

Safety and Productivity in the Construction Industry

عوامل الأمان والإنتاجية في صناعة البناء

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Abstract: Safety in construction industry of Palestine still suffers from ignorance and lack of supervision. This low consideration of safety importance caused escalation of accident rate in construction projects. Also, construction productivity is not encouraging when low productivity is causing delays in construction projects. The objective of this paper is to identify the productivity factors that are most related to safety, and determine their relative importance as perceived by contractors. A questionnaire survey, based on 28 identified productivity factors, grouped into 7 major factor categories, was conducted. Responses from 61 personnel from contractors organizations suggest that the following are the most important factors related to safety: 'skillfulness of worker improves safety', 'demonstrating daily activities to workers before start contributes to improving safety', 'anticipated risks included in safety program in order to avoid accidents increases productivity', 'accidents frustrate workers and create absenteeism which decrease productivity', and 'when foremen allocate tasks to workers, they consider safety measures'. The results also indicated that 'worker problems' is the most important among productivity groups of factors followed by 'safety program, 'subcontractors, 'inspection', 'personal protective equipment', 'factors improving productivity' and 'local conditions'. Contractors are recommended to act strategically to protect workers by continuously identifying, evaluating, and mitigating hazardous conditions, risky activities, work locations and work condition on job site.

Keywords: Safety, productivity, construction, management.

المستخلص: عوامل الأمان في صناعة البناء في فلسطين مازالت تعاني من الإهمال وضعف الإشراف. هذا الاهتمام المنخفض نسبياً لعوامل الأمان تسبب في تصاعد نسبة الحوادث في المشاريع الهندسية. كذلك فإن إنتاجية البناء تكون غير مرتفعة حينما تصبح قلة الإنتاجية سبباً في تأخير المشاريع الهندسية. تهدف هذه الدراسة الى التعرف على عوامل الإنتاجية الأكثر صلة بعوامل الأمان وتحديد الأهمية النسبية لها من وجهة نظر المقاولين. لذلك تم عمل استبيان ميداني مبني على 82 من عوامل الإنتاجية المعرفة وموزعة الى سبع تصنيفات رئيسية. تم تلقي اجابات من حوالي 16 من العاملين في قطاع المقاولات، والتي أظهرت بان العوامل التالية هي الهم من حيث الأمان: مهارة العامل تحسن من مستوى الأمان، توضيح الأنشطة اليومية للعاملين قبل البدء في العمل تسهم بتحسين ملحوظ في عامل الأمان، المخاطر المتوقعة المضمنة في برنامج الأمان تزيد من الإنتاجية، الحوادث تحبط العاملين وتتسبب في تغييرات طويلة تضعف من الإنتاجية، تحديد المسؤولين المهام للعمال بحيث يتم أخذ عوامل الامان بعين الاعتبار. كما أشارت النتائج الى ان مشاكل العاملين هي من أهم العوامل المؤثرة في الإنتاجية، تليها برامج الامان، المقاولين الفرعيين، الفحص الدوري، أدوات الحماية الشخصية، محفزات

تحسين الانتاجية، والبيئة المحلية. تخلص الدراسة الى أن المقاولين مطالبين برؤية استراتيجية لحماية العمال بواسطة استمرارية التقييم والتعرف على اسباب الخطر والتخفيف من الفعاليات الخطرة ومعالجة ظروف العمل في الموقع بالشكل الملائم.

كلمات مدخلية: الأمان، الإنتاجية، الإنشاءات، إدارة المشاريع.

INTRODUCTION

Improving safety and productivity are major concerns throughout the construction industry (Choudhry, *et al.* 2008). Many organizations in developed countries have realized that safety and productivity are important areas of consideration both for human safety and project success. Nonetheless, construction safety is not integrated into construction projects in Palestine. The lack of legislation and regulation about safety was one of the reasons that project parties did not care for safety. Also, safety culture contributes to other factors that affect safety performance in Palestine. Project parties depend on religious beliefs when comes the issue of safety and health. Religious beliefs are used incorrectly towards safety and health whilst in the developed world; it is believed that "safety pays; Injuries costs" (Hinze, 2000).

Enshassi (2003) stated that accidents not only result in considerable pain and suffering but marginalize productivity, quality, time, and negatively affect the environment and consequently add to the cost of construction. This conceptualization emphasizes on the importance of construction safety in means of human, cost and time. Howell, *et al.* (2002) suggests that human factor approach holds human error as the main cause of accidents besides design of the job site and tasks also contribute.

In Palestine, safety is not considered in the same manner as cost and schedule (Enshassi, *et al.* 2007). For example, planning and scheduling of projects do not consider applying safety provisions. On the contrary, safety is seen as a decelerating factor of schedule and is considered to be an extra cost associated with project. This situation decreased importance of safety amongst project parties. Lack of training on safety added more obstacles to have an effective safety performance in Palestine (Enshassi, *et al.* 2007). Accidents increased dramatically in construction projects due to falling from heights, dropped

objects and materials, and others, particularly due to the increase in the number of projects implemented accompanied with carelessness for safety (Enshassi, *et al.* 2007).

