AUTOMATED ATTENDANCE MANAGEMENT SYSTEM FOR CONSTRUCTION WORKFORCE MANAGEMENT

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Abstract— There is a traditional way to record attendance of construction team in Singapore which is punch card attendance system. Aiming at the disadvantages of this system, an Automated Attendance Management System (AMS) was implemented on worker's time and attendance management. This paper reported the results of configured the setting on Management Software that was able to arrange various division and work schedule, which was suitable for construction team. This system was applied to computerize time and attendance data of workers through Biometric Device & Management Software which accelerated the recording process of time and attendance data and generated comprehensive attendance reports. Furthermore, existing worker's time card was collected and conducted manually tabulation to make a comparative analysis between these two systems. Eventually, the results showed that AMS was a viable method to enhance workforce management.

Keywords— Workforce Management, Attendance Management System, Biometric Reader, Management Software.

I. INTRODUCTION

Construction projects in Singapore are labor-intensive industries and the divisions of labor involves a diverse range of trades such as structural works, architectural works, M&E works, etc. (Building and Construction Authority, 2009). Thus, builders need to employ a large number of construction workers to execute different trades at specified schedule and companies are required to keep all workers data including attendance record under employment law (The Law Society of Singapore, 2013). Attendance management is the acts of managing attendance in a construction site to minimize loss caused by workers absenteeism or not working on time. Hence, time and attendance data of workers is an essential part of the construction site as it used for workforce management (Akinduyite, C.O et al, 2013).

Workforce management is important to manage a set of workforce by track and control the workflow in construction site. Effective workforce management helps main contractor to fast and easily monitor attendance of both in house and sub-contractor workers (Stefanie Gilbert Brandenburg et al, 2003). In addition, management team is able to track availability of adequate manpower on site with the ease of monitoring. Most of the employer utilizes time and attendance system to collect working time data, and a comprehensive attendance reports significant to enhance the workforce management in term of appraising the performances of workers, evaluating the workload and controlling the manpower (Benefits Interface, 2013) (Chad Brooks, 2015).

In order to calculate the project productivity, BCA, a statutory board under the Ministry of National Development of the Singapore Government collects productivity data of building projects on a monthly basis using the Electronic Productivity Submission System (EPSS). In accordance to Regulation 10 of Building Control (Buildability) Regulations 2011, it is a mandatory requirement for builders to monitor the manpower usage in their projects and submit the monthly manpower report to BCA through the EPSS (Building and Construction Authority, 2011). This is to help builders to better manage and monitor the manpower usage to improve their productivity, and the collection of productivity data can be used to assess a project's productivity performance for builders to set improvement targets for future projects (Building and Construction Authority, 2012).

There are so many aspects of construction projects needed to be addressed, the one which is utmost important is workforce management. Manpower resources and attendance sheets are handled on everyday basis yet still confusion persists and this is common scenario on the construction sites (Snehal Joshi, 2014). Punch card attendance system would not streamline the workforce management yet it brings some hidden faults and problems of attendance data. Therefore, adopting advanced system to efficiently manage the workforce is necessary as it potentially can save time and effort (Kanchan & Shweta, 2009). While, the above studies has showed that the use of computerized system to record and report of worker's attendance and working hours was more effective than manual process system. However, some of the existing software management system is inappropriate to produce BCA monthly manpower report for construction teams in Singapore. Besides, detailed comparative analysis between software management system and punch card system is insufficient. Therefore, the main objective of this research is to study the functional specification of AMS. Subsequently, configure the setting on existing attendance management software which suitable for Singapore construction team. In addition, develop a new template in Excel link with attendance report generated from management software to accelerate

monthly manpower report generation for various trades with reference to BCA's EPSS guidebook. Another objective is to investigate the efficiency of this system by comparing the AMS with punch card system. Thus, an experiment is conducted by using Microsoft Excel to manually tabulate the time data on the time card to obtain the findings. Based on this basis, this study is to demonstrate that the AMS is a workable option which can be adopted by the construction industry to enhance the workforce management.

