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THE APPLICATION OF DRONE TECHNOLOGY IN CONSTRUCTION PROJECTS: RISK MANAGEMENT APPROACH

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Abstract. *Recent lockdowns and social distancing guidelines in several countries around the world have increased the adoption of new technologies to overcome the challenges faced by businesses to continue their ordinary operations during these unexpected periods. One of these are the challenges facing construction projects as for being physically present at the construction site to conduct site inspections. Artificial intelligence, robots, and state of the art communication technologies are increasingly adopted in businesses as part of their risk management activities to overcome these challenges. Recent literature on the utilization of drone technology in operations used the concept of "Dronification" to indicate the process of utilizing drones or "Unmanned Aerial Vehicles" (UAVs), to capture images and videos to serve several complex business operations. In this regard, the utilization of drones' technology may be viewed as an essential tool for inspections during the periods of lockdowns and social distancing. In addition, this technology may be utilized to improve the quality of the inspection by obtaining information and detail that may not be readily obtained without expensive access methods and sometime the interruption of the service is required. This technology can aid structural engineers in performing different nondestructive tests and plan future destructive ones. Also, using drones would be considered as beneficial in highways and bridges inspections where safety is a major issue.*

This paper is designed to explore the use of drones' technology in construction projects as a risk management tool in the events of pandemic. The study is designed to understand the perceptions and attitudes of the key stakeholders of construction projects regarding the use of drones' technology for inspecting construction projects.

1 INTRODUCTION

Since the beginning of 2020, the outbreak of Covid-19 pandemic affected the way businesses are conducted. Regulations related to social distancing and lockdowns made in-person activities to be very limited [1]. To be physically available in some activities such as projects inspections and valuations has become a challenge that businesses should overcome. Recently, businesses are exploring the potential of robotics and artificial intelligence in many operations [2]. The advancements of information and communication technologies, Artificial Intelligence, and robotic process automation paved the way to explore their utilization in the current period characterized with social distancing and lockdowns [1] [3]. Therefore, the unexpected events of lockdowns and social distancing are making industries to consider the utilization of new technologies in their risk management plans. In this regard, the continuity plans of business operations should be emphasized even if it is not possible for manpower to be physically available.

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In addition to that, inspections of some construction sites may be considered as dangerous or time consuming when considering in person inspections [1]. All these give raise to explore technological alternatives that replaces the necessity of physical inspection [4] [5]. In the case of construction projects inspections, this might be done by relying on robots or drones.

This paper links the utilization of drones' technology in construction projects. The main purpose of this paper is to present theoretically the potentials of using drones technology as part of business risk management plans. The paper is visionary and needs more practical experiments to be conducted in practice. Although drones are used in civil engineering project, it has not been studied from a risk management point of view. This paper is filling this gap in the literature by considering a management lens.

2 DEFINING RISK MANAGEMENT

In business research, there is no commonly agreed definition of the term "Risk". However, most literature agreed on three building blocks when defining "Risk"; these are: probability, future, and unfavorable outcome. To that end, "Risk" is often associated with the possibility that an undesirable state of reality (adverse effects) may occur because of natural events or human activities [6]. Given that lockdowns and social distancing are considered as probable, futuristic and unfavorable, they can be considered as risk factors that businesses should include in their risk management plans. In this regard, companies should consider the probability of these events to occur in the future and to put into considerations action plans to minimize the losses in case these events occur.
Risk management is a preventive based planning that a company should always consider to assure minimization of any future losses that might happen if an emergency event happen. This encompasses the continuous assessment of the company's operations as well as preparations in terms of the readiness of human resources as well as readiness of necessary technologies and procedures [6].