In Gaza Strip, safety and health have low priority in a company's plans, and it is, unfortunately, considered a waste of money without any profit (Enshassi, *et al.* 2007). This situation resulted in the increased number of accidents recently. Moreover, construction productivity in Arabic region does not differ very much from those in developing countries when low productivity in Arabian Gulf area caused delays in construction projects (Assaf, *et al.* 1995). Thus, the aim of this paper to identify the productivity factors that relates to safety, and determines their relative importance as perceived by contractors.

Literature Review

Safety in Construction

The construction industry is often criticized for its poor performance (e.g. low productivity, waste, health and safety problems) (Hoonakker, *et al.* 2003). Safety is one of the major factors that affect construction industry. It needed to be studied and investigated in order to be integrated as an inherent culture of each member of the construction project. Hinze and Bren (1996) suggested that in order to conduct a successful research study in construction industry, it is important that the research focus on those segments of the industry that truly warrant it. Safety cannot be considered as luxury. On the contrary, it is a human need firstly which emphasizes the need for making it an integral part of construction projects. Thinking of safety as a human and financial issue increases the need for the continuous improvement of safety measures until reaching the zero accident approach. Improving safety remains a priority but despite innovations that reconceived the relationship between planning and safety, no systematic theory or practice has yet been developed (Bahari

and Abd Aziz, 1999; Howell, *et al.* 2002).

According to (Koehn, *et al.* 1995), construction in developing countries is more labor intensive than that in the developed areas of the globe. Nevertheless, construction safety is not given a top priority in those countries. Sohail (1999) in his study stated that construction industry is economically important as it typically contributes 10 per cent of a developing country's GNP. Only 5-10% of workers in developing countries and 20-50% of workers in industrial countries (with a few exceptions) are estimated to have access to adequate occupational health services (Hogstedt and Pieris, 2000). Despite recent efforts to improve safety in the construction industry, statistics show that the accident and injury rate in construction is still significantly higher than that of most other industries (Elzarka, *et al.* 1999).

These poor figures of safety in developing countries were obvious in statement of (Jaselkis and Ashley, 1999) that greater effort is required to control a construction project in a developing country especially in the areas of quality and safety. For example in Hong Kong, safety is one of the most difficult issues facing the construction industry there, where the accident rate in construction is reported as highest when compared to other industries (Koehn, *et al.* 1995; Choudhry, *et al.* 2008) emphasized that preventing occupational injuries and illness should be a primary concern of all employers. They also stated that safety of both project personnel and construction workers cannot be guaranteed by legislation alone, nor should safety be the sole responsibility of the employer or the contractor.

The construction industry in Saudi Arabia employs 15% of the total labor force and accounts for 14% of the total energy consumption in the country (Jannadi and Bu-Khamsin, 2002). In Arabic region, construction safety conditions resemble those in developing countries. In construction, the working environment is constantly changing, sites exist for a relatively short time and the activities and inherent risks change daily (Jannadi and Assaf, 1998; Kartam, *et al.* 2000; Jannadi and Bu-Khamsin, 2002). It was found that higher frequencies of construction accidents occurred on projects that were over

budget and those that were competitively bid (Kartam, *et al.* 1997). Jannadi and Bu-Khamsin (2002) found that the most important factors influencing safety performance are: (1) management involvement; (2) personal protective equipment; and (3) emergency/disaster planning and preparation. One of the most prevailing problems in developing and Arabic regions is that workers and engineers receive almost no safety training and are mostly uninformed about the company's safety programs or policies (Kartam, *et al.* 2000). The absence of a unified set of safety regulations adversely affects the enforcement of safety on the job site.

Productivity in Construction

Productivity trends vary from location to another and from time to time. Lam, *et al.* (2001) revealed that productivity for the same work item is not constant throughout the construction period and varies at different stages of the production. Productivity improvement is defined as the establishment of approaches to improve productivity index (Baines, 1997). Hoffman and Mehra (1999) considered productivity improvement as a process to achieve higher levels of output while consuming same or lesser amounts of input resources.

Improvement of construction productivity is a major and continual concern of those who are responsible for cost control and quality of the constructed facility (Hinzelman and Smallwood, 2003). Debrah and Ofori (2001) asserted that the main priority of the government is to improve construction productivity by tackling the factors which impede productivity enhancement in the industry. According to them, improvements of productivity are not stop at improving manpower but it requires including improving many areas of construction industry.

Despite many techniques and procedures were introduced in different studies to improve productivity, it is still suffering from either slow progress or declination. Teicholtz (2001) used real output of construction per work-hour as measured by the US Department of Commerce and the US Bureau of Labor Statistics, and found that the construction industry's labor productivity declined by 0.72% at an annual

compound rate from 1964 to 2000. A study by Goodrum, *et al.* (2002) presented evidence that the US construction productivity measured at the activity level and using a variety of data sources improved between 1976 and 1998. Nonetheless, due to critical importance of productivity to the profitability of most construction projects, it is regarded as one of the most frequently discussed topics in the construction industry (Griffith, 2000; Srinavin and Mohamed, 2003).