II. METHODOLOGY

Whether a small or a large scale project, there are onerous tasks on the construction sites in terms of monitoring and recording time and attendance of workers (Snehal Joshi, 2014). This applied research provided solution to automate and accelerate the reporting process of time and attendance data through employed the experimental method based on hardware and software which involved fingerprint identification by using Biometric Reader to collect and download data to Management Software to experiment its operation. Additionally, existing worker's time card was collected and manually tabulated to makes a comparative analysis between two systems.

2.1. Data Collections

This research was conducted with awareness of ethical considerations for data collection and analysis. At the initial stage of this research, functional specification of apparatus which were Fingerprint Reader model VT400 (FR-VT400) & Vigilance Attendance Management Software (VAMS) was acquired from supplier called Captain Technology System. Subsequently, the primary time and attendance data of participants was collected by using FR-VT400 from a manufacture factory in which involved fingerprint identification of 50 participants with a timeframe from 1st August 2015 to 31th August 2015. Besides, the project details were on an assumption and the 50 participants was assigned in different trade as shown in **Table.1** and the "Trade-code" is reference to the item of trades on BCA's EPSS guidebook (Building and Construction Authority, 2015).

Furthermore, 10 pieces of existing time card in the month of July 2015 were collected from a land survey company and gave it to 5 participants respectively. Each participant used Microsoft Excel to manually tabulate the time data on time cards. The amount of samples such as time and attendance data and time card data for this experiment was acquired from only a subgroup rather than a large group which was based on representative samplings and it was to save time and effort. These representative samplings of data were sufficient to produce appropriate attendance reports and conduct comparative analysis. (Saunders, M., Lewis, P., Thornhill, 2007)

Table.1. Project details and sample size of AMS

Project 1				
Group	**Trade-Code**	**Decription**	**Participants**	**Timeframe**
Main Contractor	Trade 1	Site Mangement Team	5	1st ~ 31th August 2015
	Trade 31	Carpentry	3	1st ~ 31th August 2015
	Trade 32	System formwork installation	4	1st ~ 31th August 2015
	Trade 33	Steel reinforcement fixing	4	1st ~ 31th August 2015
	Trade 41	Brick/Blockwall	4	1st ~ 31th August 2015
	Trade 43	Plaster	4	1st ~ 31th August 2015
	Trade 410	Tiling/marble/stone	4	1st ~ 31th August 2015
Sub-Contractor A	Trade 37	Structural steel work	4	1st ~ 31th August 2015
Sub-Contractor B	Trade 46	Glass partition	4	1st ~ 31th August 2015
	Trade 47	Cladding/Curtain wall	4	1st ~ 31th August 2015
Sub-Contractor C	Trade 48	Waterproofing	3	1st ~ 31th August 2015
Sub-Contractor D	Trade 51	Plumbing/sanitary/gas system	3	1st ~ 31th August 2015
Sub-Contractor E	Trade 53	Electrical system	4	1st ~ 31th August 2015
		Total	50	

2.2. Procedure

Use FR-VT400 to input fingerprint data of participants into the VAMS. This system recognizes an individual by comparing participant biometrics with every record in the database. First of all, the fingerprint of the participants were captured and enrolled by fingerprint reader and the unique features were extracted and stored in a database. Consequently, participants used their fingerprint that has been enrolled in the database for authentication when they started and stopped work at workplace. During the authentication, the fingerprint of the participants was captured and the extracted feature was compared with the ones already existing in the database to determine a match. After the matching, it would update the database of attendance records of the corresponding participants. With this simple method, participants merely place the finger on the reader sensor and the time and attendance data of them can easily to obtain.

