Occupational noise emitted by digital printing machines

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Abstract:
The aim of this study was to determine noise level of different digital printing machines in Egyptian printing companies, More extensive studies are needed to determine the exact impact of noise on the workers. Technical and organizational measures in order to control noise and prevent noise exposure, and general hearing conservation program to protect workers, should be introduced in digital printing industry. The paper research followed the Experimental analytical methodology. The extent of noise in one of the Egyptian digital printing companies determined using Integrated precision Sound Level Meter (Class 1) QUEST type Sound Level Calibrator (Class 1) and sound software toolkit to calculate the collected data of sound pressure levels on equivalent A-level (dBA), the collected data performed inside two rooms in digital printing company, and measure token on two types of digital printing machines and other printing equipment. The A-weighted noise levels inside room1 were on Leq, Leq 8hr (80.4dB), whereas inside room2 (72.9dB), the paper suggested different recommendations and procedures for noise reduction, absorption and future procurement.

Keywords:
Noise Levels, Digital Printing, Safety, Acoustic Absorption, Standards, Occupational, Protect Worker Health, Knowledge, Attitude

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2/: Introduction

Occupational exposure to excessive noise is commonly encountered in a great variety of industrial processes. Printing industry is the source of heavy industrial noise (Norton 1994). The mechanism of noise generation depends on the particular noise operations and equipment including: electromechanical devices, pumps, compressors, cutters, all types of presses, etc. Noise occurs during printing, binding, folding, cutting and perforating processes. Results of many studies indicate that the workers in printing industry may be at risk of occupational hearing loss. There is causal relationship between workplace noise and hearing loss and the other health problems of the workers (Rabinowitz 2005). Non-auditory effects of noise may also include lack of concentration, irritation, fatigue, headache, sleep disturbance, depression, increased breathing rate, social isolation and greater risk of accidents and other diseases (Stansfeld 2003).

The manifestation progress and the degree of occupational hearing impairment depend on several factors: sound intensity, duration of exposure, frequency of interfering sound, age, physical conditions of workers and individual sensitivity as well as concomitant harmful occupational factors such as vibrations and ototoxic agents (Gidikova 2007). Internationally accepted noise level which does not cause temporary or permanent hearing loss is 75 dBA. However, sound levels of 85 dBA and above, for duration of 8 hours per day cause damage to the hearing after many years (Ince 1997)

3/: Research Problem

Digital printing processes can be noisy depending on multiply items. Whereas, modernisation has introduced quieter processes into the industry, high noise levels and noise exposures remain a health risk. The paper examined the problem in order to put a suitable solutions depending on site variables that faces digital printing companies.

4/: The paper aim

1. To compare the noise exposure among a sample of digital printing companies and different places, in spite of that places existing inside the same organization
2. To identify the differences between noise havens places in digital printing machines locations.
3. To generate recommendations for the most suitable methods for achieving the optimal noise levels.

5/: Methodology

This study based on experimental analysis researches in order to:

1. Determining noise levels in relation to different types of digital printing machines used in printing companies through following procedures in ISO standards.

2. Examining compliance with the standards for industrial noise exposure through an experimental analytical study and providing recommendations for noise reduction and health protection of the workers after the Statistical analysis of sound level measurements
3. Focusing on criteria for occupational noise standard, worker training and practice

6/: Noise sources

Compressed air leakage, lack of maintenance, and the installation and design of machinery. Are the three examples of common noise problems

1. Lack of maintenance

A lack of simple maintenance a major contributor to avoidable noise in the work environment. turning off the waste chute when it is not in use would help reduce general noise levels.

2. Installation and Design

Personal noise exposure data were generally split into three broad activities; press, reel stands, and post-press processing (inside the digital printing machine if possible). Reel stand noise exposure was variable and appeared dependent on a number of factors including how the press had been installed within the place, the age of the equipment and whether any additional noise controls were in place. The post-press processes if possible on the machine has shown a bit noisier than the others (Shanks 2014)

3. Modification in general

For the most part, industrial noise is caused by mechanical impacts, high-velocity fluid flow (compressed air systems), high-velocity air flow, vibrating surface areas of a machine, and vibrations of the product being manufactured

3/1: Mechanical Impacts:

To reduce noise caused by mechanical impacts, the modifications outlined below should be considered. For any of these options to be practical, however, they must not adversely affect production.

1. Reduce excessive driving forces
2. Reduce or optimize speed
3. Minimize distance between impacting parts
4. Dynamically balance rotating equipment
5. Maintain equipment in good working order
6. Use vibration isolation when applicable

6/1: How should a noise assessment be done?

The way a noise assessment is done will depend upon:

1. the type of workplace
2. the number of persons potentially at risk from exposure to hazardous noise
3. the information already available on noise at the workplace.
4. A noise assessment should be done during a typical working shift and should determine:
5. the noise levels produced during various tasks carried out during the shift
6. how long the workers are exposed to noise during each of these tasks.
7. An assessment should take into account:
8. plant, equipment and other sources of noise in operation at the workplace
9. how work activities are carried out
10. the length of the shift
11. environmental factors (e.g, types of walls, surfaces, layout of work stations)

7/: Standards

7/1: OSHA Noise Standards

General Industry: 29 CFR 1910.95, "Occupational Noise Exposure." This standard is designed to protect general industry workers, such as those working in the manufacturing, utilities, and service sectors. The General Industry standard establishes permissible noise exposures, requires the use of engineering and administrative controls, and sets out the requirements of a hearing conservation program.