There have been several researches on labor productivity in developing countries. Kaming, *et al.* (1997a) in his study used NEDO activity sampling technique to observe craftsmen on about 400 occasions randomly on five work items: working, walking, talking with supervisor, talking with mate and inactive. The proportion of unproductive time of labors in Indonesia (Kaming, *et al.* 1997a) is comparatively lower than that associated with Nigeria and the UK where unproductive time is about 50% (Kaming, *et al.* 1997a). However, the output of craftsmen in the UK is much higher, although they work for fewer hours. In Indonesia, although working longer hours and spending more time working have a lower output due to a lack of skill and low levels of training and education of craftsmen (Kaming, *et al.* 1997b).

Most developing countries share the characteristic of low productivity. In a pilot survey conducted on Iranian construction projects, Zakeri, *et al.* (1997) found that productive work was between 33 to 56%. In Turkey, the labor-intensive production is still in use in the construction sector which regarded as one of the most unproductive sectors (Kazaz and Ulubeyli, 2004). This indicates that labor in developing countries constitutes is a driving force in the construction industry particularly in terms of cost, quality and productivity. Jannadi (1995) stated that workers are the ones who carry out work in a company and they play an important role in making the company profitable or bankrupt. Kaming, *et al.* (1997b) stated that Indonesia suffers from construction time and cost overruns like other developing countries including Malaysia, Nigeria, and Saudi Arabia. Kazaz and Ulubeyli (2004) concluded that construction industries in developed and developing countries

suffer from delays and cost overruns due to labor productivity. In Turkey, poor labor productivity is accepted as one of the main causes of delays (Kazaz and Ulubeyli, 2004).

The construction industry in the Arabian region as a whole experienced a lag with regard to developed countries. Odeh and Battaineh (2002) stated that the construction industry in Jordan is not adequately prepared for project management problems accompanying the anticipated boom in construction activities and the increasing complexity of projects. Construction projects in Jordan experienced a low productivity although labor supply is not a problem considering the relatively inexpensive and flux of foreign and local laborers. Nonetheless, the problem might be attributed to lack of incentives for higher productivity, or lack of proper training coupled with the absence of trade unions or associations that regulate, train, and classify construction trades (Odeh and Battaineh, 2002).

METHODOLOGY

The questionnaire for this research was prepared based on previous related studies including Abdul-Rahman (1995); Kartam (1997); Abdel-Razek (1998); Kartam, *et al.* (2000); Arditi and Mochtar (2000); Al-Momani (2000); Ahmed, *et al.* (2002a, 2002b); and Long, *et al.* (2004). A set of 28 safety and productivity factors were identified as important and used as the basis of a questionnaire. The 28 hypothesized factors were further grouped under 7 major categories: factors improving productivity, inspection, local conditions, worker problems, subcontractors, safety program, and personal protective equipments (PPE).

Research Population and Sample Size

Research population consists of 105 Palestinian contractors in the Gaza Strip who was classified as first, second, and third class excluding fourth and fifth classes. The exclusion of fourth and fifth classes was due to the small size of their companies which would not give accurate or expressive answers regarding safety and productivity as a result of their poor administrative and practical experience. Surveyed

population included companies which had a valid registration at the Palestinian Contractors Union (PCU) in the fields of building, roads, water supply and sewage, electro-mechanics, and public works. Ayyub and Mccuen (2003) method was used to determine the sample size.

$$SS = \frac{Z^2 \times P \times (1-P)}{C^2}$$

Where:

SS = Sample size

Z = Z value (e.g. 1.96 for 95% confidence level)

P = Degree of variance between the elements of population percentage

C = Confidence interval/ (margin of error), expressed as decimal (e.g., 0.05 = ±5%)

$$SS = \frac{(1.96)^2 \times 0.5 \times (1-0.5)}{(0.05)^2} \approx 385$$

Correction for finite population

$$SS_{correcte} = \frac{SS}{1 + \frac{(SS-1)}{N}}$$

Where

N = Population

$$SS_{correcte} = \frac{385}{1 + \frac{(385-1)}{105}} \approx 83$$

Eighty three questionnaires were distributed. Seventy one records were received and 10 questionnaires got rejected because of being filled carelessly or received incomplete. Finally, 61 valid responses were analyzed.

Research Location

Research has been conducted in the Gaza Strip which constitute of four governorates. The questionnaire were distributed randomly to contractors in the four governorates which include Northern, Gaza, Middle, and Southern (Table 1). The respondents who participated in this questionnaire survey have been engaged in the construction industry for many years ranging from a minimum of 2 years to a maximum of 30 years. The majority of them were project managers who have a good experience in site safety. They executed more than 15 construction projects in the last two years.

Table 1. Questionnaire distribution in Gaza Strip.

