UNDERSTANDING THE KEY FACTORS OF CONSTRUCTION WASTE IN JORDAN

Dr. Jawad Al-Rifai & Dr . Omar Amoudi

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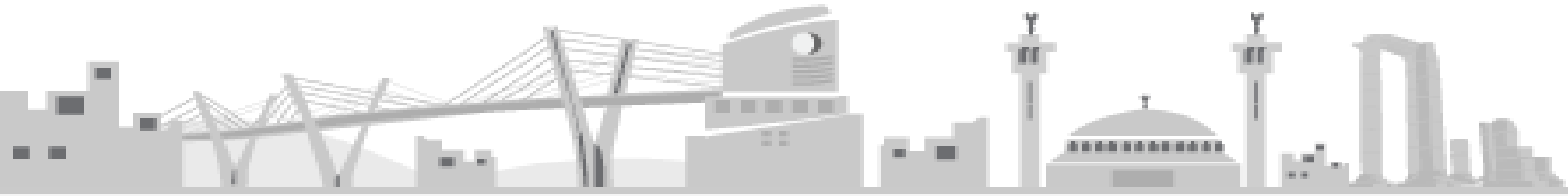
PHILADELPHIA UNIVERSITY
THE WAY TO THE FUTURE

Center for Water, Environment & Dead Sea Studies

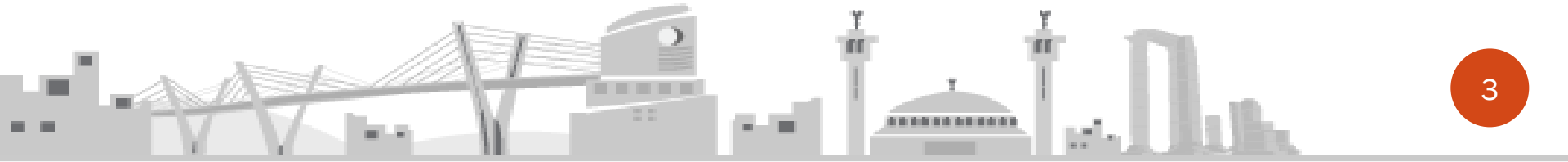
Introduction

- Building & construction activities worldwide consume 3 billion tons of raw materials each year, which is about 40% of the total
- The UK's annual construction output requires 170 million tons of primary materials and products, 125 million tons of quarry products and 70 million tons of secondary recycled and reclaimed products.
- To manufacture and deliver these products, 6 million tons of energy are consumed and 23 million tons of CO_2 are emitted



The Construction Industry in Jordan

- It represents approximately 5% of the (GDP)
- It supplies the infrastructure to other economic sectors
- Construction projects can be classified into: building or civil engineering projects
- Construction firms In Jordan could be categorized into two main categories :
  - Small and Medium Company
  - Large Size Company
- It is a **major consumer of natural resources**



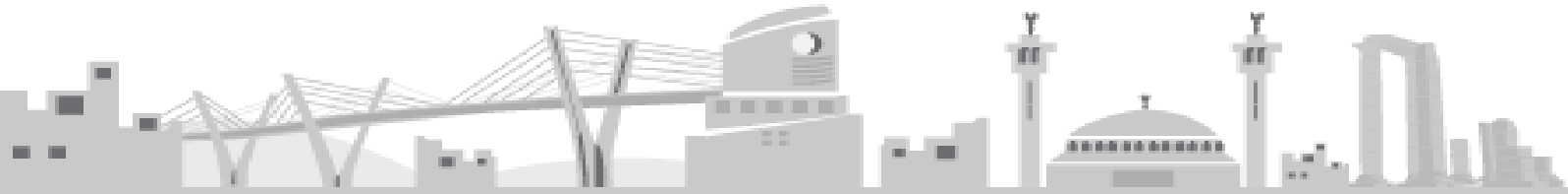
Construction Waste?

