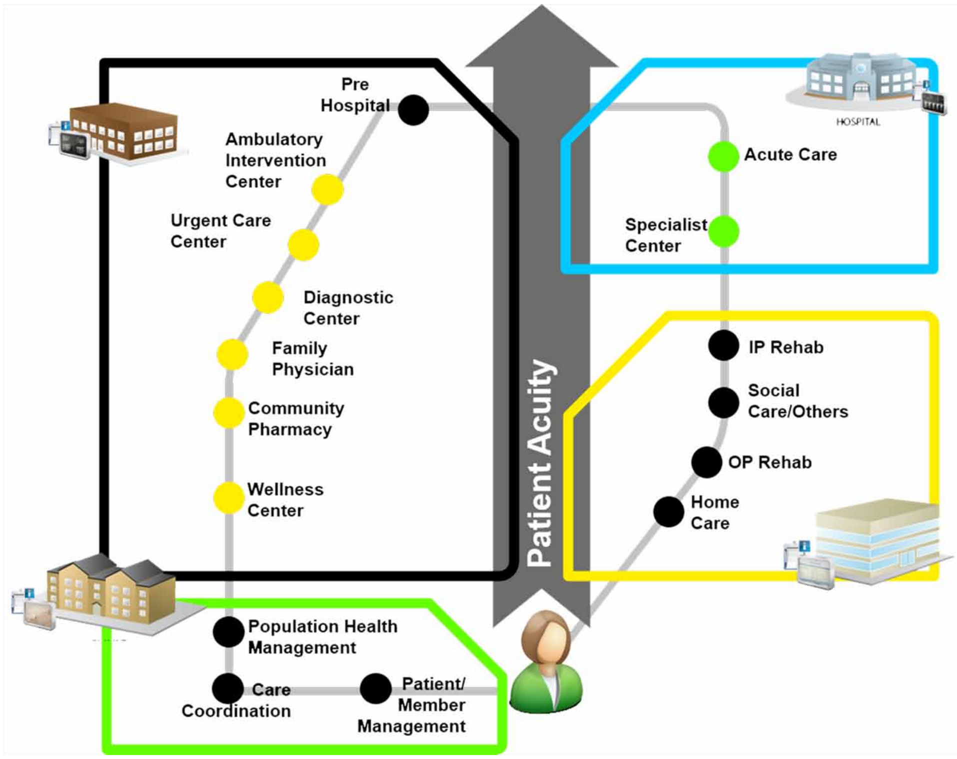
F. Alshehri and G. Muhammad (2021) conducted detailed survey of various IoT, Cloud, Edge and AI based smart healthcare solutions and its impact, challenges on the healthcare industries. With the help of IoT edge and fog, cloud-IoT convergence can be enabled (M. Aazam et.al 2020) which helps to smart healthcare deployment and quick turnaround in healthcare delivery.

The Fig.1 depicts a typical patient journey at a hospital. The patient's journey (Olutosin Taiwo et al. 2020) begins with registration. Medical records are created for the patient in the hospital's EMR/HMS system. The patient can have access to the doctors, diagnostic centre, pharmacy, wellness centre, emergency care etc. The ERM/HMS system helps have all the information available to the doctors, pharmacists, wellness centres etc. This ensures that the complete medical history is stored in one location and build over a period to provide a complete picture of the patient. The patient has access to the specialists as required. The patient can be admitted to the hospital as an in-patient and go through the required treatment including any surgeries. The patient needs to continue treatment at home, and this too can be monitored, and various parameters stored in the EMR/HMS. To fulfil the mentioned journey, hospitals are adopting various technologies to provide the next generation healthcare systems.

There are multiple use cases that make a Next Generation Healthcare system. Some of the use cases are illustrated in the blue circles in the Fig.2. This paper will focus on the few of these important use cases. Hospitals are run by multiple entities such as government, trusts, self-funded organizations etc. Each of these entities, while providing facilities by implementing the above-mentioned use cases need to focus on 3 critical areas to run their operations efficiently.

1. Optimized Economies
    a. The facilities brought in need to be affordable by the patients.
    b. The hospitals need to ensure that they can get their return on investments.

Figure 1. Patient journey

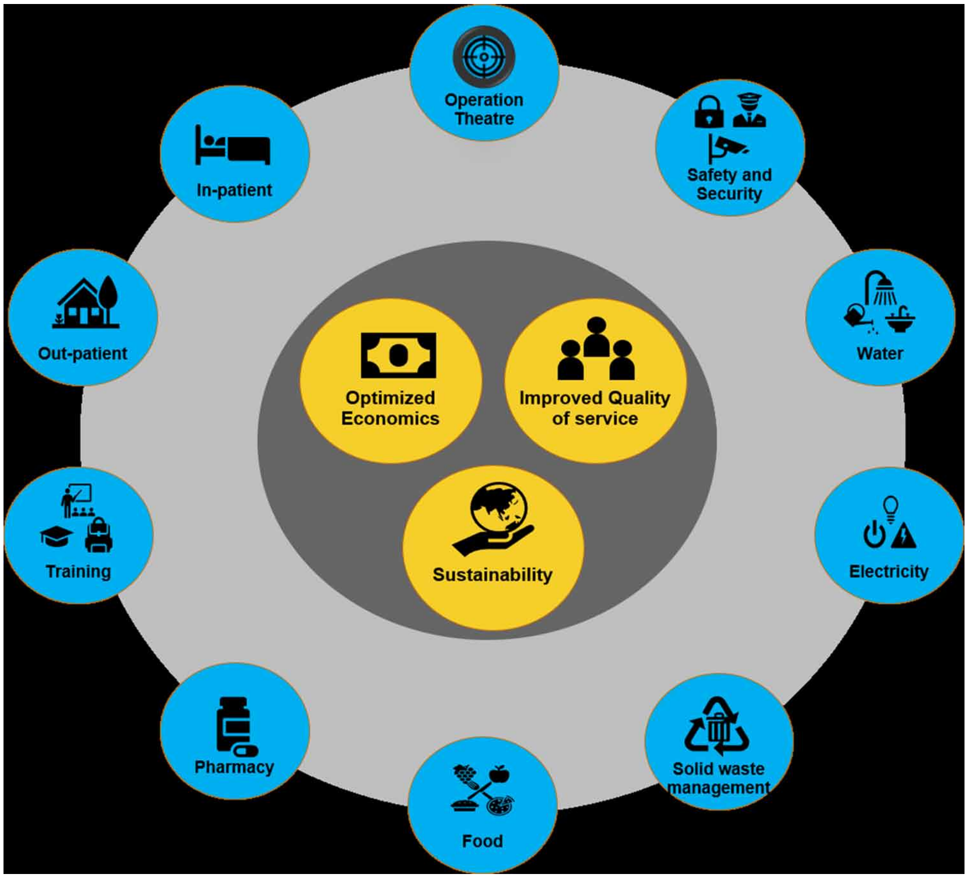


2. Improved Quality of service for
    a. Patient
    b. Doctor
    c. Pharmacy
    d. Reception and Billing
    e. Nursing
    f. Emergency and Medical transport
3. Sustainability
    a. Environment management
        i. Water management
        ii. Solid waste management
        iii. Electricity management
    b. Training of personnel

The smart healthcare use cases elaborately discussed in the next sections, can be achieved using IoT devices, AR/VR, Integrated applications. The objective of this paper to cover the following aspects of Next Generation Healthcare systems

- Discuss on the evolution of Smart Healthcare systems
- Comprehensive analysis of Smart Healthcare solutions and use cases

Figure 2. Next generation healthcare system – themes for hospitals



- Technology, reference architecture and its components

A Smart Hospital solution is built by integrating various smart solutions listed above. The Smart Hospital solution will vary from hospital to hospital as their requirements may vary. This paper recommends the various smart solutions that need to be integrated in a full-fledged smart hospital solution.