Governorate	No. of distributed	No. respondents	No. of valid respondents
Northern	15	13	11
Gaza	40	35	31
Middle	18	15	13
Southern	10	8	6
Total	83	71	61

Research measurement

In this research, ordinal scale was used because the research aimed at ranking the data extracted from respondents. The ranking was based on the Relative Importance Index (RII). RII is a commonly used method in construction to obtain priority rankings of attributes and it is particularly useful where a structured questionnaire is used to solicit measurements that are subjective in nature (Cheung, *et al.* 2000). The mean item score for each factor within groups is calculated to obtain the relative importance index (Naoum, 1998; Kumaraswamy and Chan, 1998; Chinyio, *et al.* 1998; Cheung, *et al.* 2000; Tam, *et al.* 2000; Odusami, 2002) as:

$$\text{Relative Importance Index} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N}$$

Where n1 = number of respondents for strongly disagree; n2 = number of respondents for disagree; n3 = number of respondents for neutral, n4 = number of respondents for agree; and n5 = number of respondents for strongly agree. The relative importance indices were then ranked from the highest to the lowest for the factors. The relative importance index ranges from 0 to 1 (Tam, *et al.* 2000). Five-point Likert scale was used in this research. The Likert scale was chosen in order to expand the way the respondents would reply. Content validity test was conducted by sending the pilot questionnaire to five experts in construction to evaluate: the content validity, check reliability, offensiveness of the language, adds more information and to delete unacceptable wording. Minor changes were made and the questionnaire was found valid, reliable, and ready to distribute to population sample.

RESULTS AND DISCUSSION

The collected questionnaires were analyzed. The results for the seventh safety and productivity groups are given and relevant discussion over these results is also included in this section.

Group 1: Factors Improving Productivity

Table (2) shows the respondents' perceptions about factors improving productivity with regard to safety. This group contains five factors.

"*Skillfulness of worker improves safety*" factor was ranked in the first position with RII=0.840 and was ranked in the first position among all groups of productivity. This result indicates skilled workers are committed to safety more than others. Skilled workers tend to perform tasks safely because of their high experience in construction industry. Skilled workers are company's fortune when they try to keep safe operations as much as possible. Company tends to train their skilled workers on safety obstacles and how to avoid them.

"*Increase of work hours affects safety*" factor was ranked in the second position among factors improving productivity group with RII=0.725 and was ranked in the seventh position among all groups of productivity. This result indicates that over-time would have negative effects on safety. Workers, who work over time, are exposed to exhaustion more than others. Their productivity in addition to safety would be influenced. It is not advisable to assign workers more working hours. Extra working time would worsen the safety

conditions in addition to project productivity.

"*Rework negatively affects safety*" factor was ranked in the third position among factors improving productivity group with RII = 0.520 and was ranked in the 23rd position among all groups of productivity. This result indicates that rework have negative effects on safety. Rework is needed when supervision engineers would detect bad quality work. Worker has to repair in order to overcome the quality problem. Worker would be under stress to complete rework so that work can be on schedule. This condition exposes worker to more accidents.

"*Increase of productivity is on the expense of safety*" factor was ranked in the fourth position with RII = 0.480 and was ranked in the 25th position among all groups factors of productivity. This result indicates that the increase of productivity has negative effect on safety. It was ranked low which means that majority of contractors do not support this factor. The increase of productivity is on the expense of safety if productivity is increased abnormally. Safety increases productivity because safe workers feel more confident to manage risks effectively.

"*Incentives based on productivity decreases safety*" factor was ranked in the fifth position with RII = 0.389 and was ranked in the 28th position among all groups factors of productivity. This factor was the lowest within this group. This result indicates that productivity incentives may not negatively affect safety. It ascertains that when workers are given incentives based on their productivity records, they would ignore their personal safety. Respondents did not support this

Table 2. Factors which improves productivity in worksite.

Factors improving productivity	No. of Respondents	Factors improving productivity					RII	Rank within this group	Overall Rank
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree			
Skillfulness of worker improves safety	61	0	0	4	30	27	0.840	1	1
Increase of work hours affects safety	61	0	4	8	38	11	0.725	2	7
Rework negatively affects safety	61	2	17	20	17	5	0.520	3	23
Increase of productivity is on the expense of safety	61	3	26	9	18	5	0.480	4	25
Incentives based on productivity decreases safety	61	9	23	14	15	0	0.389	5	28

idea; on the contrary, their answers were neutral. Productivity incentives would motivate workers to produce more. Productive workers are said to be skilled workers who have experience and stay ahead of learning curve. Their experience helps them to prevent accidents and job site hazards.

Group 2: Inspection

Table(3) shows the respondents' perceptions about the affect of inspections on productivity. This group contains three factors of inspection. "*When foremen allocates tasks to workers, they consider safety measures*" factor was ranked in the first position among inspection group with RII = 0.730 and was ranked in the fifth position among all factors of productivity. This result indicates that foreman role in safety cannot be ignored. Foremen are in direct contact with workers at job site. The key to success of any construction loss prevention program is its actual implementation on the job site. Field supervision is the main mechanism by which the loss prevention policy and procedures are implemented. The attitude of workers towards a loss prevention program is dependent upon the attitude of their supervisor.

The foreman's actions in directing the work are the critical link in delivering success. If foremen are given clear responsibilities for job site safety, and are held accountable through a performance review, the likelihood of accidents will be reduced to achieve greater construction productivity and worker safety. The foreman who understands the mechanics of direct and indirect

accident costs as well as overhead implications for workers' compensation and other insurance coverage is in a better position to make intelligent decisions in directing the work activities.

"*Involvement of foremen in preparing schedule can increase productivity and safety*" factor was ranked in the second position among inspection group with RII = 0.689 and was ranked in the 13th position among all factors of productivity. This result indicates the important role of foreman in ensuring safer and productive job site. Because foremen are in direct contact with workers and job sites, they have good experience in safe working procedures. They can assist the project manager on the best time required to accomplish a task safely. Involving foremen to participate in task scheduling would give the project manager better opportunities to complete the project within the time frame while maintaining safety and productivity at job site.