- 'Any substance or object (such as bricks, concrete, and steel) which is generated as a result of construction work and should be discarded as it no longer can be used as part of the construction processes'
- In term of money, construction material waste can be understood as the difference between the value of materials delivered and accepted on site and those properly used as specified and accurately measured in the work

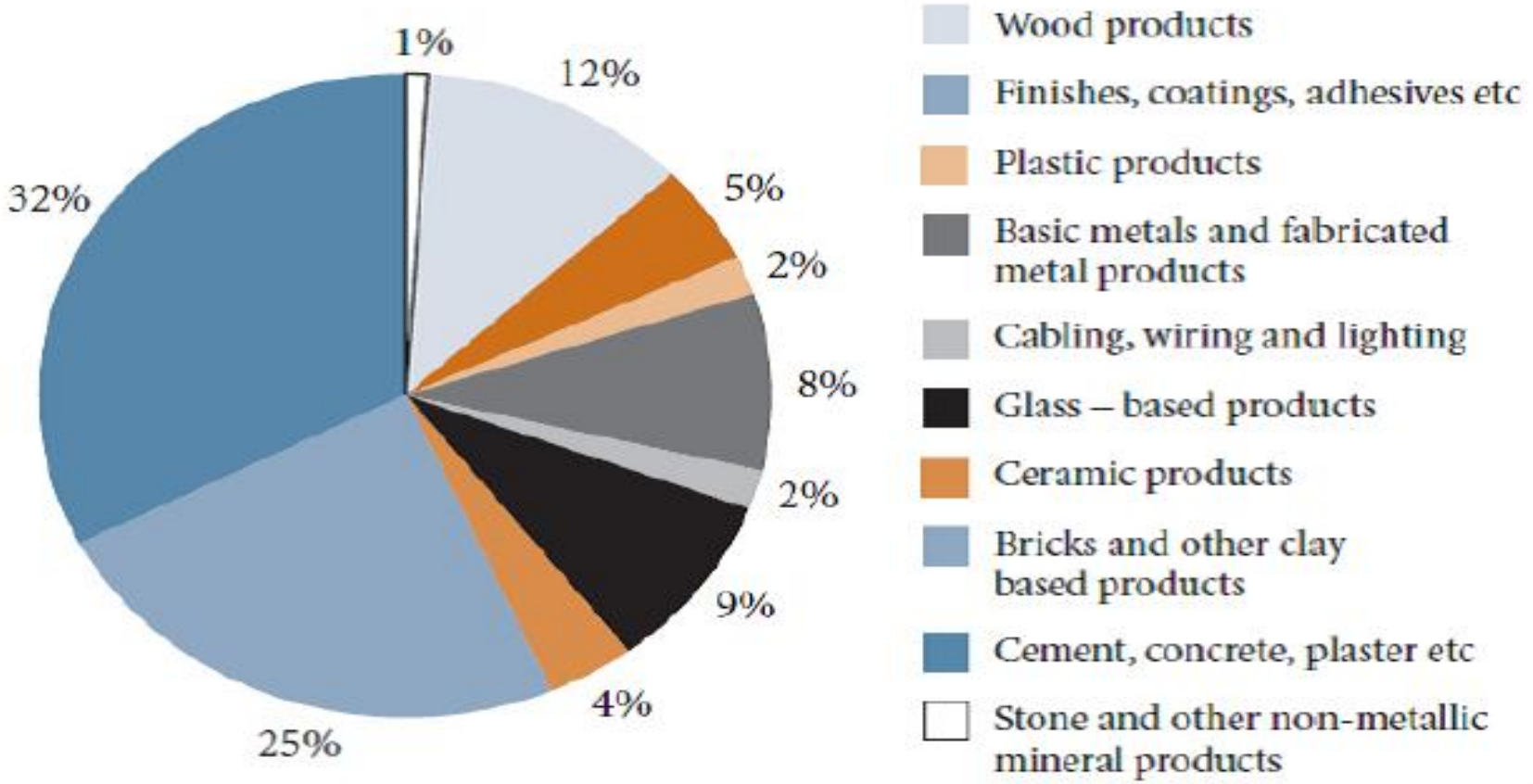
Construction Waste

- In UK approximately 13% of material delivered to construction site goes the skip without being used.
- Annually, the UK produces around 400 million tons of waste of which 72 million come from the construction industry, this is equivalent to about 1.45 tones for every person in the UK.
- In the USA by comparison, about 24% of solid landfill waste is generated by the construction industry.
- Up to 95% of construction waste is recyclable, most is clean and un mixed

Ref: Ochsendorf, J. Sustainable Design: The role of the construction industry



Wastes from construction materials and products industry, kt (excluding quarry wastes)

