

Comparison Of The Supervisory Cost Of Using An Unmanned Aerial System And Conventional Methods In Construction Projects

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Abstract. Unmanned Aerial Systems (UAS) are a growing aircraft technology being used in all sorts of industries. Despite studies exploring the potential applications of UAS, such as photographs or video collected by UAS, its benefits for the supervisory job on construction sites is not well understood. This paper presents a comparison of the supervisory cost generated using UAS and that from the conventional method. In this study, both five projects applying UASs and another five using the conventional supervisory method participated voluntarily. The survey used questionnaires targeted to people working in a supervisory job within the five projects. The results showed that most potential applications were particularly suited for tracking and monitoring job progress, evaluating safety monitoring and support, and inspecting difficult areas. In comparison, it was found that applying UAS was more cost-effective than the conventional supervisory method. The average supervisory cost to total wage generated from the project supervisory job by applying UAS and conventional methods were 0.212% and 0.450% respectively. Despite insignificant differences, the study provided a picture that, by applying UAS properly, it would be able to have a potential cost saving in the supervisory job in construction.

Objectives. This study focuses on UAS (drone) as a supervisory device to compare the effectiveness of drone application and traditional methods in monitoring and inspection. The study aimed at 1) evaluating the current application of UAS in construction projects; 2) analyzing the factors influencing supervising and monitoring a project using UAS, and 3) comparing the cost of monitoring and supervising using UAS and conventional (traditional) methods.

Methodology. A literature study was used to get as detailed information as possible about the use of drones in the construction world; the authors found five sources as benchmarks for this study. Research conducted by Yukio [5], Irizarry et al [15], Zack [8] and Irizarry and Costa [12]. From these five studies, the authors developed an overview of the use of drones in the construction industry, as well as a reference in looking for data related to this research. The primary data were delivered to the respondent office either directly or using email, while the secondary data, such as detailed workers, costs and current application type, obtained from the project. To examine the problem, the authors used questionnaires and interviews with several parties that participated in the construction sector. The data obtained from the questionnaire was the primary data. The instrument used in this research was adopted by Irizarry et al. [15, 17]. To identify the data, several steps were taken. After the questionnaire was filled out by the respondent, the completeness was checked.

Results and Discussion.

General information. The number of questionnaires that were distributed is 30. They were sent to several construction companies that have a project on Yogyakarta, Makassar, and Jakarta. From the total surveys distributed, 14 questionnaires were returned and ten were required for this study. The ten questionnaires consisted of 10 construction companies. Distribution and collection of the questionnaire required approximately two months. Some of the companies rejected and did not respond to the questionnaire due to: i.e., company privacy, busy on their project, etc. There were ten cases, five that implemented the UAS partially, and another five that applied purely conventional (traditional) supervision. The respondents were placed in four groups based on their work experience. The respondents with the largest percentage were respondents with work experiences 15 years—30% for each group. Next, respondents with 10–15 years of work experience is 10%. The analysis of ten projects shows that most of the projects have five similar salary projects with costs from 3–6 Million Rupiahs for UAS Supervision, and the rest of the projects with the same salary had 3–6 Million Rupiahs. Some of the chief engineers were interviewed and reported that the salary for the UASs supervisor is the same as the conventional because the duty is the same, but there is an additional charge due to the ability operator obtain a Remote Pilot Airman Certification from FAA (Federal Aviation Administration) worldwide, but the Indonesia regulation is Indonesian Ministry of Transportation no 180: 2015. In addition to the regulation, the Indonesian Air Force also restricts the open flight area.

Comparison analysis of the cost of monitoring and supervision. The study of ten projects showed whether most of the projects had a similar salary range, five projects paid 3–6 Million Rupiahs for UASs Supervision, the other 5 projects with the same pay were 3–6 Million Rupiahs. From both methods, there was no difference in salary for supervisors or inspectors in term of UASs and conventional monitoring. Referring to the cost for supervision, some of the chief engineers interviewed said that the salary for the UASs supervisor is the same as the conventional because the duty is similar, but there is an additional in charge fee because the ability operator can operate and obtain a Remote Pilot Airman Certification from FAA (Federal Aviation Administration).

Table 1. Knowledge and experience of using a drone.