"*Over-inspection by foreman decreases productivity and safety*" factor was ranked in the third position among inspection group with RII = 0.480 and was ranked in the 24th position among all groups factors of productivity. This result indicates over-inspection by foreman brings negative results particularly by decreasing productivity due to rework, or thorough measurement tools and insignificant safety measurements. Workers whose performance is over inspected would feel reluctant to correct errors which would negatively affect worker's safety who may encounter hazards without preparedness.

Table 3. Affects of inspection on productivity.

Inspection	No. of Respondents	Frequency of occurrence					RII	Rank within group	Rank
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree			
When foremen allocates tasks to workers, they consider safety measures	61	0	4	7	39	11	0.730	1	5
Involvement of foremen in preparing schedule can increase productivity and safety	61	0	3	13	40	5	0.689	2	13
Over-inspection by foreman decreases productivity and safety	61	0	27	15	15	4	0.480	3	24

Group 3: Local Conditions

Table (4) shows the respondents' perceptions about local conditions with regard to productivity. This group contains five factors of local conditions. "In order to avoid closure, workers tend to leave early which would decrease safety and productivity" factor was ranked in the first position among local conditions group with RII = 0.689 and was ranked in the 12th position among all groups of productivity. This result indicates workers share in decreasing safety and productivity at job site when they leave work early to avoid closures and barriers. In Gaza Strip, barriers between north and south existed in addition to closure of borders between Gaza Strip and Green Line. Workers tend to leave job site early due to security risks which enforce them to complete their assigned tasks earlier. Foreman sometimes enforce workers to complete tasks earlier to avoid payment of extra wages. These conditions tend to reduce workers safety because of extra efforts exerted. Productivity apparently increases due to extra efforts, but if workers get exhausted their productivity may decline because of incidents.

"Current security conditions affect workers negatively which would decrease both productivity and safety" factor was ranked in the

second position among local conditions group with RII = 0.672 and was ranked in the 15th position among all groups of productivity. This result indicates that security conditions have great affects on construction workers. When security conditions worsens in Gaza, workers who work in infrastructure projects especially are exposed to more hazards and thus a worker's brain would be occupied by worry and tension. Workers' brain being occupied by such negative feelings would have great influence on their performance in a manner that decreases their concentration and accidents are more probable to occur. Worker's productivity will decrease due to these conditions. Errors are more probable to occur and rework actions will happen.

"In order to overcome delays resulting from closures, productivity pressure increases which would increase accidents" factor was ranked in the third position among local conditions with RII = 0.582 and was ranked in the 20th position among all groups of productivity. This result indicates that workers who are forced to work more than expected are more exposed to accidents at job site. When delays are overcome by putting pressure on workers to be more productive, contractor may get negative results. Accidents decreases productivity when workers will be

Table 4. Effect of local conditions on safety and productivity.

Local conditions	No. of Respondents	Frequency of occurrence					RII	Rank within group	Rank
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree			
In order to avoid closure, workers tend to leave early which would decrease safety and productivity	61	2	4	10	35	10	0.689	1	12
Current security conditions affect workers negatively which would decrease both productivity and safety	61	2	9	5	34	11	0.672	2	15
In order to overcome delays resulting from closures, productivity pressure increases which would increase accidents	61	0	15	12	32	2	0.582	3	20
Strikes and non-default nonworking days accelerates work thus affecting safety negatively	61	3	14	13	27	4	0.557	4	22
Putting much concern on regulations of safety slow downs productivity	61	2	30	14	12	3	0.430	5	26

absent and other colleagues of injured worker will be thinking of their friend which makes them reluctant to worker with enthusiasm.

"*Strikes and non-default nonworking days accelerates work thus affecting safety negatively*" factor was ranked in the fourth position among local conditions group with RII = 0.557 and was ranked in the 22nd position among all groups of productivity. This result indicates that strikes and nonworking days would affect safety. Respondents did not support this factor so much. The only conditions when work stops are lack of materials due to closure and national holidays.

"*Putting much concern on regulations of safety slow downs productivity*" factor was ranked in the fifth position among local conditions group with RII = 0.430 and was ranked in the 26th position among all groups of productivity. This result indicates that respondents did not support this factor which can be noticed from its low rank within its relevant group and overall rank of productivity. Compliance with safety regulations would not decrease worker's productivity because such regulations were designed and applied to maintain worker's safety and productivity. Compliance with safety regulations were assembled to ensure worker's comfort at job site taking into considerations all means of project success as well including productivity.

Group 4: Worker Problems

Table (5) shows the respondents' perceptions about worker problems with regard to productivity. This group contains four factors of worker problems. "*Demonstrating daily activities to workers before start of activity would contribute to improving safety*" factor was ranked in the first position among worker problems group with RII = 0.807 and was ranked in the second position among all groups of productivity. This result indicates that when foreman briefs about daily activities to workers prior to start of any activity, safety conditions will be better. Workers would understand expected hazards when they are briefed about daily tasks to perform. Workers would feel that foreman shares information with them which strengthens their moral and would have a goal to achieve. They will feel that they contributed to task planning which makes them more committed to completing tasks. They would eliminate such hazards because they have been shown schedule which enables them to forecast hazards inherited.