7/2: EN 1010 Standard

One series of safety standards (C type) exist for printing machinery in Europe (EN 1010), noise is identified as a significant hazard for the families of machines covered by this standard (EN 1010 standard, 2004)

This standard requires noise emission values to be determined in accordance with EN 13023. The EN 1010 also require the instruction manual to give declared noise emission values and information on the protective measures to be taken by the user, for example, personal protective equipment , sound hoods, noise enclosures.

7/3: Noise test codes

EN 13023 standard defines a noise test code for printing machines, the standard required a measurement of emission sound pressure level L_{pA} at workstations, and sound power level L_{wA} for large machines (linear dimensions exceeds 15 meter), the operating conditions for each machine defined include speed, substrates size and quality, web width, cutting angle and material feeding. The measurement positions include the control desk, delivery unit, feeding unit, winding unit and unwinding unit. In some cases the measurement conditions are as agreed between the manufacturer and user. (EN 13023 standard, 2003)

7/4: NIOSH Criteria for a recommended occupational noise standard

Noise-induced hearing loss (NIHL) is gaining a significant attention in recent years and contribute 16% of hearing loss across the world in adults.

The exposure to noise can lead to auditory and non-auditory effects. The auditory effects are evident when exposed to sounds louder than 85dBA. National Institute for Occupational Safety and Health (NIOSH) suggests that exposure to 85dBA sound for a duration of 8 hours leads to Permanent Threshold Shift (PTS). If sound intensity is below the level of Damage Risk Criteria (DRC) it could still lead to hearing damage which is reversible, it is called Temporary Threshold Shift (TTS). However, the recovery period is dependent on the type of stimulus, the intensity, location and duration of the stimulus. Apart from hearing loss, the noise will also cause auditory effects like tinnitus and hyperacusis. (US/NIOSH 1998). Industrial workers are mostly prone to hearing loss caused due to noise. In their work setting, most of the machines have a continuous or intermittent type of noise with varying centre frequencies. Moreover, the tonal components of noise can be impulsive or have unpleasant and disruptive temporal sound patterns (Olayinka 2009).

Basheer and his teamwork has a study about knowledge, attitude, and practice of printing press workers towards NIH (Basheer 2019), the results showed evidence regarding lack of knowledge and poor practice when it comes to hearing loss caused due to noise. So there is need to create awareness in printing press workers. NIHL is totally preventable, so educating and creating awareness regarding the hazards of noise in the workplace will create huge difference.

Training on effects of noise and studying the efficacy of training programs among workers of printing press is become highly required.

8/: Digital Printing Noise Experimental

8/1: Noise measurement methods for digital printing organization

The test performed according to the International Standard for sheet fed printing presses: BS EN 13023 and ISO 9612:2009(en)

- selecting the microphone positions for all the measurements has been done
- calibration of the used equipment before the measurement
- measurements has been repeated at each microphone positions 5 times in order to calculate the repeatability
- select the measurement time interval to cover all significant variations in noise emission and propagation. The duration period shall be not less than 15 seconds

8/2: Noise level Measurements procedures

This study was conducted in digital printing company in Cairo, the noise level measures was made in different types of digital machines, new and used machines, the digital colour press were HP Indigo 7800 installed as a new machine in printing company by 2018, the mono (Black) digital press were Xerox WorkCentre 5875 version of 2011.

8/3: Noise Measurement

For noise measurement, the microphone location is preferred to be a) Standing worker 1.55 m ± 0.075 m above the ground on which the worker standing (at the position of the workers' head) as near as possible to the midpoint of its vertical and horizontal adjustment and approximately 1 m from sound transmission elements such as windows or air-intake opening, also in such a way as not to be in the acoustic shadow of any obstacle in appreciable field of reflected waves.

The choice of the instrument influence the uncertainty of the measurements: the expanded uncertainty at our measurement is about 1.67 dBA , as the class of the instrument was Class 1, so the uncertainty was accurate more than other devices which can the uncertainty level reach to 5 dBA

The calibration procedure of the instrument was performed before the actual measurements using standard acoustic calibrator (sound level calibrator). The direction of the QUEST device was towards the nearby source at each point of measuring.

8/4: Instrumentation

Table (1): Experimental of digital printing noise exposure equipment

Equipment	Type	Calibrated by
Integrated precision Sound Level Meter (Class 1)	QUEST	NIS Calibration Laboratory
Sound Level Calibrator (Class 1)	QUEST	NIS Calibration Laboratory
NIS: National Institute of Standards Calibration verification: Both Class 1 sound instrument and sound Calibrator calibration verification proceed according to standards No. IEC 61672, furthermore, calibrations traced at laboratory as per of the standard requirements.		