Below is the brief description on the way rest of this paper is organized

- Section 2 presents the evolution of smart healthcare systems.
- Section 3 explains the classification of smart healthcare solutions, detailed explanation and use cases.
- Section 4 describes the technology elements of smart healthcare systems and S
- Section 5 provides conclusions.

EVOLUTION OF SMART HEALTHCARE

Health care service providers are looking for solutions that can be provided to the patients inside and outside the hospital. To achieve this, hospitals need to be

- Innovative
- Patient-centric
- Cost-effective
- "Smart" by adopting technology

Sector is moving from a volume game to value game. Accelerated innovations and technology driven evolution (André Henriksen et.al 2018) in the sector are observed around the following areas of healthcare

Wearables

On body biosensor and bio-patches for remote healthcare and for real-time monitoring enabling proactive and predictive services

Portable Devices

Cost effective homecare services with portable devices hooked on to Internet. This enables remote monitoring and proactive homecare at the convenience of patient and affordable charges without in-patient billing at hospitals.

Patient Data Availability – "Always Available"

Advanced networking options to transfer Healthcare data in bulk and in real-time. This data is maintained in cloud and made available to right people "Anytime Anywhere" for quick opinions, analysis and diagnosis.

Assisted Procedures

Medical Healthcare and hospital procedures is witnessing a tremendous transformation in assisted procedures. Robotic high accuracy assisted surgeries, AI and analytics based quick pre and post-Operative procedures and efficient nursing care.

Enhanced Patient Care Systems and Better Experience

Healthcare with service providers and Payers Integrated leveraging technology like blockchain has made patient experience simple and rich. Cashless admissions integrated and secured payments delivered through true end to end digital eco system has increased patient experience by multiple fold. Innovations and evolutions are still on in the path of Treatment to Care to Payments.

SMART HEALTHCARE SOLUTIONS

Smart Healthcare solutions are broadly classified into 6 dimensions. The use cases underpinned into hospital Electronic Medical Records (EMR)/ Hospital Management System) HMS.

- Patient care
- Operation Theatre related
- Emergency response
- Administrative
- Integrated Command and Control Center
- Robust Network

Healthcare providers get enormous benefits using the solutions. The key benefits include

- Persona based approach (right patient, right information, right therapy, right outcome)
- Best possible experience, across the continuum
  - Proactively making decisions
  - Contextual interactivity through optimized AI
  - Automation
  - Innovation
- Intelligent routing of contextual and pre-curated Information
- Cross-link information to derive new insights
- Employing the power of Information mediation by bridging the gap between the systems of engagement and systems of record
- Open multi-disciplinary clinical collaboration network
- Underpinned by Security & Platform services

Patient Care

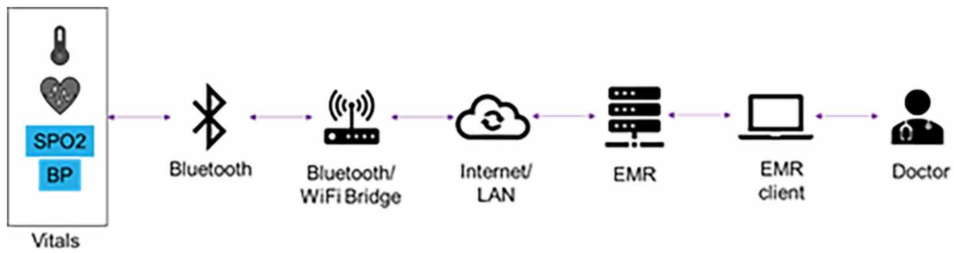
Vital Parameters

Vital parameters are critical to be considered while treating a patient; be it as an in-patient or at home. Depending on the kind of ailment the patient has, the frequency of measuring these vitals would differ. However, it is important that these vitals get recorded and the doctor can review the data and alerted as and when required. The doctor can see patient record of the patient through EMR/HMS. So, if the vitals related data is synchronized with EMR/HMS system, the doctor can have a real time view.

The vital parameters that typically need to be monitored are

- Temperature
- Heart rate
- Blood pressure
- Oxygen Levels

Figure 3. Synching vitals with EMR



There are various BLE devices available in the market that can be used to monitor these vital parameters. However, this would need customization to integrate these devices. Please note that there is no standardization of APIs that these device manufactures publish. Hence, it is recommended that a hospital partners with 1 or 2 device manufactures and establishes a common API layer so that the rest of the systems can consume them. Also, this will be become a standard for the given hospital.

There are devices that are available in the market that can be used to record these vitals. However, once the patient is monitored the records are handwritten on a paper and handed over to the doctor as required. To ensure that the doctor get these inputs through EMR/HMS, this information needs to be entered the EMR/HMS. The Next Generation Healthcare system (M. Shamim Hossain et al 2015) recommend that there are no manual interventions and the records are uploaded automatically. To enable this, devices are built with Bluetooth so that the data is transmitted to local hub; laptop at home which is connected to a Wi-Fi or a Bluetooth/ Wi-Fi bridge at the hospital wardroom.

Motion Analyzer for Patients

Some patients, people with chronic ailments, old age, disability need extra attention. These patients need to be monitored to ensure that when they move around there are no jerks, fall or are waiting for long time. Bluetooth enabled wristband are developed that constantly analyze motions (J. P. Silva Cunha et al. 2016). In case of any incident like fall, long waiting, or restlessness the Bluetooth enabled wristband would generate an alert and transmit the alert to the nursing station, while in hospital, through the Bluetooth/ Wi-Fi hub.

In a scenario where there is an attender, this Bluetooth enabled wristband can be paired with another Bluetooth wristband or a Mobile App that will receive the alert. The attender and patient Bluetooth wristbands can be geo-tagged to ensure that the patient and attender do not move too far away from each other. This can be applied to mother and infant born at the hospital and both can be tagged using Bluetooth enabled devices like wristbands or strip.