During the attendance data collection period, VAMS was installed in the computer and network interfaced with fingerprint reader to download individual fingerprint data of 50 participants and input their information such as name, job title and etc. into VAMS. Consequently, configured the setting on VAMS to set up the group, division and "Trade-code" then allocated the 50 participants in their trade respectively. Furthermore, added the timetables and created work schedule with time range from 1st August 2015 to 31th August 2015 then arranged the schedule of trades to 50 participants. After data collection was completed, used computer to run the VAMS to obtain the attendance reports. In addition, developed a new template by formulate cells and format sheet in Excel with reference to BCA sample report to generate monthly manpower report through set up the mode of the attendance report in VAMS to export the data out and insert it into Excel spreadsheet. In addition, 10 pieces of existing time cards were collected from a company and gave it to 5 participants respectively. Each participant used Microsoft Excel to manually tabulate the time data on time cards and makes a comparative analysis on the

length of time for recording process, accuracy of time data and functionality between the two systems.

III. RESULTS AND DISCUSSION

This section provided a general overview of comparative results of AMS versus punch card system in term of the length of time for recording process, accuracy and functionality between the two systems. In the test of punch card system performance, the results showed that each administrator spent approximately 100 minutes tabulated and calculated the time data on time cards of 10 workers by using Microsoft Excel. However, there are total 50 typo errors and 43 miscalculations of time data during the data entry process conducted by 5 administrators. Furthermore, no automatic report was generated through punch card system. Experiment results showed that the AMS spent approximately 1 minute recored the time data into VAMS for each worker and there are no typo error and no miscalculation during recording and calculating process. Besides, in the functionality test, AMS could automatically calculated time information of each worker through VAMS and generated 10 types of worker's attendance reports in about ten minutes. These attendance reports showed the detailed time information of each worker in August such as daily attendance statistic, working time, workday, timetable, late arrival and leave early time, overtime, etc. Furthermore, results of developed a new template in Excel link with attendance report generated from VAMS was success and the BCA monthly manpower report in August of 50 workers was successfully produced through new Excel template in about five minutes. This August report showed the total manpower usage of various trades in manday and one manday is taken as one worker working for 8 hours. Moreover, daily manpower usage of various trades was indicated in total hour and tabulated in the report.

The results of comparative analysis between AMS and punch card system were tabulated as shown in **Table.2**. Subsequently, 10 types of attendance reports generated from VAMS were tabulated as shown in **Table.3**. Besides, the BCA monthly manpower report of 50 workers with reference to the project details in **Table.1** generated from new Excel template was shown in **Fig.1** and **Fig.2**.

Based on the results of the test as shown in **Table.2**, the total time for recording & calculating process of time data in punch card system was more than five times, compared with AMS for 50 workers. Therefore, the length of time for processing of time data could be reduced 90% by using AMS and this can be a great time saver to administrators. AMS has good performance in provide high accuracy of time data due to all the time data of workers was automatically flowed from FR-VT400 to VAMS without manual intervention through placing the finger on the fingerprint reader sensor and the clock in and clock out data was recorded and downloaded directly to VAMS. Hence, this attendance system provided a very convenient manner to obtain worker's time information and in the meanwhile prevented impersonation and ambiguity of time data. In addition, the test result showed the punch card system contained more error rate then AMS and the main source was finding from data manually entered incorrectly and miscalculated the working hours.

Effective workforce management required the system to provide comprehensive attendance reports of workers to track and control the workflow in construction site. Therefore, implement attendance management system with functionality of automatic reports generation was an essential part of workforce management (Stefanie Gilbert Brandenburg et al, 2003). The proposed AMS is a computerized system that able to generate 10 types of attendance reports and this attendance reports able to link with new Excel template that developed in this research to accelerate in producing BCA monthly manpower report. Subsequently, this system enabled builders to submit monthly manpower report to BCA in a more accurate and automated way. Instead, punch card system is a manual system without functionality of automatic reports generation and yet lead to a number of additional issues such as inaccurate and unreliable timekeeping. Thus, AMS able reducing the time it takes to record and calculate the working hours of worker for payroll process while also increasing the data accuracy by automating calculate of time information can lead to increases in both productivity and cost savings (Sage HRMS, 2013).