8/5: First Measurement: HP Indigo 7800 Digital Press

8/5/1: Room 1 conditions

- **Room Location:** has one door , no windows, three walls without any covers absorbs machine sounds, reflecting surfaces reflects 100% of all sound inside room, the fourth wall is from normal

glass, thickness about 9mm, capable of sound permeability. Roof and floor were totally concrete and has reflects 100% of sound waves

- **Room temperature:** supported with air condition.
- **Room Dimension**: 4.5 m^2 (width) × 9 m^2 (length) ×2.8 m^2 (height)
- **Labour:** minimum one worker inside the room, maximum up to 3 depends on production quantity, while there was one worker handling our job printing. None of the workers wore any ear protection inside or outside the room.

8/5/2: Indigo Current Job specification: CMYK, 90 gm Couche gloss-coated paper, size 33 ×48 cm^2, printing both paper sides

Machine automatic speed (about 90 sheet per minute with the used paper size with four colour printing), resolution 2438 x 2438 dpi HDI

Time of each noise level point measurement: 5 minutes with variable five results for each point

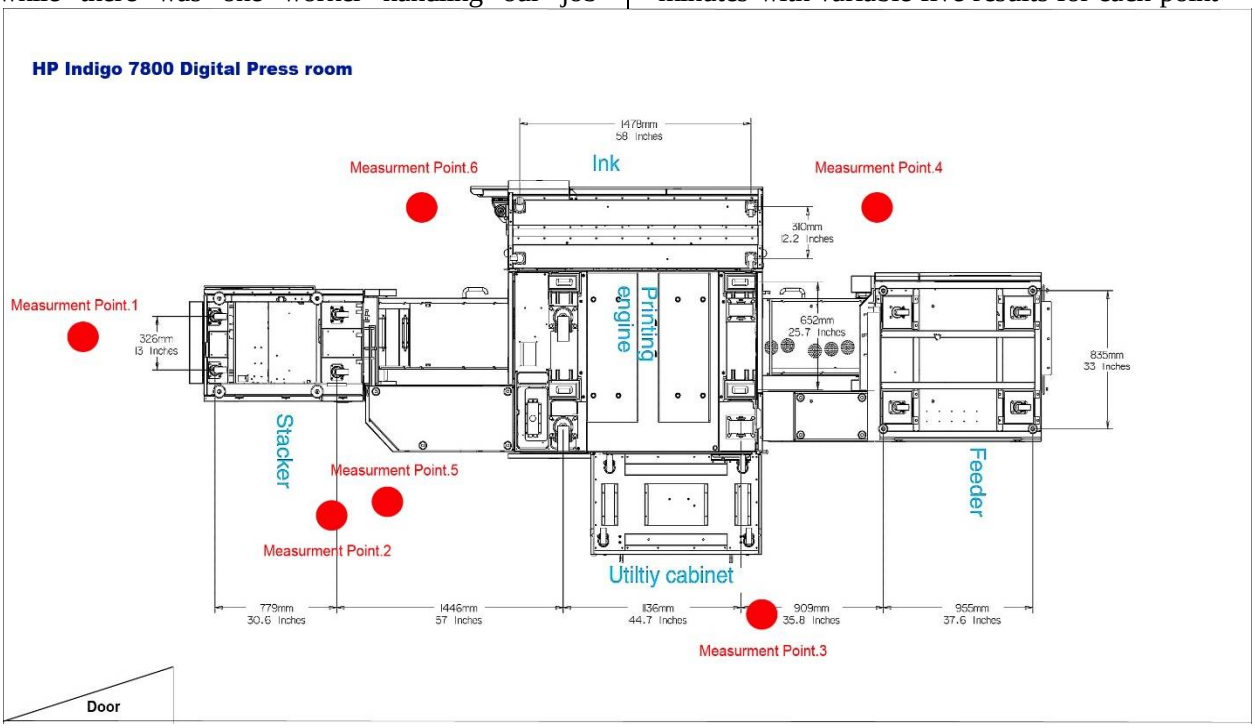

Figure (1): HP Indigo 7800 Digital Press (2018) measurement points as following (Measurement Point.1: in front of stacker unit, Measurement Point.2: by stacker unit side and the measurement while paper delivery were inside the unit tray, Measurement Point.3: by the utility cabinet and pressing unit, Measurement Point.4: were in between feeder side and imaging oil recycling system, Measurement Point.5: by stacker unit side and the measurement while paper delivery were taken from the proof tray above the unit, Measurement Point.6: between the printing unit and delivery transmission belts)

8/5/3: Sound pressure level by using the instrument in table (1), we were collected SPL as in table (2) in 6 points around the machine located in fig. (1 and 2), measurements were taken over a period of 5 minutes per each point, each minute has its own level equal of 5 noise levels for each point. Alarm set its measurement at point 5 at machine break and has one level of noise measurement

Table (2): Noise level measurements of Hp Indigo 7800 (6 points)

Machine Type	**Noise level measurement points**					
	Point 1 Mean L (dBA)	Point 2 Mean L (dBA)	Point 3 Mean L (dBA)	Point 4 Mean L (dBA)	Point 5 Mean L (dBA)	Point 6 Mean L (dBA)
HP Indigo 7800 Digital Press	77.7	76.5	77.7	80	76.1	75
	74.2	77.9	78.2	80.5	75.4	74.9
	76.8	77.5	77.8	80.7	76.8	75.5
	77.4	75.9	77.5	81.5	75.4	74.9
	77.2	78.3	78.2	82.7	Alarm 66.8	75.5
Mean (Average)	76.7	77.2	77.9	81.08	76 (without alarm)	75.2
Total Mean for 6 points (without alarm) approx. about 77.4 dB						