"*Personal and family problems of worker affect safety and productivity negatively*" factor was ranked in the second position among worker problems group with RII = 0.730 and was ranked in the sixth position among all groups of productivity. This result indicates that when worker's mind is

Table 5. Effect of local conditions on safety and productivity.

Worker problems	No. of Respondents	Frequency of occurrence					RII	Rank within group	Rank
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree			
Demonstrating daily activities to workers before start of activity would contribute to improving safety	61	0	1	5	33	22	0.807	1	2
Personal and family problems of worker affect safety and productivity negatively	61	0	2	10	39	10	0.730	2	6
Safety and productivity is affected negatively when workers perform work without supervision of a foreman	61	0	3	7	43	8	0.725	3	8
Turnover creates unusual relation between workers which would decrease productivity and increase accidents	61	0	11	11	33	6	0.635	4	18

pre-occupied by personal and family problems, the probability of having accident is high. This factor is similar to what Hinze (2003) has found in his study. The personal and family problems not only cause accidents but also decrease worker's productivity because of the mental occupation and conscious dispersion (Hinze, 2003).

"*Safety and productivity is effected negatively when workers perform works without supervision of a foreman*" factor was ranked in the third position among worker problems group with RII = 0.725 and was ranked in the eighth position among all groups of productivity. This result indicates that the role of foreman on job site cannot be neglected. The foreman guides workers to complete activities of project based on his extensive experience in construction. Foreman having good experience in safety knows risks associated with tasks and thus would warn workers to avoid them.

"*Turnover creates unusual relation between workers which would decrease productivity and increase accidents*" factor was ranked in the fourth position among worker problems group with RII = 0.635 and was ranked in the 18th position among all groups of productivity. This result indicates that respondents ranked this factor the lowest within its relevant group and also relatively low within overall rank. Worker turnover is the ratio of the number of workers that are replaced in a given time period to

the average number of workers. Turnover occurs because of completion of a project, end of contract, better opportunity, or other problems. Turnover can cause loss in productivity at the beginning.

Group 5: Subcontractors

Table (6) shows the respondents' perceptions about subcontractors with regard to productivity. This group contains four factors of subcontractors. "*Accidents frustrate workers and create absenteeism which would decrease productivity*" factor was ranked in the first position among subcontractors group with RII = 0.738 and was ranked in the fourth position among all groups of productivity. This result indicates that lack of worker's safety negatively affect the worker's productivity. Injured worker would feel frustrated and reluctant to come back to work being demoralized. Colleagues of injured worker would feel the same feeling. Injured workers would be away of work until they are recovered. This happens when the injury is moderate or more hazardous and needs medical action for remedy. Workers who help the injured worker would be away of work until they bring their colleague to hospital or medical center for treatment. Injuries play a direct role in the overall productivity of a construction project. When an injury occurs, the productivity of the entire crew usually comes to a complete stop. Not only will there be down time where work will not be completed but also when the crew does return to work they will

Table 6. Subcontractors safety rules and regulations.

Subcontractors	No. of Respondents	Frequency of occurrence					RII	Rank within group	Rank
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree			
Accidents frustrate workers and create absenteeism which would decrease productivity	61	0	4	6	39	12	0.738	1	4
Hiring of more subcontractors to increase productivity may create lack of coordination which leads to less safety attention	61	0	10	12	32	7	0.643	2	17
Subcontractor's lack of safety concerns decreases productivity	61	1	9	16	27	8	0.627	3	19
Accidents increase when a subcontractor is hired for specific task	61	1	11	72	15	7	0.561	4	21

be left short-handed and productivity is often below normal (Hinze, 1997).

"Hiring of more subcontractors to increase productivity may create lack of coordination which leads to less safety attention" factor was ranked in the second position among subcontractors group with RII = 0.643 and was ranked in the 17th position among all groups factors of productivity. This result indicates that hiring large number of subcontractors exposes the project to poor coordination which would be at the expense of safety. Having more subcontractors does not necessarily mean more productive environment because a crowded job site is said to be less productive and more risky.

"Subcontractor's lack of safety concerns decreases productivity" factor was ranked in the third position among subcontractors group with RII = 0.627 and was ranked in the 19th position among all groups of productivity. This result indicates that unsafe subcontractors are probably unproductive. General contractor is generally aware of subcontractors' safety records during the selection process. Unsafe subcontractors are frequently exposed to rework because of errors caused by them when they are exposed to accident. Productivity decreases because workers would be stressed when they feel that subcontractor is not aware of their personal safety.

"Accidents increase when a subcontractor is hired for specific task" factor was ranked in the fourth position among subcontractors group with

RII = 0.561 and was ranked in the 21st position among all groups of productivity. This factor holds the lowest rank within its relevant group and extremely low rank within overall rank of productivity. This result indicates that respondents did not support the idea that hiring subcontractors for specific trades affect safety negatively. Safety considerations must be integral to the planning and execution of all phases of subcontracted construction work done. Subcontractors are responsible for providing their employees and members of the public with a work site that is free from safety and health hazards. General contractors often rely on the special expertise of subcontractors, who may know more about the hazards of the particular job they are supposed to perform. Generally, it is agreed that auditing safety performance of subcontractors against safety program is critical for success.