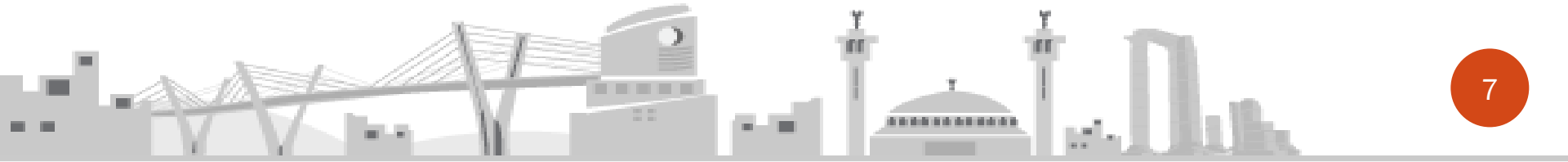


Ref: Bradley, J. Sustainable construction,

Construction Waste

Construction material waste can also be classified as follows:

- Waste of materials as a result of damage which cannot be repaired and utilized anymore
- Waste of materials as a result of loss during construction process
- Waste of materials as a result of errors in construction and excess of actual quantities comparing to theoretical quantities in drawings

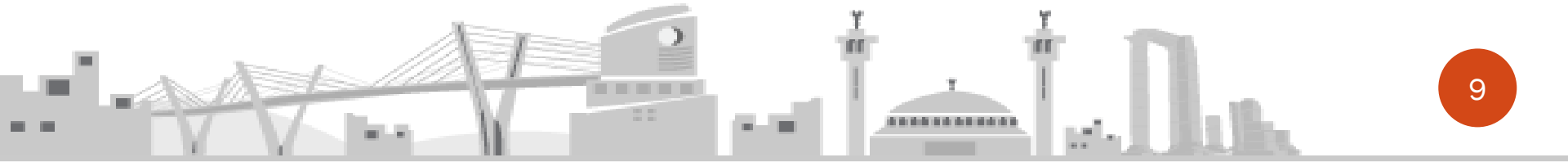


Aim of the study

Identifying the main factors causing waste in construction materials in order to help decision makers to manage and minimize the negative impacts of construction waste on the economy and environment in Jordan.

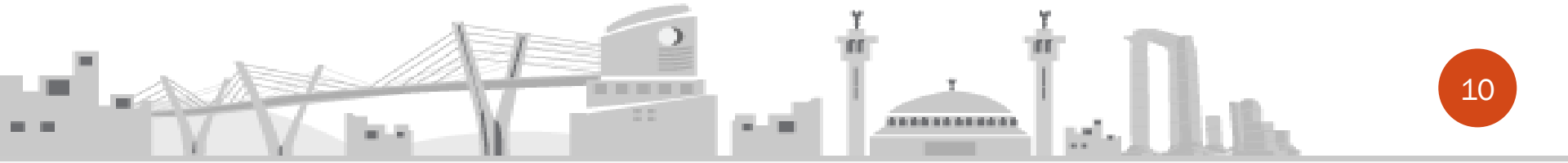
Study Scope

- Large construction companies
- Large building projects



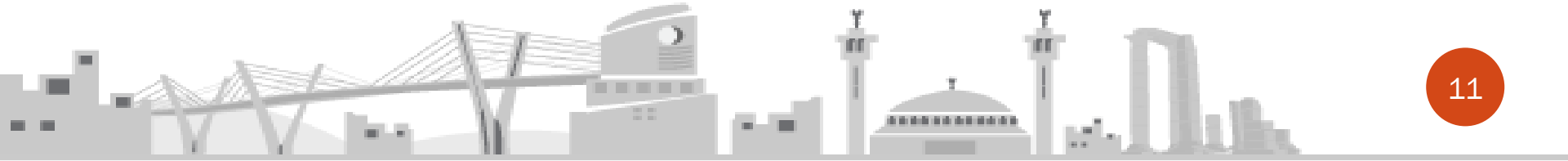
Research methodology

- Intensive Literature review to identify the main factors causing waste in construction
- Semi-structured interviews to identify the degree of factors on construction waste



Data Collection

- Semi-structured interview was employed
- March 2014 and May 2014
- Targeted interviewees: Project Managers, Site Engineers and Company Managers
- Three parts of interview:
  - Project and company information
  - Degree of contribution of each factor to the waste based on a Likert scale (1-4)
  - Comparison between expected percentage of waste and actual waste