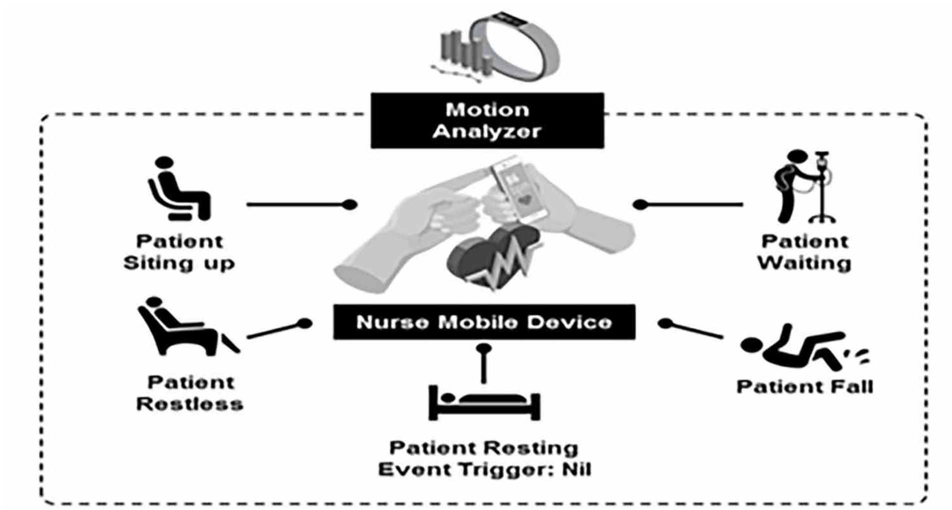
Wellness

Since people are leading stressful lives especially in urban areas, the physician does ask the patients to maintain, record and keep a track of a healthy lifestyle. Typical wellness parameters are

- Steps walked in day

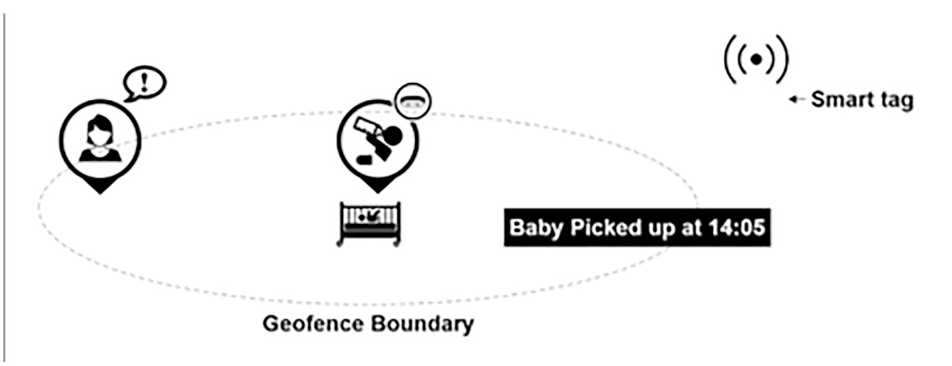
- Sleep monitoring
- Anaerobic and Aerobic monitoring

Figure 4. Motion analyzer using wearables



Conventionally, it is difficult to managing and keep track of daily activities. With the advancement of Sensors, IoT and cloud, it is possible to automatically record the daily activities and check the individual performance at any time (P. S. R. Garcia et al. 2020) (Koo, S.H et al. 2018) (Ashley Colley et al. 2020). Bluetooth enabled wristband are available in the market that can monitor these parameters. In most cases, these devices come with Mobile Applications that can sync data from these devices. Mobile Apps such as Google Fit can easily to integrated with EMR systems and data be stored as part of the patient record. Alerts can be generated by analyzing this data and appropriate steps can be suggested by the physician/doctor to the patient.

Figure 5. Infant/patient tracking through geo-fencing



Blood Sugar Monitoring

This is the most critical parameters that needs to be for diabetic patients. There is lot of work being done developing invasive devices that can be programmed to check blood sugar levels at specific times. These devices are Bluetooth enabled and can be integrated with EMR in the same manner as described in the previous use cases. While work is being done on the invasive devices, there are non-invasive devices available currently that is used in general at home and hospitals. However currently people record the reading on paper and share this with the doctor as and when required. Typically, these devices store last 20-30 readings. If these devices are enabled with Bluetooth, it will ensure that data is immediately uploaded to EMR using a Mobile App or through client on laptop. The doctor can proactively advice the patient on the kind of medicine based on the alerts that he/she gets.

Operation Theatre

The Operation theatre related activities can be divided into 3 broad categories.

- Pre-Operation
- During Operation
- Post-Operation

Pre-Operation

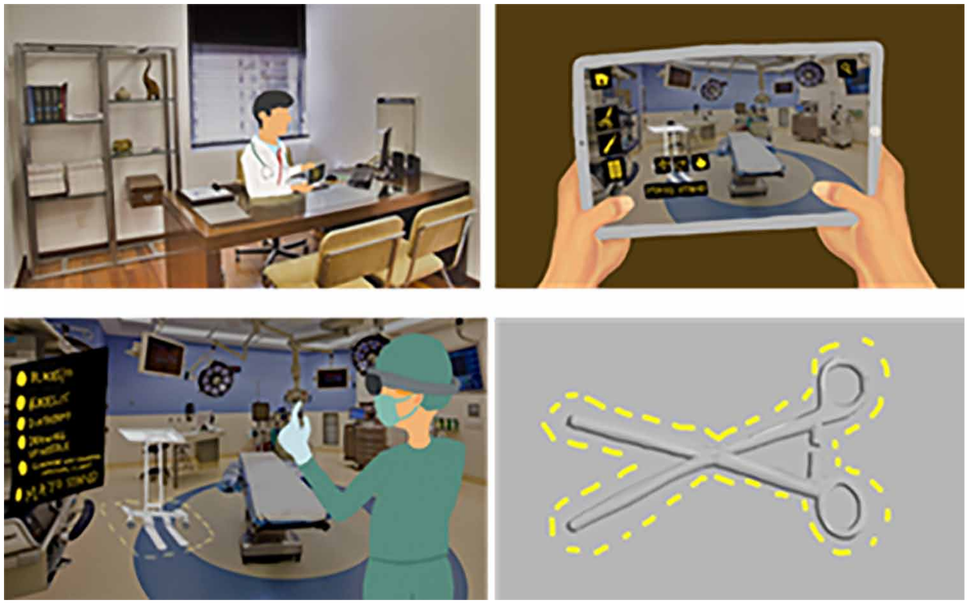
A surgery or operation needs planning. Things can go wrong, and the doctor needs to have a plan on what should be done in a normal course and in case of any exception. This plan needs to be understood by the nursing staff and other doctors assisting the surgeon. These plans can be dictated by the surgeon and get recorded in a system for the rest of the team to either listen to the plans or take prints for their reference. Collaboration tools with drawing facilities, video and audio conferencing and recording facilities. Voice to text conversion.

Each surgeon has his/her way of arranging the various surgical tools. The nurse understands the pattern by taking a dictation, in the current scenario. However, if the surgeon is given an option of using AR/VR to position the tools on a screen and the same data is available to the nurse while he/she is arranging the tools the chances of errors are reduced dramatically and comfort of the surgeon is not compromised.