3 THE CONCEPT OF "DRONOFICATION"

Previous literature on the utilization of drones in businesses introduced the term "Dronification" which indicates the process of using drones to capture videos and images to perform numerous complicated operations [7]. This novel technology is progressively being considered as emerging in several businesses sectors such as construction projects. Prior studies pointed out many benefits for using this technology in certain activities, for example: operations are being conducted more in more efficient and effective manner, lowering risks and increased safety, and cost reductions. These benefits are motivating for more opportunities to employ drones ranging from environmental surveys to massive projects such as bridges and highways. [8] explained that drones are considered as a technique of technological sensors for collecting information on the principles of IoT technology for enterprise management purposes. It is noted that the literature in this area is limited in business and management studies. In this regard, it is indicated in recent studies in emerging accounting technologies noted the potentials of drones to automate some traditional and repetitive accounting processes (for example: inventory management, safety, and environmental audit). Stemming from this fact, [7] projected that the future of the profession of accounting will be significantly affected by several innovations including drones. Moreover, international accounting firms with clients with mining activities are using drones to capture videos and pictures for asset measurement procedures. As a result, the auditor can estimate the natural reserve according to the captured images from the drone. Recently, and according to [1] and [8] PricewaterhouseCoopers (PwC) has started experimenting the first inventory count audit relying on drones. The images were used to measure the capacity of the natural resource, and then the value of the natural resource is measured according to the capacity of the reserve. Accordingly, various implications can be employed using drones in the auditor work, this includes efficiency in terms of time and efforts, accuracy of the estimates as well as the measurements and, the observed advantages in terms reducing risk. Moreover, drones can be used in construction projects in different stages commencing from the preliminary site survey toward the final stage of the project. In this regard, site surveys which may be time consuming in the traditional ways can be completed within hours if drone technology is employed. Likewise, drones are used in agricultural projects, offering the ability to capture, save, and process the captured videos and images of remote and large farming lands [7].

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4 USING DRONES IN CONSTRUCTION PROJECTS

When compared to the literature in business and management studies, prior literature examining harnessing the power of drones technology in civil engineering is well established. According to [9] the attention toward drones technology in civil engineering has increased dramatically. The study explained how to use a drone as a supplementary tool for bridge inspection. It is demonstrated that the site inspection of the bridge is performed at a lower cost. In addition, using drones can have safety benefits when collecting data from areas that are perceived to be dangerous to reach in person. Also, the data captured by drones are considered more accurate as well as improved quality of images and videos. Other benefits are documented regarding applying the technology in construction projects including: the suitability of applying the technology in huge and risky projects, safety issues related to insuring the safety of persons involved in construction sites inspections, improved accuracy outcomes, assessing in determining the percentage of accomplishment of the construction projects [1], and finally being part of the risk management plan of the company.

Prior studies indicated the challenges of applying the technology in construction projects inspections, these include: (1) the speed of the wend during the flying time, (2) sun and snow overexposure to the camera of the drone, (3) areas with low levels of light, (4) governmental policies and restricted areas, and (5) obstacles objects in the drone flying path [9] [10]. In addition, [9] explained the four steps regarding using drones in construction projects: (1) the identification of the construction project structure, (2) the flying route path of the drone, (3) capturing images and videos, and (4) storing and processing the captured images and videos.

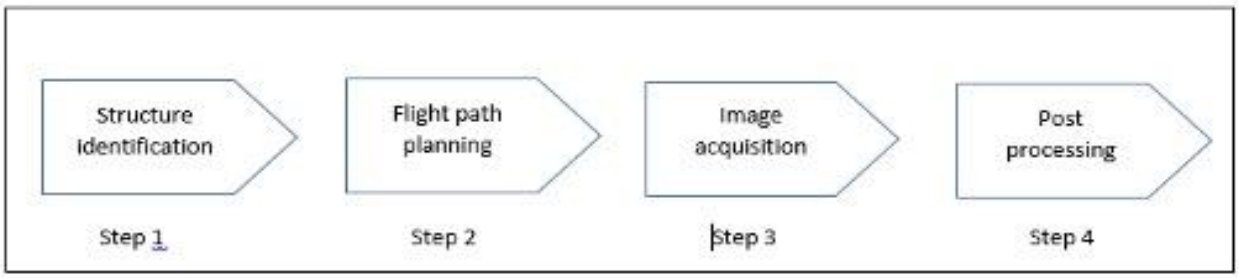

Figure .1 Fig. 2. Steps to use drone technology in construction projects site survey. Source [9]

5 PROPOSING A RSIK MANAGEMENT FRAMEWORK

The proposed risk management framework in this paper is presented in figure (2). The framework considers two time periods: the first time period represents normal periods with no emergencies or pandemic regulations, the company in these periods is making sure that it is always "being prepared" for any unexpected event. The second time period is during the pandemic where there are restrictions related to lockdowns and social distancing that prevent engineers to be physically present in the construction project to conduct site inspections.

In the "being always ready" phase, the company needs to make sure that the persons who will be involved in using drones for sites inspections are getting the necessary training. The training should consider the actual drones that will be used in the case of emergencies as well as the construction sites. In addition to that, in this stage the company should go through the specifications of the drones that will be needed. In this regard, [9] highlighted the following specification for bridge inspection (p113): "to efficiently select a drone, the following seven considerations were studied.