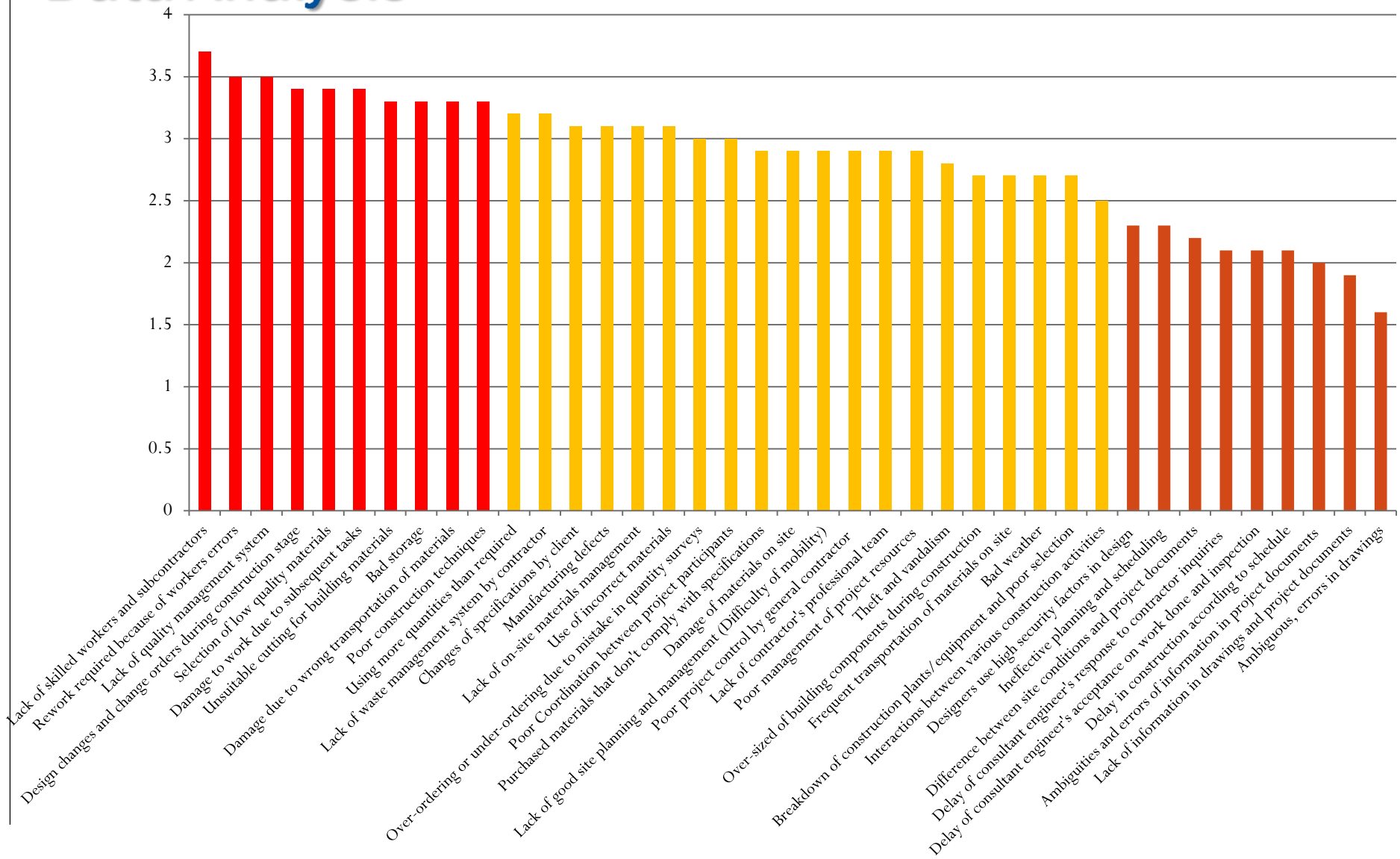
Data Analysis

Project and company information

Job position	Percentage	Experience in years	Percentage
Company Manager	10	Less than 5	0
Project Manager	60	5-10	20
Site Engineer	30	10-20	30
Supervisor	0	More than 20	50
Company age in years	**Percentage**	**Project size in 1000 JD**	**Percentage**
Less than 5	0	Less than 250	10
5-10	20	250-1000	20
10-20	30	1000-10,000	50
More than 20	50	More than 10,000	20
Contractor Grade according to contractors syndicate	**Percentage**	**Size of the company Number of employees**	**Percentage**
First	60	1 – 50	0
Second	0	51 - 100	20
Third	40	101 - 250	20
Fourth	0	≥250	60