The surgeon needs to have

- Complete history of the patient
- Reports including all scans
- Clearance from
  - Anesthesia
  - Insurance
  - Billing
- List of
  - Surgical tools
  - Consumables including blood
- Booking of Operation Theatre

Figure 6. AR based arrangement of tools according to the surgeon's comfort



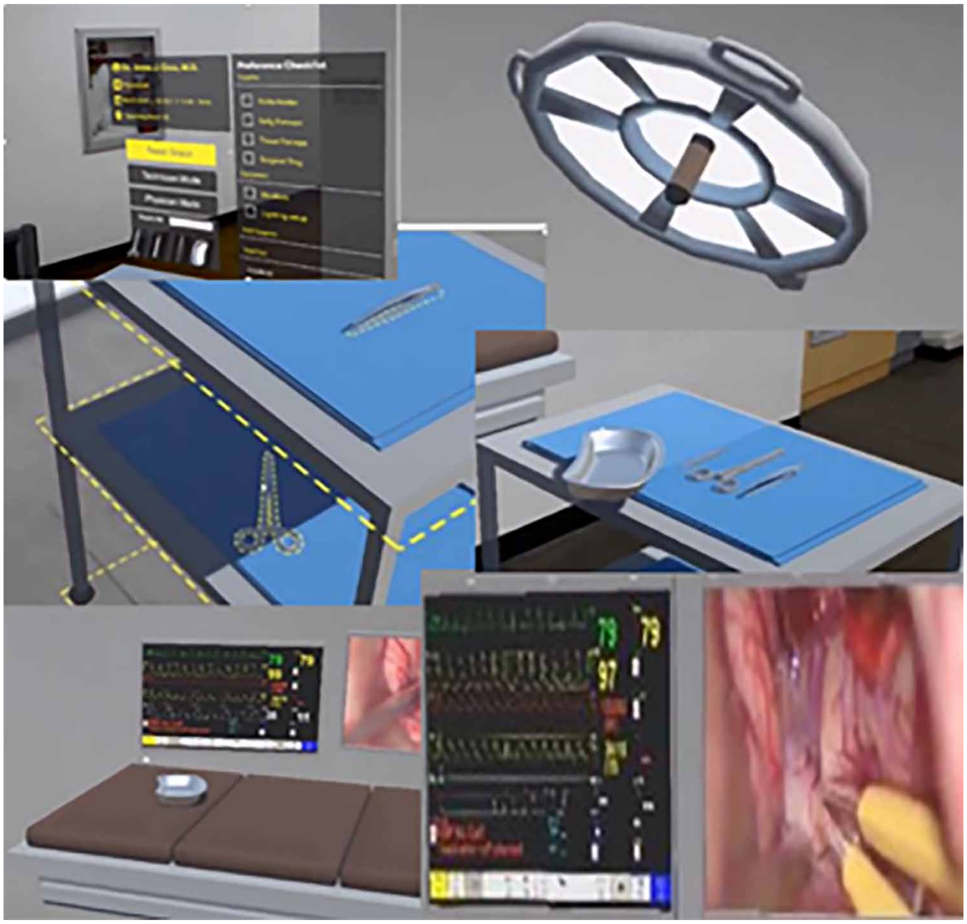
An integrated EMR and HMS systems comes in handy. This integrated system needs to be available and can be accessed by the surgeon anytime, anywhere. Operation theatre readiness is one of important aspects. Here again an integrated HMS system that allows the nursing staff to confirm - Hygiene/Sterilization, Housekeeping, Oxygen supply. The patient needs to be briefed of the surgery. This will include mediation, mental state of patient, shaving etc. Handheld devices for nurses to update the checklist for doctor/OT manager to view and approve. The consumables need to be tracked. Bar code readers for each consumable cover. Alerts and notification to various departments on the requirement. Restricted access of the staff to the operation theatre is important, hence an access management needs to be in place.

During Operation

Each surgery is unique as surgeries will always have some improvisation. Hence it becomes an important learning for the surgeon to record the surgery for future references and to explain the patient and the family about how the surgery was conducted. This can be used by students aspiring to be surgeons. In case of any specific findings that needs to be published with various medical councils, these recordings can come in handy. A camera can be mounted as a headgear of the surgeon. This video can be displayed on the screen as well, if required. It is also possible to transmit the visuals to doctors supporting from remote locations. A Robotic Recording and Playback Platform can also be an option. To ensure that the surgery is recorded, high speed secured connectivity to the server with enough storage would be key.

Based on the requirements, the surgeon can order for consumables other than the ones that are already available. The nurse can order the consumables using handheld devices. Each department providing the consumables will use the same bar to scan and send to the Operation Theatre and update their system as dispatched. The consumables will have a bar code which will be scanned and updated in the system as received.

Figure 7. Smart operation theatre



At the time of surgery, the patient is in safe hands of the surgeon. However, the relatives of the patients are nervous as they don't get updates. This situation arises in cases where the surgery is complex and takes hours. Notification indicating the start and end of surgery can be provided to the patient's family so that they are ready to receive the patient at the end of the surgery and briefing by the surgeon. In case of any delays in concluding the surgery, the patient's family get notified that there is a delay. This is possible through a simple mobile application that can be given to the patient's family.

Post Operation

Different departments within the hospital may be managing various consumables required during the surgery. Hence it is critical that an integrated HMS is implemented by the hospital to have real-time and accurate exchange of information across departments. In most cases the list of consumables needs to be submitted to the insurance agencies to help the patient claim insurance and is billed according to the consumption. An integrated HMS – Billing system can help speed up the consolidation process at the hospital insurance desk and the TPA.

The surgeon needs to provide the briefing to the relatives of the patient. The surgeon can communicate with the patient's family, using the family's mobile app, by allocating a timeslot for them to visit and clarify doubts, if any. The surgeon can update the guidance on the patient database and the relatives can view this at any given point in time. The surgeon will update the details of treatment to be given post-surgery. These details will be available to the floor head nurse and the nurse assigned can access on their handheld devices.

The discharge summary can be written by the surgeon once he/she decides to discharge the patient. This discharge summary is accessible to the nursing station and the billing department. Since the billing is integrated with HMS, all the various chargeables like Doctor's consultation fees, surgery fees, consumables, ward fees, medicines etc. are all available with the billing department in real-time. This helps faster consolidation of the bill (A manual process typically takes 3-4 hours to consolidate). Post consolidation the insurance department takes over to communicate with the TPA for final approval.

The discharge summary including prescription, billing, treatment given at the hospital are all available in the EMR for the patient to refer through a mobile application. These records can be used in the future for any other ailments that patient comes back with.

Emergency Response

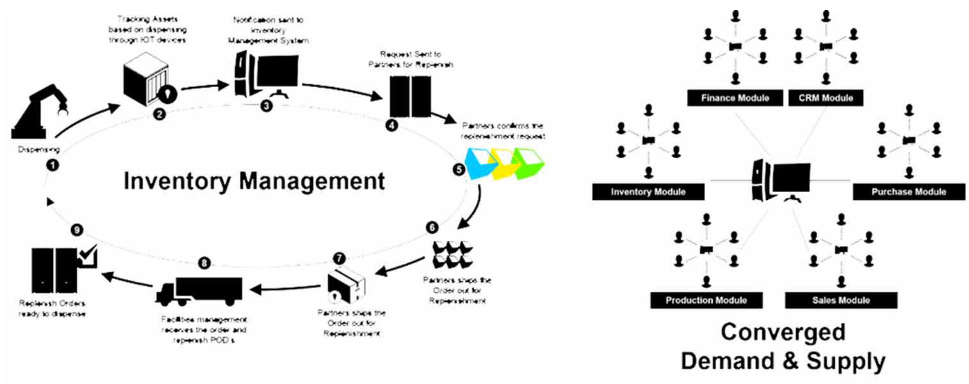
Emergency response system is extremely critical especially in hospital environment. Sensor based devices can detect and prevent accidents from happening (Zhengming Fu et al 2008) (Shany T et al. 2012). Some of the examples are stated below are some of the triggers

1. Patient falling from bed
2. Patient/child moving away from the attender
3. Arrival of ambulance into the premise
4. Responding in case of any untoward incidents such as
    a. Fire
    b. Earthquake
    c. Accident

In case of any of the above-mentioned incidents, the sensors would send alerts of the events. Since these sensors are tracked, the location of the sensor/event is identified. Using this information, the Emergency Response Team can alert the nearest nursing station/security team for an appropriate action. In case of an ambulance arriving, the security can be alerted to ensure that the Ambulance landing place is clear, and the Emergency Ward doctors are alerted to receive the patient. This helps save precious time and in turn save the life of the patient.