Figure (2): The experiment on site (room 1) while measuring sound levels: a) QUEST noise level instrument, b) Point 1 measurement, c) Point 2 measurement, d) Point 3 measurement, e) Point 4 measurement, f) Point 5 measurement, g) Point 6 measurement

8/5/4: The First Noise Statistical Analysis Results (Room 1)

Sound measurements statistical analysis calculated at MS Excel software toolkit based on the following ISO 9612 equations, by entering the pervious noise level measures values at (table 2):

8/5/4/1: A-weighted equivalent continuous sound pressure level Lp,A,eqT

$$L_{p,AT} = L_{P,A,eqT} = 10\log\left[\frac{\frac{1}{T}\int_{t1}^{t2} p_A^{2(t)dt}}{p0^2}\right] dB$$

where the reference value, $p0$, is 20 μPa

ten times the logarithm to the base 10 of the ratio of the time average of the square of the A-weighted sound pressure, p_A, during a stated time interval of duration T (starting at $t1$ and ending at $t2$), to the square of a reference value, $p0$, expressed in decibel

8/5/4/2: A-weighted noise exposure level normalized to an 8 h working day daily noise exposure level

$L_{EX,8h}$

$$L_{EX,8h} - L_{P,A,eqTe} + 10\log\left[\frac{T_e}{T0}\right] dB$$

where

Lp,A,eq$T$e is the A-weighted equivalent continuous sound pressure level for Te;

Te is the effective duration, in hours, of the working day; (real time of work, calculated as 7.5 hours)

$T0$ is the reference duration, $T0$ = 8 h (The work duration at the organization shift, Note: some other places shift is 12 hours)

LAeq,T = 80.6dB

8/5/4/3: The meteorological conditions calculation

C_1 (dB) is the reference quantity correction of the meteorological conditions at the time and place of the measurements

$$C_1 = -10log\frac{p_s}{p_{s,0}} dB + 5\log\left(\frac{273.15+\theta}{\theta_0}\right) dB$$

=+0.5dB

p_s is the static pressure in the test room at the time of test in kPa. $p_{s,0}$ is the reference static pressure= 101,325 kPa. θ (C°) is the air temperature in the test room at the time of test. θ_0=314 K , θ_1=296 K

The sensitivity coefficient (c_{K1}) due to the background noise,

$$|c_{K1}| = \frac{1}{10^{0.1\Delta L_p} - 1}$$

= +0.8dB

LAeq 8 hr = 80.4dB

L*Aeq 8 hr* equivalent continuous sound for 8 hr of noise exposure

8/6: Second Measurement: Xerox WorkCentre 5875 and HP Indigo Chiller

8/6/1: Room 2 Condition:

- **Room Location**: Open location, HP Indigo chiller room has 5 windows Fig. (3, b), 3 walls without any covers absorbs machine sounds, reflecting surfaces reflects most of sound inside room, the fourth wall isn't exist as shown in fig. (3,b). Roof and floor were totally concrete, sounds reflects outside through 5 open windows and may the neighbour receive most of chiller noise, at the other side of chiller's wall located 2 Xerox WorkCentre 5875 machine version of year 2011, while the rest of hole area have finishing line and malfunctional machines.

- **Room temperature:** doesn't supported with air condition.

- **Room Dimension**: 7 m^2 (width) × 12 m^2 (length) ×2.8 m^2 (height). In addition to two opened doors has been observed

8/6/2: Sound pressure level were collected as in table (3) in 2 points near HP Indigo 7800 Chiller located in fig (3), measurements were taken over a period of 5 minutes per each point, each minute has its own level equal of 5 noise levels for each point. No alarm has been found. Measures has been made about 3 meter far from the chiller point, in which the worker most movements