- The first specification to consider is the flying time of the drone, the longer flying time is the better providing a more efficient and inclusive site inspection. In this regard, the battery life of the drone is an important element to consider.
- Adding additional cameras with high resolution capabilities to the drone which will enhance the ability to capture detailed images and videos.
- Ability to add extra components to the drone such as flashlight as well as LED lights to the drone
- Long-range remote control of the drone.

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In the second phase which is the occurrence of the unexpected event of "lockdowns" and "social distancing", the engineer is restricted from being physically available at the construction site to conduct the site inspection. In this case, the company will initiate using drones on the needed construction projects site visits. It is important for the company in this phase to document the experiences of the persons involved in this process so that they give their feedback to continuously improve their inputs for future training and selection of equipment.

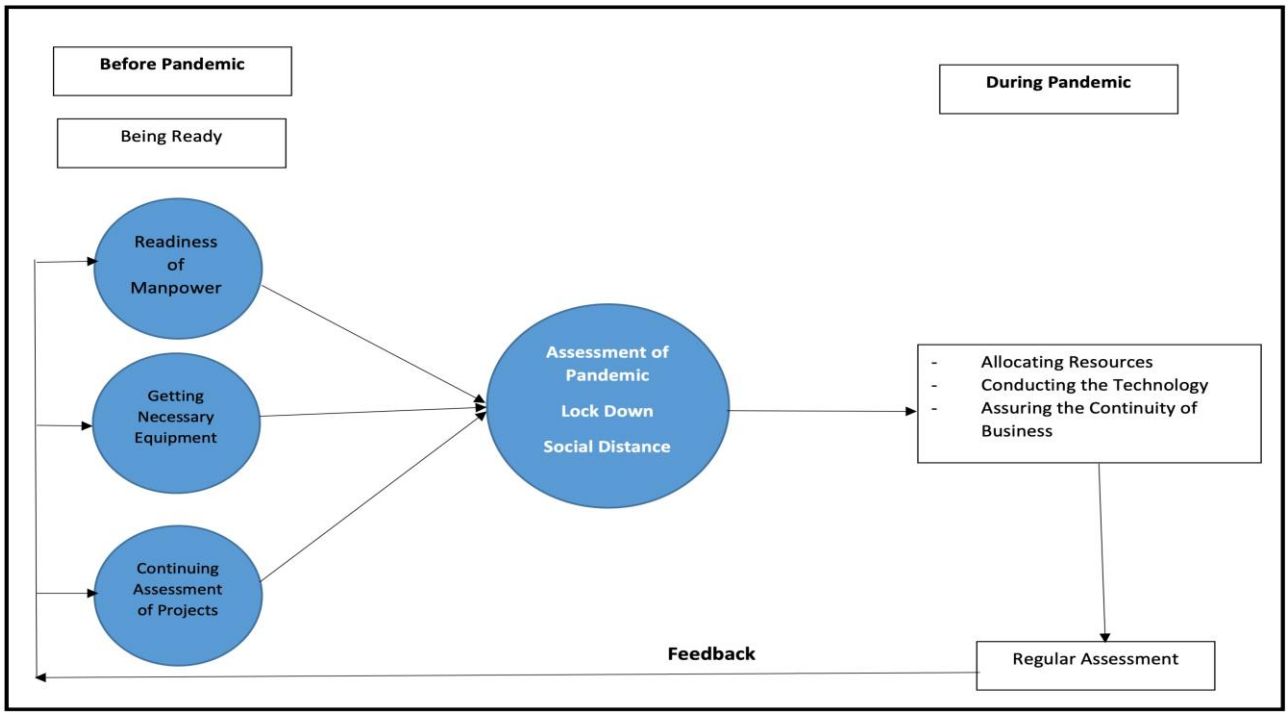

Figure 2. Proposed framework of including drones in Risk Management plans

6 CONCLUSIONS

The recent events of lockdowns and social distancing made businesses consider unconventional methods to ascertain the continuity of business operations. This paper is focusing on the challenges facing construction projects when lockdowns and social distancing guidelines are implemented. In this case, in-person site visits are not possible. Construction projects can consider the use of drones to replace the role of the engineer as for being physically present at the construction project site. In addition, companies should include the application of drones technology in their risk management plan. The proposed framework presented in this study is depicted in figure (2). The main theme of the proposed framework is based on the idea of being prepared, implement, assess, getting feedback and continuous improvement.

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