Emergency caused due to fire within a particular wing of the hospital means evacuation of people from the affected areas apart from controlling the spread of fire and containing fire itself. The plan for evacuation is always available with the Emergency Response team. Any last-minute modifications, if any, can be made using AR/VR. Digital Signages informing people on the direction and route to take are available. The security team and police will use the information from the Emergency Response team to help people evacuate. CCTV feeds from the affected area can be an important input for the Emergency team to guide the security team and police and any other agencies involved. SoS buttons on Mobile apps come in handy as a press the SoS button can provide information on where they are stranded and what

Figure 8. Inventory management



kind of help, they would need. Inputs on number of people around he/she can help Emergency Response team to provide the necessary support through security team and police. The number of people stranded in each location can be arrived at by processing video feeds from various CCTV cameras with the help of AI/ML.

In case of accidents within the hospital campus, CCTV footages can provide real-time feed to the Command-and-Control center who are monitoring these footages. Emergency teams can be alerted through the command-and-control center for necessary action.

Administrative

Inventory Management

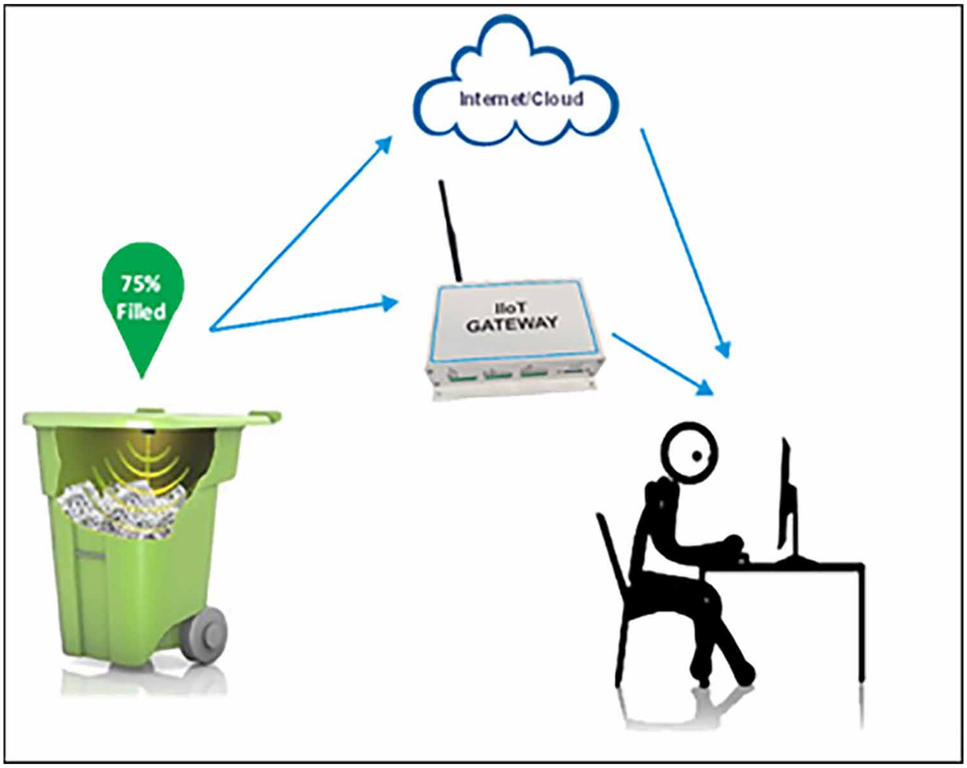
The consumption of the consumables consumed by a patient during the stay at the hospital will be updated in the inventory management system so that the inventory can be replenished in-time. Alert can be generated on each item in the Inventory management system based on threshold value set for that item. The threshold value is set by understanding a pattern of rate of consumption, time taken by the procurement to raise purchase order and time taken by the vendor to supply. Artificial Intelligence and Machine Learning can make the inventory management system a fail-proof system.

Depending on the type of equipment/material various technologies like BLE tags, RFID tags, Video based tracking etc. can be brought in to track the stock and consumption. This can be integrated with Supply Chain Software to cater to the requirements. The Supply Chain Software can be used to place order with the right vendors in time. Analytical tools will help in predicting when to order based on the rate of consumption and pace of the delivery from the supplier based on historical data.

Solid Waste Management

It is extremely important for a hospital to manage its waste especially the medical waste that the hospital generates. The various bin used to collect waste can be monitored using sensor to check the level of garbage. The garbage collector can be alerted once the garbage level crosses the threshold level. The trash can be mounted with GPS tags so that they can be located by the garbage collector. The garbage

Figure 9. Solid waste management



collector collects the garbage bins and replaces them with fresh bins. Each GPS tag associated with the type of waste that will be collected.

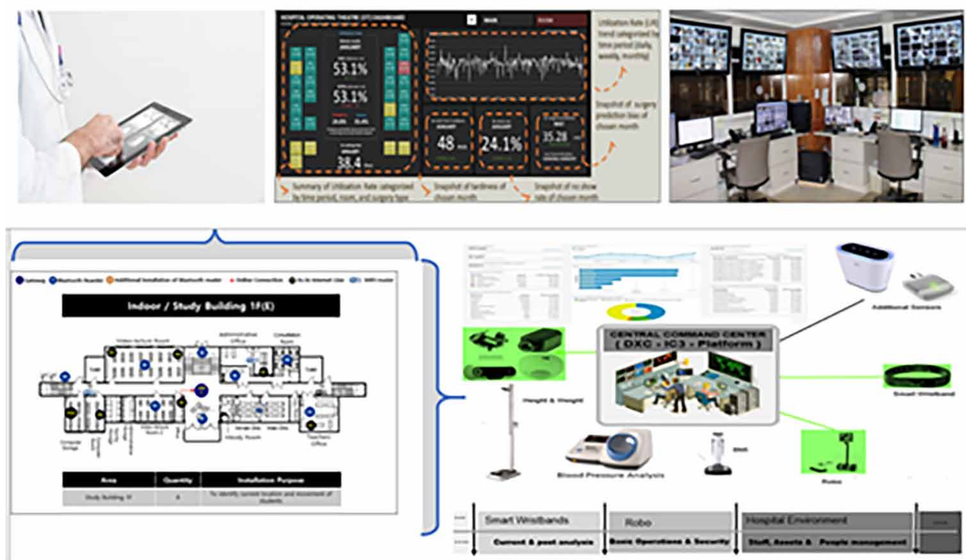
The waste needs to be disposed as per the standard operating procedures defined by the government. In most case the disposal of waste is outsourced. However, it is still the responsibility of the hospital to ensure that the waste is disposed appropriately. To achieve this goal each vehicle can be mounted with GPS systems. The vehicle routes can be fixed so that they don't deviate from the route and destination. A complete information of the time taken for the vehicle to reach the destination is monitored. All this can be achieved through a robust Vehicle Tracking System clubbed with garbage management system.