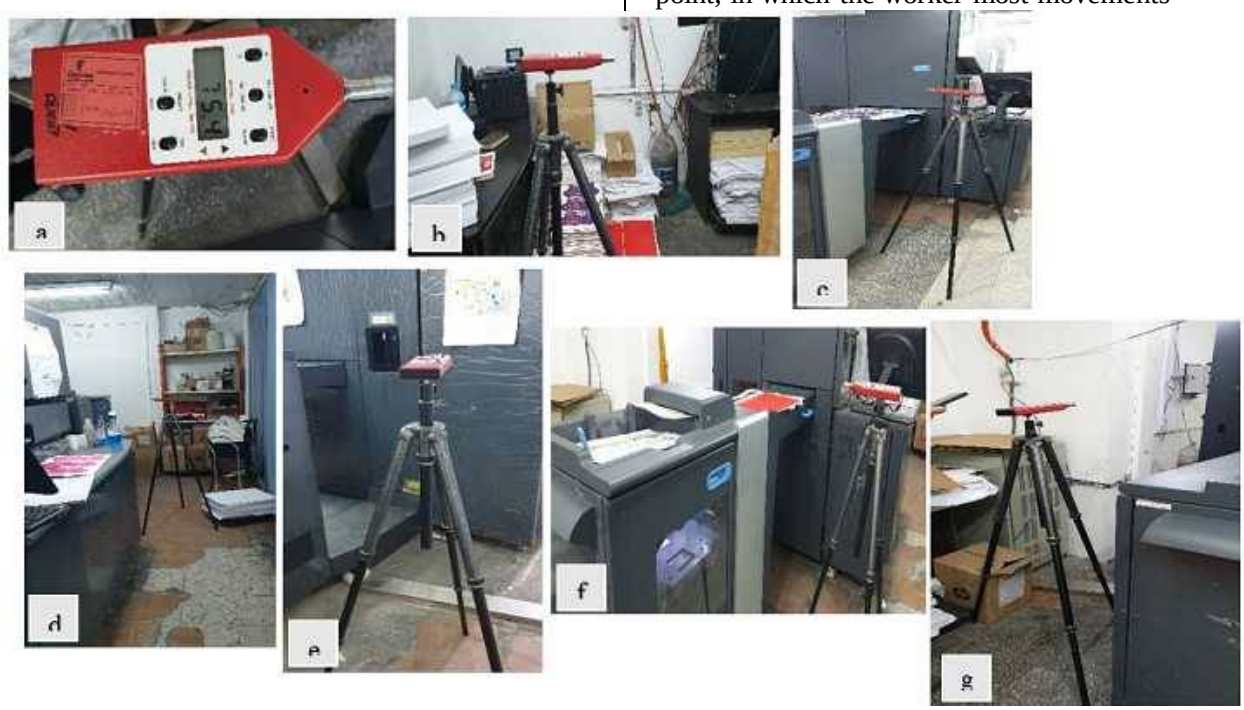

Figure (3): The experiment on site (room 2) while measuring sound levels: a) Two Xerox WorkCentre 5875 Digital printing presses , b) HP Indigo 7800 Digital Press Chiller , c) both of machines set – up places

Table (3): Noise level measurements of Hp Indigo 7800 chiller + Xerox workCentre (2 points)

Machine Type	**Noise level measurement**	
	HP Indigo Chiller Point Mean L (dBA)	Xerox WorkCentre 5875 Point Mean L (dBA)
HP Indigo 7800 chiller + Xerox WorkCentre 5875	71.5	76
	71.2	66.7
	72	66.8
	72.6	66.4
	72.6	66.5
Mean (Average)	72	68.5
Total Mean for 2 points (no alarm is found) appox. about 70.2 dBA		

8/6/3: The Second Noise Statistical Analysis Results (Room 1)

For room 2 points according to the previous ISO 9612 equations by entering the pervious noise level measures values at (table 3):

HP Chiller LAeq,T = 69.46dB, Lex,8h = 69.18dB and C1= 0.1752dB

Xerox Workcentre (5875) LAeq,T = 68.099dB, Lex,8h = 67.819Db and C1= 0.1752dB

Total LAeq,T for both chiller and Xerox machine = 68.10dB , Lex,8h = 67.83dB and C1= 0.1752dB, while the main background noise is running in all cases.

The sensitivity coefficient (c_{K1}) due to the background noise = +0.8dB

8/7: The main background noise

Background noise is the definition of the non-working machines is observed while there is still noise listened in the background, at our case here is because of continues working of the HP Indigo chiller and other auxiliary factors. The main background noise were at our case 50dB expanded through the digital printing company in general in room 1, room 2, and other places

9/: Findings and recommendations

1. Author observed that room 1 with its conditions is much smaller than the needed place for HP indigo, in addition to the absence of sound absorbers, so the noise levels exceed the normal noise levels tolerance. On the contrary of that condition has been found on room 2, which place condition were suitable and have many windows and doors, also the place is very wide while many of machine inside it are malfunctional, HP Chiller position is far from workers movements inside the workplace and this is very suitable, in spite of the continuous background noise.
2. Noise pressure levels affected by the metrological condition of pressing rooms which causes decreasing noise levels about 0.5dB by using air conditions inside digital pressing room 1, while the author didn't notice any reduces of the same noise level inside room 2 , the experimental found that some sort of reducing noise pressure levels in general depends on reducing room temperature. So, the author highly recommended using of air conditions in all digital pressing rooms inside digital companies or setup a central air condition.
3. A suggestion that Hearing protection device (HPD) such as ear muffs and ear plugs and ear canal caps should be widely used in the workplace to provide hearing protection for workers exposed to high levels of noise (Peters 2003 / Niland 1994). Previous studies also has indicated that only in younger workers, with minor professional experience and with high educational background, HPD are effectively used to protect their hearing (Arezes and Miguel, 2005), in another study showed that HPD use is more consistent in workers who had health education before employment (Tabarraie 2008).
4. Alarm noise level measured were very good level with HP Indigo 7800, hearable and very suitable to the workers environment, and this is can support prevention a lot of accidents inside the workplace.
5. HP Digital press Measurement point 2 where the delivery was inside stacker tray noise level much higher than the measurement point 5 where the delivery was on proof tray above the stacker unit
6. According to HP Indigo 7800 site preparation guide the maximum noise level measures generated by the press with close doors set on 80dBA. At our measures it was higher than 80 dBA with open doors. That is means it has exceeded the maximum level inspite of open room door. Even though the 80 dBA still in the recommended tolerance range by ISO standards as it is the maximum higher level before turning to be dangerous if it goes to reach 90 dBA , but it's almost seems that's going around leaving the tolerance range towards the higher dangerous level in near future. Belongs to the installed HP digital press in year 2018 as a new machine. The machine has history of working for 2 years only. The author also had to study the environment of the room for HP and other machines. For HP digital press with its large size dimensions was almost need a wider place to put it, with this action noise wave length will spread in the place and the noise levels will be much lower than the current levels. In another solution to absorb noise levels, press room surfaces treatment will be effectively. The author suggested various design and fabricate porous materials with their advantages of wide absorption frequency range, low cost, and easy molding (Cao 2018). synthetic fibrous with their two types microfibers and Nanofibres as sound absorption materials are used most widely in the fields of noise control owing to their good acoustic performance, superior durability, and fungus growth resistance. Some of microfibers materials can be made as sandwiche sound absorber structure, the layers from top to bottom were composed of PET nonwoven, TPU honeycomb grid, and PU foam, Sound absorption coefficient of this structure, the average and the largest coefficient showed that is a highly sound absorbed materials (Lin 2011). According to another studies, author found jute natural fibre material environmentally friendly, the material were a very suitable, cheap absorbent panels,