Group 6: Safety Program

Table (7) shows the respondents' perceptions about safety program with regard to productivity. This group contains four factors of safety program. "In order to avoid accidents, anticipated risks are included in safety program which increases productivity" factor was ranked in the first position among safety program group with RII = 0.750 and was ranked in the third position among all groups of productivity. This result indicates that the inclusion of hazards identification into safety program helps in

Table 7. Effect of safety program on productivity.

Safety program	No. of Respondents	Frequency of occurrence					RII	Rank within group	Rank
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree			
In order to avoid accidents, anticipated risks are included in safety program which increases productivity	61	1	0	11	34	15	0.750	1	3
Safety program contributes to increasing productivity	61	0	0	13	40	8	0.725	2	9
Training new and old workers on preventive actions and first aid increases productivity	61	0	5	11	37	8	0.693	3	11
Scheduling of safety meetings contributes to increasing productivity	61	0	4	18	28	11	0.684	4	14

increasing productivity. Occupational Safety and Health association (OSHA) states that an effective safety and health program depends on the credibility of management's involvement in the program; inclusion of employees in safety and health decisions; rigorous worksite analysis to identify hazards and potential hazards, including those which could result from a change in worksite conditions or practices; stringent prevention and control measures; and thorough training. Productivity is increased by identifying hazards and including them in safety program, which helps worker to avoid hazards and thus preventing worker from being injured.

"*Safety program contributes to increasing productivity*" factor was ranked in the second position among safety program group with RII = 0.725 and was ranked in the ninth position among all groups of productivity. This result indicates that safety program is important for achieving a productive work environment. Safety program consists of instructions and methodologies that outline how safety can be achieved on site. By achieving safety, workers feel comfortable and more loyal to their work. They would be more productive in safe conditions.

"*Training new and old workers on preventive actions and first aid increases productivity*" factor was ranked in the third position among safety program group with RII = 0.693 and was ranked in the 11th position among all groups factors of productivity. This result indicates that training of workers on safety contributes to productivity.

Training of workers on safety increases their safety management knowledge, which would increase productivity.

"*Scheduling of safety meetings contributes to increasing productivity*" factor was ranked in the fourth position among safety program group with RII = 0.684 and was ranked in the 14th position among all groups of productivity. This result indicates that respondents did not support that safety meetings contribute to enhancing productivity. Safety meeting ensure that all employees and management is ready to address safety issues. According to some contractors, productivity comes before safety in many instances. Respondents probably did not consider safety meetings an important factor of productivity because their companies do not use to hold such meetings. Safety meetings will be non productive if meeting's information and decisions are not met at job site.

Group 7: Personal Protective Equipment (PPE)

Table (8) shows the respondents' perceptions about PPE with regard to productivity. This group contains three factors of personal protective equipments. "*When workers do not wear PPE, safety and productivity are affected negatively*" factor was ranked in the first position among PPE group with RII = 0.721 and was ranked in the tenth position among all groups of productivity. This result indicates that PPE play an important role in maintaining safety and productivity. PPE can reduce the number and severity of injuries

Table 8. Effect of personal protective equipments on safety and productivity.

Personal protective equipments (PPE)	No. of Respondents	Frequency of occurrence					RII	Rank within group	Rank
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree			
When workers do not wear PPE, safety and productivity are affected negatively	61	0	1	8	48	4	0.721	1	10
Hot weather decreases productivity and workers feel exhausted which exposes them to more accidents	61	1	10	6	36	8	0.660	2	16
Use of PPE puts constrains on workers movement which decreases productivity	61	2	43	7	16	2	0.422	3	27

and illnesses. Personal protective equipment not only helps protect people but also improves productivity and profits. Comprehensive worker education through ongoing training programs about the use, wear and care of PPE is a critical first step in creating a safer working environment and reducing injury-related costs. This result also rejects the relatively widely spread idea in Gaza Strip that PPE prevents worker from working properly.

"Hot weather decreases productivity and exhausts workers which exposes them to more accidents" factor was ranked in the second position among PPE group with RII = 0.660 and was ranked in the 16th position among all groups factors of productivity. This result shows that hot weather conditions, which are a prevailing condition in Gaza Strip from June until November, exposed workers to accidents. Hot weather exposes workers to headache, sun stroke, and heat exhaustion. Under these conditions workers feel reluctant to work and their productivity decreases noticeably.

"Use of PPE puts constrains on workers movement which decreases productivity" factor was ranked in the third position among PPE group with RII = 0.422 and was ranked in the 27th position among all groups of productivity. This result indicates that respondents were reluctant to support that PPE puts constrains on workers' movement and thus decreases productivity. Using PPE doesn't hinder worker's movement especially if the worker is trained on how to use their PPE and keep it clean.

Summary of Group Ranking

Table (9) shows a summary of ranking of productivity group factors. It can be noticed that the "Worker problems" was ranked in the first position among productivity groups of factors. This result indicates that worker's problems affect his performance very much on job site. Worker problems caused mind distraction of worker, which decreased productivity and increased the exposure to accidents. It is difficult to overcome this problem unless foreman is to be aware of workers problems in order to avoid accidents.