Integrated Command and Control Centre

Integrated Command and Control center (GE command and control center 2020) is setup to monitor all the activities happening inside the hospital. Representatives from each department are stationed in the Integrated Command and Control Center. This helps the hospital to co-ordinate across various departments smoothly. A digital trace is maintained of all the interactions for any audits in the future. a direct beneficiary of such a network.

The command and control center can be used for monitoring and alerting various systems like Emergency response, inventory management, locating people (lost on the premises), identify suspects (through face recognition), solid waste management etc. The data collected from each of the various systems in the hospital can be analyzed using Artificial Intelligence and predictions can be made on adverse situation

Figure 10. Integrated command and control centre



can be made. These proactive alerts can help the hospital save millions of dollars by avoiding a disaster to occur, as recovery from a disaster is always an expensive and time consuming. The command and control center are the key to success for managing various aspects of the hospital from a central location.

Robust Network

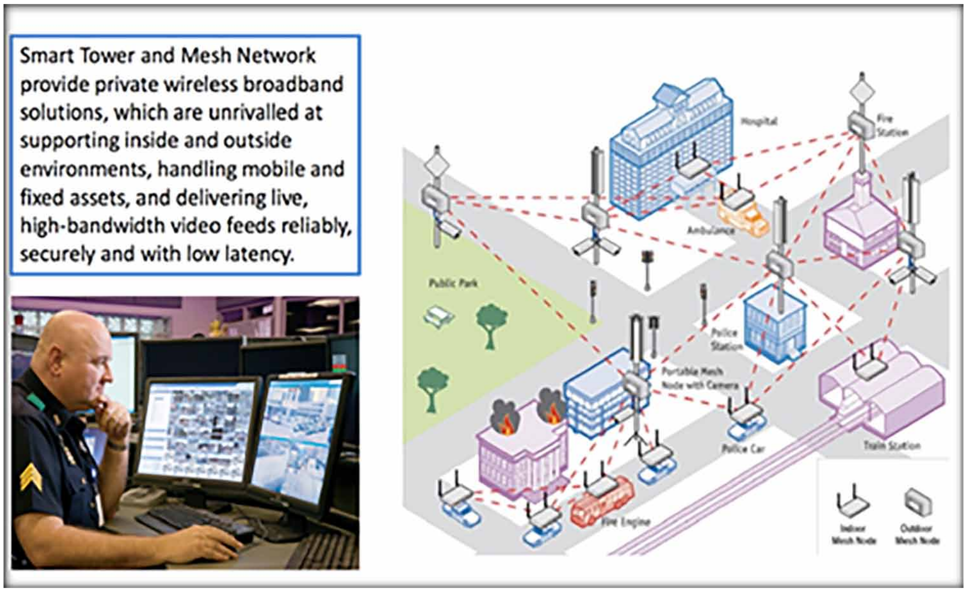
To achieve the smart healthcare use cases, a robust network within the hospital is critical. A Smart tower and mesh network help provide an integrated network within the hospital premises. This network can be used to connect various systems. This network can be used to communicate with various agencies like Ambulances, Fire engines, Police vehicles, public transport network etc. The CCTV feed from various locations with the hospital campus can be carried using this network.

TECHNOLOGY AND REFERENCE ARCHITECTURE

This section provides technology and reference architecture of end-to-end next generation health care system (Selvaraj Kesavan et al. 2018). As illustrated in Fig, the technology architecture comprises of

- Device and connectivity
- IoT Platform
- Aggregation systems
- Data management, analytics, and cloud infrastructure
- Business Applications layer
- Users and channels

Figure 11. Smart tower and mesh network



The smart healthcare use cases discussed in section 3 can be achieved using the reference architecture illustrated in Fig.12. Our focus in this section will on various technologies that enable build these use cases. There has been mention of Bluetooth based devices which collect, store and transmit the data over a given network. These devices can be easily termed as IoT devices. Though there is a mention of Bluetooth, there are other technologies that can be explored.

Below are some characteristics of IoT devices and various technologies that can be used.

IOT Devices and Connectivity

Devices and Sensors

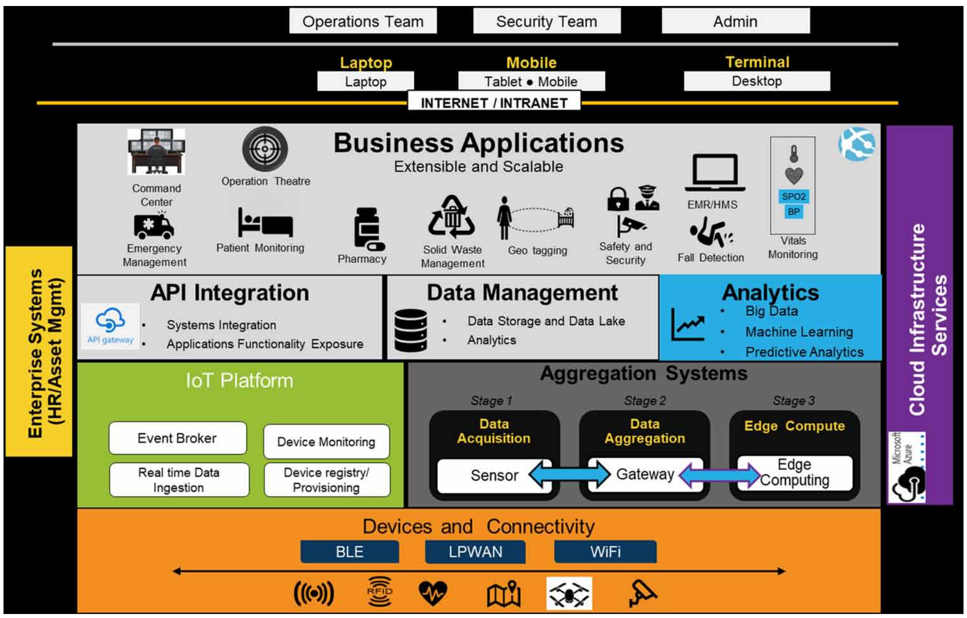
The devices and sensors are small computing devices which has unique identities. These devices and sensors can transfer data over a network. There is no need of any human-to-human or human-to-computer interaction.

The key characteristics of IoT sensors are

- Miniaturization
- Low power consumption
    - Optimal ROM and RAM
- Heterogeneous
- Unobtrusive
    - Often embedded into systems or devices without the user being aware or interaction
    - Respond to changes in the environment without user inputs
- Unique ids for each device
- Ability to communicate with

- other IoT devices
- Controlling nodes over the internet

Figure 12. Technology and reference architecture



It is important to consider all the aspects to design robust, power efficient IoT devices and create end to end solution.