acoustically efficient (Iannace 2013), and the material can be integrated with Micro – Perforated Plate (MPP) (with its various hole wide (1/2,3/16, 1/4, 1 inches), depending on the needed absorption range) which succeeded to improve jute felt sound absorption performance and will act as a highly acoustic panel (Bansod 2017) . also, the ecologically friendly thermo jute material has earning the insulation a top rating of '0' (according to SS EN ISO 846: include physical properties tests to all plastics materials for sound absorbs, and the suggestion are porous materials such as plastic foams, jute… etc , ISO also includes fungi test growth for porous/ecological materials as well as any physical attack on the specimen) and highly recommended as an acoustic panels. Whist, sheep wool and the coconut absorption coefficient were very excellent. The two natural material highly promising and also a suggested sound absorbing materials (Berardi 2015). One more suggestion by the author to absorb sound acoustic and resist fire, It has many uses, shapes and colors .created by BAUX made from wood wool, cement and water with 2D and 3D panel eco-friendly models. Fig (4)

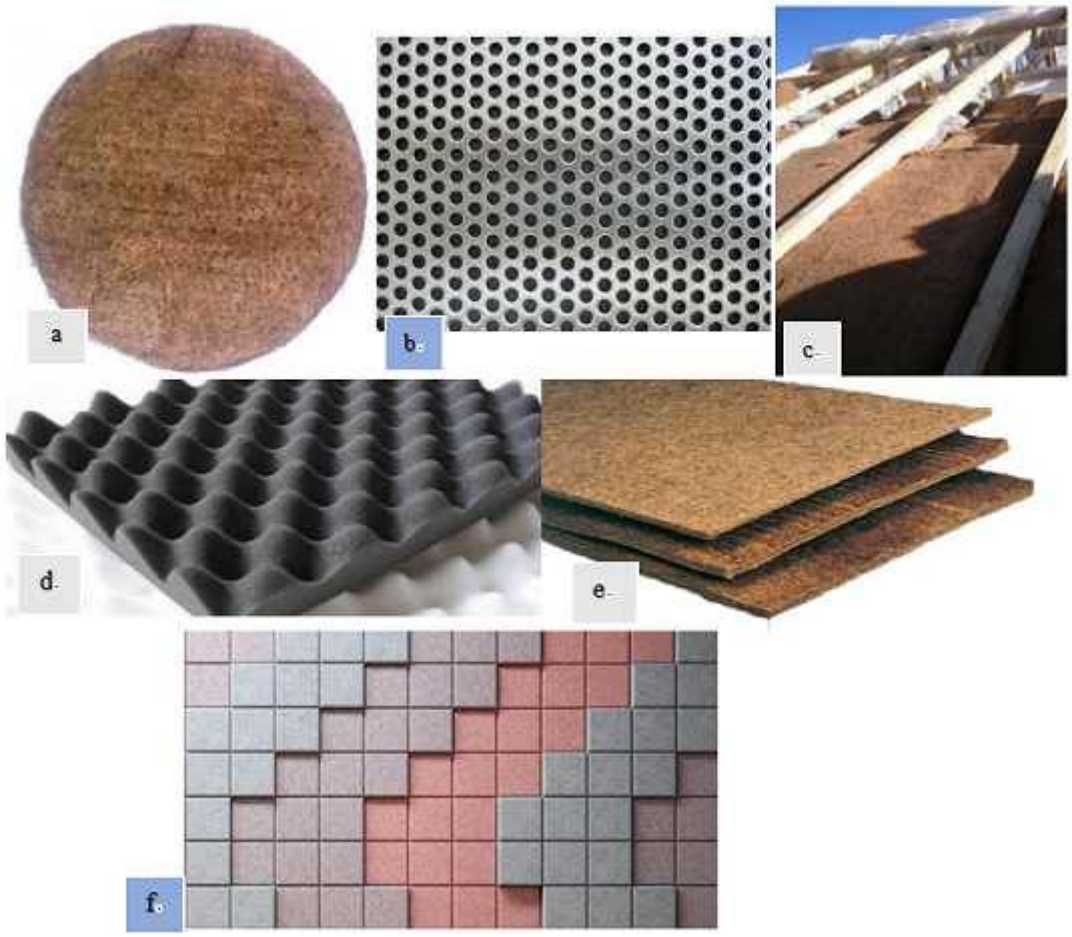

Figure (4): Suggested eco- friendly acoustic sound absorber panel includes: a) Jute material panel. b) Micro Perforated Pates (MPP) which can be integrated with jute material to increase jute panel sound absorbing performance. c) Thermal jute. d) Eco Plastic foams panel. e) Coconut fibre sound absorber panels. f) Baux sound absorb Wood Wool resistant fire eco-friendly 3D panel model