No	Response	Answer	(%)
A	I know very well, and I have the experience to use it	1	10%
B	I know but do not have the experience to use it	4	40%
C	I am interested and studying it now	4	40%
D	I only know the word UASs (drone)	1	10%
E	No, I do not know it all	0	0%
Total		10	100%

Table 2 shows that the number of respondents that answer questions about the number of staffs to implement UASs (drone) supervision: 2 to 4 staffs in projects is two (40%), 5 to 7 staffs are 3 answers (60%). For conventional supervision staff, four (80%) answered from 8 to 10 staffs, and only one project answered with more than 11 staffs.

Table 2. Total employees acquired for supervisory of two methods.

No	Staff	Partial UASs	Conventional
1	2 – 4	2 (40%)	
2	5 – 7	3 (60%)	
3	8 -10		4 (80%)
4	> 11		1 (20%)
Total		5 (100%)	5 (100%)

Table 3. Comparison of worker wages cost using drones and conventional methods.

No	Cases	Cost to Total		Total Wage
		UASs (%)	Conventional (%)	
1	Project 1	0.040%	0.117%	0.157%
2	Project 4	0.054%	0.163%	0.217%
3	Project 7	0.022%	0.065%	0.087%
4	Project 8	0.034%	0.171%	0.203%
5	Project 9	0.066%	0.329%	0.394%
		Average		0.212 %
6	Project 2		0.339%	0.610%
7	Project 3		0.164%	0.196%
8	Project 5		0.711%	0.853%
9	Project 6		0.196%	0.235%
10	Project 10		0.295%	0.354%
		Average		0.450 %

Comparison of cost between two methods. Supervision cost for both methods were based on the working experience of the respondents. The respondent who applied UAS were being aware of the cost components when applied to supervision such as to: 1) train the staffs, 2) conduct a study of UAS implementation in the company, 3) purchase UAS and obtaining license; and 4) establish the company's UASs procedures or manuals in operation and maintenance. In the light of these awareness, respondents provided the supervision cost as shown in Table 3. It shows the comparison the total wage staff to determine which method is issuing more cost-effective financing. Calculating both supervisory wages showed that the average costs were 0.212%, and 0.450% for using drones and conventional, respectively. Note that the projects using drones should also be partially applied to conventional since the nature of building projects in interior works are difficult to access by the drones. From the result of the calculation shown in table 3, it also shows the difference in the total staff wages based on the planned and specified budget. Despite there were found different of average supervision cost for both methods, a test was carried out using independent samples t-test for comparing UASs and conventional supervision. Result obtained a probability of 0.113 from t test indicating that there was no significant difference between the two methods.

Conclusion. In terms of the data, quality and costs factors are very important in construction project implementation for this study. This study found that UASs and conventional supervision has an effect or impact benefit and outcomes on data, quality, and cost factors due to obtaining visual assets. Specifically, the result means that factors have significantly impacted the project timeline, as well as the project, receive a very high return on investment. In terms of factors in project implementation construction, the results indicate that UASs and conventional supervisors have effect benefits and outcomes on management aspect factors due to obtaining visual assets. It was found that the management aspect is more beneficial and with fewer outcomes in terms of obtaining visual assets. The responses of contractors and consultants on usage factors were carried out using independent samples t-test for comparing UASs and conventional supervision. The study shows that there was no significant difference between two methods. These results indicate that UASs have increased benefits and outcomes on usage factors due to obtaining visual assets compared to conventional supervision. The study found that by implementing UASs on construction projects, not only could the contractors able to increase the effectiveness of the job they perform but they could also reduce their return on investment for projects, all due to the innovation and usefulness of UASs.

Suggestions. Base on this study regarding UAS application in construction projects, there are some recommendations as consideration for further studies. 1) Research should focus on evaluating the financial implications in detail to determine what project characteristics could affect the financial feasibility of UASs in inspecting and supervising both for new building, and operation/maintenance. 2). The study would further include the impact of UAS application, the impact of the learning curve in the use of UAS technology by construction personnel, privacy concerns, and safety issues that may be related to the use of UAS technology on job sites. 3) UAS application is not widely used in construction stages and can greatly vary from project to project. Future research should observe supervisors operate a drone in a proper way and assess the performance of UASs for the tasks that may be considered feasible with UAS technology in the field. 4) UAS Applications seem to be more effective in infrastructure projects covering larger areas such as highway and bridge, dam, airport, seaport, and energy projects construction.

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