Communication Protocols

To support various IoT enabled systems like in Healthcare, many protocols are evolving to collect, transmit and transport data. The communication and application protocols should have the capability to transfer information from one source to multiple sources. These protocols should further be able to collect events and respond (S. Al-Sarawi et al. 2017) (T. Moraes et al. 2019).

The key application-level protocols are

Depending on the use case, the device and the communication protocol is chosen. In all the use cases mentioned in this paper, MQTT will be applicable. Selecting Data link and physical layer protocols are important for robust, real time communication. The most preferred wireless technologies are

- Bluetooth LE
- Wi-Fi
- ZigBee
- ANT+

Other available technologies are

Table 1. Protocol – Type of communication mapping

Protocol	Type of communication
Data Distribution Service (DDS)	Device-device communication
Message Queue Telemetry Transport (MQTT)	Device-Server communication
Advanced Message Queuing Protocol (AMQT)	Server-server communication
eXtensible Messaging and Presence Protocol (XMPP)	Device-server protocol for continuous pushing of data
Constrained Application Protocol (CoAP)	Device-Server communication

- X10 – mostly home automation
- Insteon – mostly home automation
- Z-wave – mostly home automation

Wireless Topologies

These are various topology options available while designing a network using IoT devices. The table 2 depicts topology mapping with the technologies that can be used. It is recommended to deploy Mesh Network Topology in a Smart Hospital as there will be multiple walls and obstacles in a hospital. Also, alternate routes can be found easily in case one route fails.

Operating Systems

The sensors and devices are embedded hardware or small microcontroller, should have the ability to connect to the local network, running the code and transfer the data. IoT operating system (O. Hahm et

Figure 13. Communication protocol stack

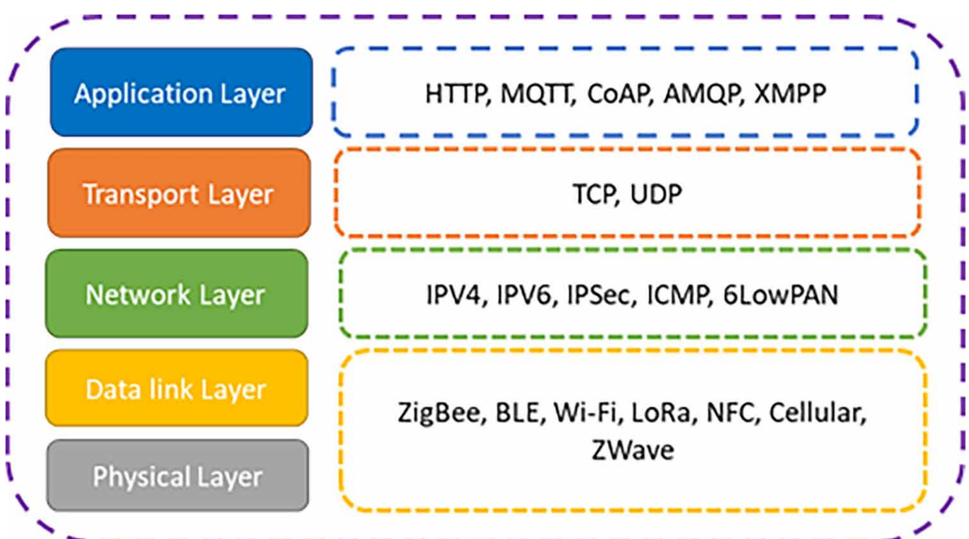


Table 2. Key specification of BLE, Wi-Fi, ZigBee and ANT

Technology	Supported by	Operating band	Range	Throughput		Latency	Power Consumption	Usage
				Burst mode	Normal mode			
Bluetooth LE	Bluetooth Special Interest Group	2.4 GHz ISM band	100 meters	1 Mbps	305 Kbits/s	2.5 milliseconds	72 microwatts	smartphones, audio headsets and wireless desktops
ANT +	Dynastream; Nordic Semiconductors and TI	2.4 GHz ISM band	30 meters	20Kbits/s	10Kbits/s	Negligible	183 microwatts	Sports and fitness. Home and industrial automation systems
Zigbee	Zigbee Alliance	2.4 GHz ISM band 784 MHz ISM in China 868 MHz ISM in Europe 915 MHz ISM in USA and Australia	100 meters	250 Kbits/s in 2.4 GHz 200 Kbits/s for the rest		20 milliseconds	90 milliwatts	Industrial and home automation
Wi-Fi HaLow	Wi-Fi Alliance	900 MHz ISM	1 Km	346 .66 Mbps	150 Mbps	1 millisecond	.210 watts	Smart Home Connected car Digital healthcare Smart factory Retail, Agriculture, Smart City.

al. 2016) (N. Al-Taleb et al. 2019) with small footprint allow the devices to perform computer functions in the embedded devices and hardware. There are multiple operating systems available that can be used to build IoT devices and solutions. The key IoT operating system which are prevalent in the market are

- Embedded Linux
- Contiki
- RIOT OS
- BeRTOS
- Tiny OS
- Free RTOS
- Windows IoT core

The top 3 Operating systems are most popular.

- Embedded Linux
    - Smartphones from Android

Figure 14. Network topologies

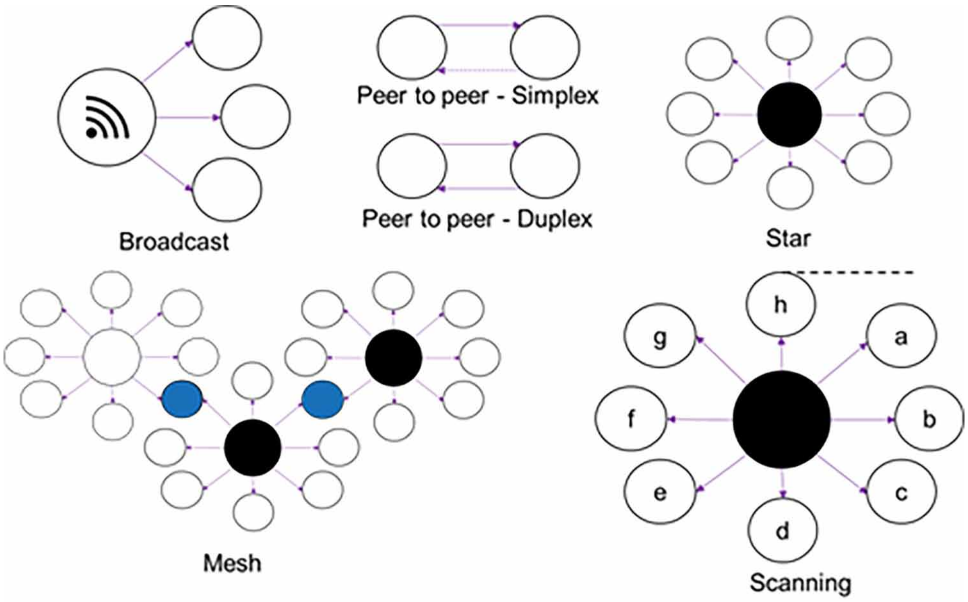


Table 3. Topology – technology mapping

Topology	Bluetooth LE	ANT +	ZigBee	Wi-Fi HaLow
Broadcast	√	√		
Peer-to-peer	√	√	√	√
Star	√	√	√	√
Scanning	√	√	√	
Mesh	√	√	√	