Table.2. Analysis result of AMS versus punch cars system

Test	Description	Attendance Management System	
		AMS	Punch Card System
Quantity	Number of Worker	50	50
Length of Time	Total Time for Recording & Calculating Process of Time Data	50 minutes	500 minutes
Accuracy	Typo Error	0	50
	Miscalculation	0	43
Functionality of Automatic Reports Generation	Type of Attendance Report	10	0

Table.3. Attendance reports generated from VAMS

Report	Description
Type-1	Daily Attendance Statistic
Type-2	Attendance General
Type-3	Department Attendance Statistic
Type-4	Daily Attendance Shifts
Type-5	Summary of Overtime
Type-6	Time and Attendance Summary Report
Type-7	Lateness Report
Type-8	Early Out Report
Type-9	Absenteeism Report
Type-10	Time and Attendance Report

Submission of Monthly Manpower Usage	
Builder UEN No.	1234
Project BP No.	A1211-0011-2015
Project Name	Project 1
Builder	AAA BUILDER PTE LTD
Month that data is submitted for	August
Year that data is submitted for	2015
Trade	**Manpower Usage (mandays)**
Site Mangement Team	
Site Mangement Team	119.1
Basement	
Site clearance and mobilisation	
Machine operator	
Excavation work	
Temporary earth retaining structures (TERS)	
Carpentry	80.5
System formwork installation	117.7
Steel reinforcement fixing	74.2
Concrete placement	
Pre-stressing work	
Precast structural concrete component installation	
Waterproofing	74.8
Architectural Works	
M&E works	
Subtotal (Basement)	347.2
Structural Works	
Carpentry	80.5
System formwork installation	117.7
Steel reinforcement fixing	74.2
Concrete placement	
Pre-stressing work	
Precast structural concrete component installation	
Structural steel work	84.5
Subtotal (Structural Works)	356.9
Architectectural	
Brick/Blockwall	89.4
Precast concrete wall panel installation	
Plaster	62.7
Skim-coat	
Dry partition wall	
Glass partition	81.3
Cladding/Curtain wall	126.3
Waterproofing	74.8
Floor screeds/protecting screed/hardeners	
Tiling/marble/stone	115.6
Wood flooring	
Resilient flooring (carpet,vinyl)	
Resilient flooring (laminate)	
Raised floor	
False ceiling	
Door	
Window	
Carbinets and wardrobe	
Painting	
Roofing system	
Subtotal (Architectectural)	550.1
Building Services or M&E Works	
Plumbing/sanitary/gas system	76.8
Fire prevention and protection system	
Electrical system	84.9
ACMV/HVAC system	
Lift/escalator	
Other M&E systems	
Subtotal (Building Services or M&E Works)	161.7
General	
Machine operator	
Quality assurance	
Scaffold	
Safety and health	
Subtotal (General)	
Esxternal Works	
Estate roads,driveways,road ancillaries,footways	
Landscape	
Subtotal (Esxternal Works)	

Fig.1. BCA Monthly Manpower Report - Part 1 generated from new Excel template.