7. According to Xerox WorkCentre 5875 version of 2011 site preparation guide the maximum noise level measures generated by the press set on 58dBA. At our measures it was 72.9dBA with open doors for both Xerox WorkCentre 5875 and HP Indigo 7800 Chiller. That is means the 2 Xerox machines in addition to the chiller has exceeded the maximum level inspite of open room door, several windows and the very suitable wide area around the two machines and chiller, author recommended the previous suggested action taken of HP Indigo 7800 and periodically maintenance as in the next point (number 8).
8. Author suggest carrying out a prevention maintenance, for example, to facilitate machine parts fraction or to change old parts which they need to exchange. Maintenance should regularly establish every 3 or 6 months as maximum period, with taking other suggestions into consideration, this suggest will change noise level in printing location

9. For new digital printing equipment or printing machines will be installed in future, author finds that a recommended study should be done about machine work location and how it will be installed, which can make a big difference to workers' noise future exposure. Apply the Egyptian code prepared by The Ministry of Environment Egyptian Environment Affairs (EEAA) and Ministry of Housing, Utilities, and Urban Communities (HUUC) before machine installation and during building built, The code were created within the framework of MSEA plans and policies developed to protect environment against pollution, the code has been developed to reduce Egypt noise levels to the safe levels permissible by Law 4/1994 and international standards. The plan is to be implemented in accordance with planned stages. (www.eeaa.gov.eg)
10. Regularly collective noise level measures through the digital printing organization in order to deal with and control the measure results, using the suggested questionnaire by author.
11. Workers should receive information and training to help them understand and deal with the noise-related risks. This should cover:
    - The risks
    - noise control and hearing protection measures, including HPD
    - when workers are entitled to health surveillance, and its purpose
    - The results of the risk assessment and any noise measurements, including an explanation of their significance
12. Workers should check regularly the measures in place as in the next sound investigation questionnaire (number 11), to prevent or control noise are still working effectively. Depending on their noise exposure, workers have a right to appropriate health surveillance. Where this occurs, individual health records must be kept and information provided to the employees. The knowledge gained from the surveillance should be used to review the risks and control measures.

10: A Suggested Regularly Sound Investigation Questionnaire for Digital Printing Organizations

A sample of suggested questionnaire can be applied by experts with the co-operation of digital printing companies' owners and workers or by the companies' owners and workers after training about noise exposure and levels and importance of controlling it. The questionnaire can help to assist noise exposure levels and its effect of health worker safety, while it is present the digital printing organization machines and workers condition at the time they apply it.

Description of work location:

……..

Activities at workstation:

……..

Assessed by: ……..

Date: ……..

'Yes' to any of the following indicates the need to carry out a noise assessment if exposure to the noise

cannot be immediately controlled.

Hazard identification questions Yes No

1. Is a raised voice needed to communicate with someone about one metre away?
2. Do your workers notice a reduction in hearing over the course of the day? (This may only become noticeable after work, for example, needing to turn up the radio on the way home)
3. Are your workers using noisy powered tools or machinery?
4. Are there noises due to impacts (such as hammering, pneumatic impact tools) or explosive sources (such as explosive powered tools, detonators)?
5. Are personal hearing protectors used for some work?
6. Do your workers complain that there is too much noise or that they can't clearly hear instructions or warning signals?
7. Do your workers experience ringing in the ears or a noise sounding different in each ear?
8. Do any long-term workers appear to be hard of hearing?
9. Have there been any workers' compensation claims for noise-induced hearing loss?
10. Does any equipment have manufacturer's information (including labels) indicating noise levels equal or greater than any of the following:
    (a) 80 dB(A) LAeq,T (T= time period over which noise is measured)?
    (b) 130 dB(C) peak noise level?
    (c) 88 dB(A) sound power level?
11. Do the results of audiometry tests indicate that past or present workers have hearing loss?
13. Are any workers exposed to noise in the workplace?
14. Are any workers exposed to noise and hand-arm vibration?