Table 4. Topology – Use cases mapping

Sector	Bluetooth LE	ANT+	Zigbee	Wi-Fi HaLow
Remote control	√			√
Security	√		√	√
Health and Fitness	√	√		√
Smart meters	√		√	√
Smartphones	√	√		√
Heart rate	√	√		
Blood glucose	√	√		
Positioning	√		√	√
Tracking	√		√	
Intelligent transport	√	√	√	

  - Supports cloud technology
  - Works on
    - Intel x86/x64
    - ARM A-series
- Contiki
  - Open Source, multitasking environment
  - Intended for IoT systems requiring
  - Networking (built-in TCP/IP stack; supports both IPv4 and IPv6)
  - Small memory footprint (30 KB ROM for OS storage and 10 KB RAM
  - Low power consumption
  - Web server
  - Telnet client
  - Works on
    - Atmel and AVR CPUs
    - Freescale MC13224
    - Various CPUs from TI
    - Apple II
    - Commodore
    - X86 based systems
- Riot OS
  - One of the smallest memory footprints
    - 5000 bytes ROM
    - 1500 bytes RAM
  - Same code can be compiled for 8, 16 and 32 bit platforms
  - Supports
    - TCP/IP both IPv4 and IPv6
    - UDP
  - 6LOWPAN (IPv6 over lower power wireless area network)
  - Works on
    - MSP 430 from TI
    - ARM 7
    - Cortex – M0/M3/M4
    - x86

Radio-Frequency Identification (RFID)

Radio-frequency identification (RFID) promises to advance the modern industrial practices for

- Identification and tracking
- Asset management
- Inventory management.

This technology is being successfully adopted in

- Healthcare
- Manufacturing
- Transportation and Logistics
- Retail stores
- Defense installations

RFID is fast and reliable. There is no physical line of sight nor contact required between readers/scanners and the RFID tagged item. It is categorized into passive, semi-passive and active

- Passive
    - Consumes power from radio frequency transmitted from antennas
    - Low storage capacity (up to 1 KB)
    - Short ranges (4 inches to 15 feet) to read
    - Write-Once-Read-Many or Read-Only tags
- Semi-Passive
    - Relies on batteries and RFID reader signal to communicate.
    - Reads over greater distances and broadcasts high frequencies from 850 to 950 MHz
    - Can be read from 100 feet (30.5 meters) or more
- Active
    - Relies on batteries
    - Higher storage capacity (512 KB and more)
    - Can be read from 300 feet
    - RF Interrogators can re-write if required

IOT Platform

IoT platform helps to manage connected IoT devices (Selvaraj Kesavan et al. 2021). It also provides real-time control, dynamic provision of devices and monetize IoT deployments. The major functionalities of the IoT platform are

- **Event broker-** Provides event broker to communicate large scale of device and sensors using publish subscribe pattern.
- **Device monitoring-** centrally manage of multiple devices at scale, provide remote configuration, monitoring and decommissioning
- **Real time data ingestion** – Receive real time, streaming data from multiple devices and able to analyze, store and derive insights with the help of tools.
- **Device registry and provisioning** – Dynamically on-board devices, sensors and able to provision with required credentials to communicate and stream data to the platform

Aggregation Systems

Aggregation systems comprises of

- Data acquisition - Data collected from multiple sensors, devices and actuators simultaneously.

- Data Aggregation - Data collected from variety of sources. Post data collection, data noise to be removed, filtered and aggregate the data for processing and platform ingestion.
- Edge compute - The real time data storage, computation and analysis closer to the field to improve the response, save time and act quickly. It also utilizes the local computing resources to process and analyze the data at the edge. These nodes might be gateway devices, PCs, or micro data centers.

Field gateway is part of the aggregation system and provide seamless connectivity between southbound and northbound. It also provides secure onboarding and sensor connectivity, data filtering and edge analytics.

Data Management, Analytics and Cloud Infrastructure

Data from field devices has variety, volume and velocity. To extract meaningful information from the streaming data, it is important to

- Store
- Process
- analyze the data.

Three basic elements help to achieve are

- Data Management layer – Provide big data store and data lake to store streaming and processed data.
- Analytics layer – The store big data needs to process with distributed, parallel computing environment and tools. The appropriate learning algorithms applied to derive descriptive and predictive insights. The derived performance index and insights can be directly viewed from the business applications.
- Cloud infrastructure - Platform to provide on-demand compute, storage and network resources as a service without direct management by the user

Business Applications Layer

Business application layer comprises of multitude of healthcare applications such as vitals monitoring, Fall detection, EMS/EHS, smart waste management, smart operation theatre, geo-tagging, command and control center. The various use cases and stockholders' responsibilities are described in the section 2. The applications can use the underlying components and provide the real benefit to the healthcare users.

Users and Channels

The various channels such as smart mobile, desktop, tablets help to access derived smart healthcare use cases. The potential users of the smart healthcare system are patients, doctors, operational, security team and administrators.

CONCLUSION AND FUTURE WORK

This current work has been presented in this paper and it is very clearly articulated that Smart Healthcare is getting into a reality zone as more hospitals experiment / adopt to the new ways of providing Health care services. The sections above demonstrate with clarity that the key elements of Smart Healthcare encompass the following primary tenets,

1. IoT enabled Smart Health (including Cloud Technology)
2. Increased efficiency in Post and pre-operative procedures leveraging technology (Like Robotics)
3. Improved patient care experience using body sensors, wearables and wireless networking. (Remote Monitoring, high patient mobility and data Analytics)
4. Wellness is a key proactive health driver in the coming years (Preventive Health care)
5. Socially responsible Connected Hospital Management with ERS and Waste management

It is very evident that a city / nation can revolutionize Health care only with robust and good networking (mobile, Internet, Wide Area Hospital Networks). Connected hospitals, Connect Medical Transport and patient Data made available anytime anywhere from various cloud technology, not only makes an ERS highly efficient, but also creates a patient care eco system which delivers with highly reliability and rich patient experience. By now it is obvious that technological evolution is redefining the way healthcare is changing. As a future innovation, emphasis is on the following areas,

- More accurate biosensors, body bio-patches: Increased patient mobility and powered for critical care
- Miniaturization with high power optimization
- Wearable devices for accurate and real-time Vitals monitoring
- Highly intelligent robotics for Assisted procedures
- Real-time data analytics and AI technology for quick diagnosis (preventive measures through predictive analytics driven by medical domain algorithms)
- Improve data security handling for making patient data available from a cloud anywhere anytime – Consolidated EMR / HDR in cloud.
- Standards and compliances for Next Generation Smart Health
- High speed and secured Networking / connectivity

While Technology innovations are targeted, below areas of medical field are the targets for future work in a bigger medical landscape,

1. Geriatric care,
2. Robotic Surgery,
3. Assisted Diagnosis based on AI,
4. Machine Opinions,
5. Auto drug dispensing with dosage to patients with Real-time diagnosis

Finally, and as an Authors note, cost effective, reachable, and affordable healthcare to public in every nook and corner of nation is the next big development largely populated nations like India are evolving towards. Some of the government initiatives are poised in that direction. E.g. Ayushman Bharat healthcare program in India by GOI for the people of India to benefit a population of billion plus.

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