Table 9. Ranking of groups of productivity.

Group	RII	Rank
Group 4: Worker problems	0.724	1
Group 6: Safety program	0.713	2
Group 5: Subcontractors	0.642	3
Group 2: Inspection	0.633	4
Group 7: Personal protective equipments	0.601	5
Group 1: Factors improving productivity	0.591	6
Group 3: Local conditions	0.585	7

"Safety program" group was ranked in the second position. Safety program is considered one of the most important elements which are necessary for good safety management. Safety program is essential in establishing safety management plan. Safety program in its contents directs all project parties to proper action in order to avoid accidents. "Subcontractors" group was ranked in the third position. This result indicates the importance of safety by the subcontractors on jobsite. Professional general contractor hires subcontractors taking into account their safety records.

"Inspection" group was ranked in the fourth position. This result indicates the importance of inspection on job site and the foreman role in providing directions of safe actions cannot be ignored. If foremen are given clear responsibilities for worker safety, and are held accountable through a performance review and reward system, the likelihood of accidents will be reduced helping to achieve greater construction productivity, and worker safety. On the contrary, over-inspection contributes to decreasing safety measures on job site due to extra pressure exerted by foremen on workers. "Personal protective equipments" group was ranked in fifth position. This result indicates the importance of PPE in maintaining safety and productivity. PPE can reduce the number and severity of injuries and accidents if workers are used to such tool. This result indicates that PPE doesn't restrain movement of workers during their work; on the contrary it helps them performing their tasks safely.

"Factors improving productivity" group was ranked in the sixth position. Skillfulness of workers helps improving safety because skilled workers when performing their tasks avoid

associated risks. Skilled workers are company's fortune when they try to keep safe as much as possible. Increasing work hours and incentive-based productivity increases the exposure of workers to hazards. Rework exposes workers to more accidents due to pressure that workers were put under while correcting defective work. "Local conditions" group was ranked in the seventh position. This group was ranked in the lowest position among productivity groups. Border closure in Gaza Strip caused long delays in project schedules which enforced workers to more work hours when borders open in order to overcome delays. This would increase accidents among workers who spent longer work times.

CONCLUSION

The primary objective of this questionnaire survey was to identify and investigate the relative importance of the productivity factors that relate to safety, according to the perception of contractors. Twenty eight factors, which were further grouped under 7 major categories, were identified and ranked. Table (10) shows the most important five factors of productivity which have a strong linkage with safety based on overall ranking among productivity groups. Results indicated that "*Skillfulness of worker improves safety*" factor has been ranked in the 1st position with regard to its importance in sustaining safety and productivity of project. This factor belongs to factors improving productivity group. In terms of productivity, skillful workers are more productive because they perform tasks on time. Results show that skilled workers enhance safety. This factor

shows the significant linkage between safety and productivity.

Results shown that "*demonstrating daily activities to workers before start of activity would contribute to improving safety*" factor has been ranked in the 2nd position. This factor belongs to worker problems group. This factor of productivity is similar to the factor "*Non-orientation of new workers decreases productivity and increases risk they face*". This indicates that orientation of either newly hired workers or regular workers is essential especially for irregular job tasks. Demonstrating daily activities to workers helps in avoiding discrepancies with safety regulations.

Results show that "*in order to avoid accidents, anticipated risks are included in safety program which increases productivity*" factor was ranked in the 3rd position. This factor indicates the importance of safety program in sustaining a safe environment at jobsite. It indicates that safety program enhances productivity because of less accidents and injuries.

The results show that "*accidents frustrate workers and create absenteeism which would decrease productivity*" factor was ranked in the 4th position. This factor belongs to subcontractors group. Accidents can decrease injured worker's productivity in addition to other workers' productivity because of mind distraction or fear of associated risks. This result indicates that link between safety and productivity is strong. "*When foremen allocate tasks to workers, they consider safety measures*" factor was ranked in the 5th position. This factor belongs to inspection group. This indicates that there exists a good linkage between safety and productivity when worker

Table 10. The most important productivity factors that relate to safety.

Factors of productivity and safety	Related group	RII	Rank
Skillfulness of worker improves safety	Factors improving productivity	0.840	1
Demonstrating daily activities to workers before start of activity would contribute to improving safety	Worker problems	0.807	2
In order to avoid accidents, anticipated risks are included in safety program which increases productivity	Safety program	0.750	3
Accidents frustrate workers and create absenteeism which would decrease productivity	Subcontractors	0.738	4
When foremen allocate tasks to workers, they consider safety measures	Inspection	0.730	5

and task allocation is major component of good productivity management.

The results found that "worker problems" is the most important among productivity groups of factors followed by "safety program", "subcontractors", "inspection", "personal protective equipment", "factors improving productivity" and "local conditions". Finally, contractors are recommended to act strategically to protect workers by continuously identifying, evaluating, and mitigating hazardous conditions, activities, work locations, and site conditions on job site. It is advisable to provide specific job related training to all workers working on the job site specific to the hazards of whether they are moving construction vehicles, equipment or other risks such as fall and electric shock.

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Ref. No. (2502)

Rec. 05/01/2009

In-revised form: 01/09/2009