MONTHLY MANPOWER REPORT 2015

Group Desc	Trad Trade	1-Aug	3-Aug	4-Aug	5-Aug	6-Aug	7-Aug	8-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	24-Aug	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	31-Aug	Total
=Site Mangement Team	Site Mangement Team	42.9	43.45	31.45	39.45	41.45	21.2	5657	45	39.65	38.95	21.35	43.45	38.95	35.74	39.54	38.45	22.35	55.01	34.85	39.75	39.37	3888	26.52	35.35	20.38	993.02
=Structural Works	Carpentry	29.01	28.03	25.84	27.94	28	17.01	2652	20.55	28.04	24	28.85	28.53	26.52	28.52	26.02	25.52	25.57	24.88	285	28.53	88	2566	26.51	30.02	18	645.57
Structural Works	Steel reinforcement fixing	29.76	32.24	33.26	34.76	14.86	16.86	6.42	13.72	13.96	16.76	16	14.92	34.1	32.86	25.53	28.58	34.01	27.94	31.86	29.28	1771	2011	16.62	9	15.77	593.89
Structural Works	Structural steel work	21.42	21.51	23.3	30.65	24.16	23.29	1665	19.64	29.04	26.51	21.82	23.24	24.4	29.88	30.08	21.65	28.68	21.03	30.85	27.42	1845	1422		16.57	21.11	675.85
Structural Works	System formwork installation	34.19	35.09	34.19	33.75	38.09	21.49	5308	53.14	53.29	48.82	34.04	51.37	29.16	34.2	34.52	27.82	33.2	32.82	33.57	33.09	3332	2222	26.53	28.15	21.35	941.47
=Architectectural	Brick/Blockwall	25.95	33.03	33.07	29.78	20.1	28.45	2508	33.03	32.8	28.03	21.15	24.48	32.85	34.23	29.29	30.17	32.11	25.65	33.05	33.07	215	3202	27.13	24.33	23.25	774.78
Architectectural	Cladding/Curtain wall	37.14	37.08	34.68	29.62	18.55	25.75	1652	25.01	34.54	31.05	24.45	28.04	37.55	34.03	36.26	34.21	43.55	47.45	67.18	62.65	6659	4588	30.54	56.57	43.04	1011
Architectectural	Glass partition	56.42	38.58	39.57	41.54	26.52	27.04	165	42.58	39.19	37.66	28.11	41.58	39.58	43.1	40.08	0	0	0	0	0	0	0	0	0	0	648.93
Architectectural	Plaster	29.81	33.02	31.71	27.18	28.88	22.75	1322	29.81	33	32.87	31.61	29.52									1674	2835	25.55	23.58	20.14	521.25
Architectectural	Tiling/marble/stone	29.32	31.42	33.18	33.57	21.98	22.72	1668	28.88	32.01	31.79	21.45	29.55	54.42	38.67	45.17	47.08	55.37	58.8	61.81	63.45	3231	2454	24.32	32.56	21.48	934.05
Architectectural	Waterproofing	24.62	25.71	26.44	22.18	28.16	27.8	2542	27.88	22.8	28.54	21.21	23.88	25.87	23.22	28.65	25.32	25.68	27.35	20.16	28.67	2638	2207	19.62	37.05	19.59	988.01
=Building Services or M&E Works	Electrical system	34.59	33.58	32.46	26.45	29.9	16	2622	35.56	30.95	34.11	25.52	17.04	32.81	26.35	31.88	25.81	22.18	25.76	22.85	21.61	1588	1652	33	23.1	19.42	970.77
Building Services or M&E Works	Plumbing/sanitary/gas system	29.01	27.34	24.06	17.17	28.16	20.02	2412	29.89	31.03	26.02	21.02	16.07	30.15	29.04	24.04	25.01	20.06	29.01	15.26	20.05	2801	29	22.79	27.57	23.25	913.54
Total		422.23	418.52	409.31	393.77	377.64	405.82	55.01	423.73	426.1	394.5	378.76	391.82	395.98	375	389.07	373.88	366.4	388.59	387.23	395.87	395.37	346.66	298.13	332.85	314.79	9496.7

Fig.2. BCA Monthly Manpower Report - Part 1 generated from new Excel template..

CONCLUSIONS

This research is to cover the problems faced by most of the organization using punch card system. The proposed AMS was implemented through configured the setting on VAMS that provided more detailed and accurate real-time records of entry and exit of all individuals to the construction site. Meanwhile, this system could generate documentary reports of time data and program issues for both in house and sub-contractor workers. Thus, AMS reduces most of the administrative jobs and minimizes human errors, avoids “buddy-punching” and eliminates time-related disputes which resulted from the drawbacks of punch card system. In addition, this study developed a new Excel template for builders to submit monthly manpower report to BCA by a very simple way which was exported attendance report from VAMS and inserted it into Excel spreadsheet to produce the report. This system is very helpful for saving valuable time and effort in the process of making various attendance reports. Besides, according to the test results, it has been found that the implementation of AMS are faster in term of execution time and better functionalities compared with punch card attendance system. Furthermore, the new developed excel template is helpful for builders to accelerate the generation of monthly manpower report to submit to BCA. Thus, based on the findings of this research, it has been concluded that the functionality of AMS will be very useful to enhance workforce management.

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