11: References

1. National Institute for Occupational Safety and Health (NIOSH). Criteria for a recommended

standard: occupational noise exposure: revised criteria 1998. US Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, 1998
2. Olayinka OS, Abdullahi SA. An overview of industrial employees' exposure to noise in sundry processing and manufacturing industries in Ilorin metropolis, Nigeria. Ind Health ;47:123-33, (2009)
3. A. Mihailovic· S. Grujic, J. Kiurski, J. Krstic · I. Oros, I. Kovacevic, Occupational noise in printing companies, Environ Monit Assess, 2011, 181:111–122
4. Standard, EN 1010: 2004 +Al: 2010 safety of machinery , safety requirements for the design and construction of printing and paper converting machines – part I: common requirements
5. Standard, EN 13023: 2003 + Al: noise measurement for printing and paper converting, paper making machines and auxiliary equipment – accuracy grades 2 and 3
6. International Standard ISO 9612: Acoustics — Determination of occupational noise exposure —Engineering method, second edition 2009
7. Shanks, Noise in the United Kingdom industry: then and now, Health and safety laboratory United Kingdom
8. R. Basheer, PG. Bhargavi, H. P. Prakash, Knowledge, attitude, and practice of printing press workers towards noise-induced hearing loss, Noise & Health International Journal, Vol. 21, Issue : 99 , 62-68, (2019)
9. O. M. P. Norton, Fundamentals of noise and vibrations analysis for engineers, Cambridge University Press, Cambridge, 1994.
10. Code of Practice, Managing noise and preventing hearing loss at work, Safe Work Australia Government statutory agency, December 2011
11. BS EN 13023:2003 +A1:2010, British Standard: Noise measurement methods for printing, paper converting, paper making machines and auxiliary equipment — Accuracy grades 2 and 3, version correct as year (2015), British Standard Institution, ISBN 978 0 580 63989 0
12. Y. Tabarraie, S. Refahi and M.H. Dehghan. Effective Factors on Occupational Noise Protection Among Industrial Workers, Medwell Journals, Research Journal of Biological Sciences 3 (4): 382-384, 2008
13. P. Rabinowitz, T. Rees, "Occupational hearing loss". In: Rosenstock, L., Cullen, M., Brodkin, C., Redlich, C. (Eds.), Textbook of clinical occupational and environmental medicine. Second Edition. (pp. 426- 362). Philadelphia, USA: Elsevier Saunders, 2005.
14. R.J. Peters. The role of hearing protectors in leisure noise. Noise Health, (2003), 5: 47-55.
15. Niland. Occupational hearing loss, noise, and hearing conservation. In: C. Zenz, O. Dickerson, & E. Horvarth (Eds.), Occupational medicine (3rd ed.,pp. 258–296). St Louis Missouri: Mosby Publication. (1994)
16. Stansfeld, S. A., Matheson, M. P.. Noise pollution: non-auditory effects on health, British Medical Bulletin, 68(1), 243-257. (2003)
17. Arezes, P.M. and A.S. Miguel. Hearing protection use in industry: The role of risk perception. Safety Sci., 43: 253-267. (2005)
18. I-INCE International Institute of Noise Control Engineering (Ed.). Final report, technical assessment of upper limits on noise in the workplace. I-INCE Publication 97-1. Noise/News International, 203-216. (1997).
19. P. Gidikova, G. Prakova, P. Ruev, and G. Sandeva, Hearing impairment among workers occupationally exposed to excessive levels of noise, Central European Journal of Medicine, 2007, Vol. 2, No.3, pp. 313-318.
20. Cao, Q. Fua, Y. Sia, B. Ding, J. Yu . Porous materials for sound absorption, Composites Communications 25–35, ELSevier (2018)
21. J.H. Lin, C.M. Lin, C.C. Huang, C.C. Lin, C.T. Hsieh, Y.C. Liao, Evaluation of the manufacture of sound absorbent sandwich plank made of pet/tpu honeycomb grid/ pu foam, J. Compos. Mater. 45 1355–1362, (2011).
22. G. Iannace, A. Trematerra, P. Trematerra, Acoustic correction using green material in classrooms located in historical buildings, Acoust. Aust. 41 (3) 213:218, (2013).
23. U. Berardi, G. Iannace . Acoustic characterization of natural fibers for sound absorption applications, Building and Environment, EL Sevier 1:13 , (2015)
24. V. Bansod, T. S. Teja, A. R. Mohanty, Improvement of the sound absorption performance of jute felt-based sound absorbers using micro-perforated panels, Journal of Low Frequency Noise, Vibration and Active Control, Vol. 36(4) 376–389, (2017)
25. Swedish / British SS EN ISO 846:2019: Plastics - Evaluation of the action of microorganisms, Edition 2, Swedish institute of standards (2019)

26. MPP, Product retrieved from https://www.indiamart.com/proddetail/crc-perforated-sheets-4733629948.html
27. Plastic Foam acoustic sound absorber panel, Product, retrieved from https://www.fanyafoam.com/Product/PU-Foam-Rubber-Plastic-Sound-Absorbing-Cotton-with-Back-Rubber.html
28. Thermal Jute acoustic sound absorber panel, Product, retrieved from https://www.ecologicalbuildingsystems.com
29. Coconut fibre acoustic sound absorber panel, Product, retrieved from https://www.corkshopbcn.com/en/acoustic-insulation/148-coconut-fibres-for-acoustic-insulation.html
30. Baux Wood Wool 2D, 3D Acoustic panels, Product, retrieved from https://www.baux.se/woodwool-tiles-3d-pixel/
31. EEAA Egyptian Code, retrieved from http://www.eeaa.gov.eg

12/: List of Abbreviations

dB	decibel(s)
dBA	decibel(s), A-weighted
OSHA	Occupational Safety and Health Administration
NIOSH	National Institute for Occupational Safety and Health
ANSI	American National Standards Institute
EEAA	Ministry of Environment Egyptian Environment Affairs
HUUC	Ministry of Housing, Utilities, and Urban Communities