Data Analysis

Factors impact ranking



Classification of Factors Impacts

High	• Range from 3.25 to 4
Medium	• Range from 2.25 to 3.25
Low	• Range from 1.75 to 2.5
V Low	• Range from 1 to 1.75

Data Analysis

Factors contributing to waste

Class	Factor description	Average	SD
High Impact Factors	Lack of skilled workers and subcontractors	3.70	0.67
	Rework required because of workers errors	3.50	0.53
	Lack of quality management system	3.50	0.71
	Design changes and change orders during construction stage	3.40	0.84
	Selection of low quality materials	3.40	0.70
	Damage to work due to subsequent tasks	3.40	0.70
	Unsuitable cutting for building materials	3.30	0.95
	Bad storage	3.30	0.48
	Damage due to wrong transportation of materials	3.30	0.67
	Poor construction techniques	3.30	0.82

Data Analysis

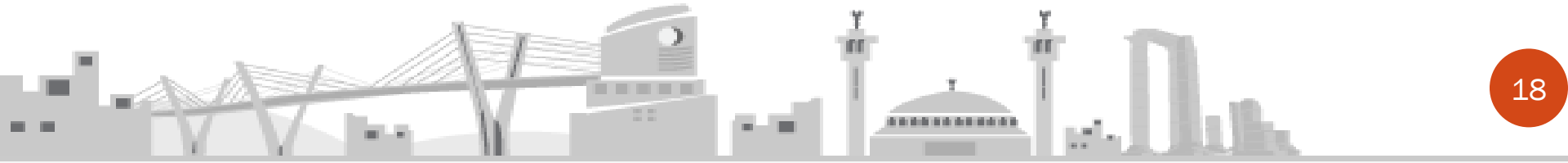
Factors contributing to waste

Class	Factor description	Average	SD
Medium	Using more quantities than required	3.20	0.92
	Lack of waste management system by contractor	3.20	0.63
	Changes of specifications by client	3.10	0.74
	Manufacturing defects	3.10	1.10
	Lack of on-site materials management	3.10	0.74
	Use of incorrect materials	3.10	0.99
	Over-ordering or under-ordering due to mistake in quantity surveys	3.00	1.25
	Poor Coordination between project participants	3.00	0.47
	Purchased materials that don't comply with specifications	2.90	1.20
	Damage of materials on site	2.90	1.29
	Lack of good site planning and management (Difficulty of mobility)	2.90	0.99
	Poor project control by general contractor	2.90	0.88
	Lack of contractor's professional team	2.90	0.88
	Poor management of project resources	2.90	0.88
	Theft and vandalism	2.80	1.03
	Over-sized of building components during construction	2.70	1.16
	Frequent transportation of materials on site	2.70	1.06
	Bad weather	2.70	0.67
	Breakdown of construction plants/equipment and poor selection	2.70	0.95
	Interactions between various construction activities	2.50	1.18

Building items	Actual vs. Expected waste percentage	Possible causes
Concrete	higher than expected	• over-sized of building components during construction • lack of management team and labour awareness • Lack of quality management system
Steel	higher than expected	• unsuitable cutting • lack of proper supervision team • Poor construction techniques
Formwork	Within the range	• frequent cutting of formwork to shape various types of structure elements • lack of constructability in design • lack of labour awareness
Sand and Aggregate	higher than expected	• over-sized of building components during construction • bad storage • damage during to transportation on site • Lack of on-site materials management
Cement	higher than expected	• bad storage • Frequent transportation of materials on site • Lack of on-site materials management
Bricks	Within the range	• unsuitable cutting • Lack of skilled workers and subcontractors • damage during to transportation
Stone	Within the range	• Similar to bricks • Selection of low quality materials
Tiles	Within the range	• unsuitable cutting • Lack of skilled workers and subcontractors • Manufacturing defects • Forced cutting to match required dimensions • Selection of low quality materials
Ceramic	Within the range	• Similar to tiles
Pipes	Within the range	• unsuitable cutting
Paint	Within the range	• lack of labour awareness • Damage to work due to subsequent tasks • Rework required because of workers errors • Selection of low quality materials

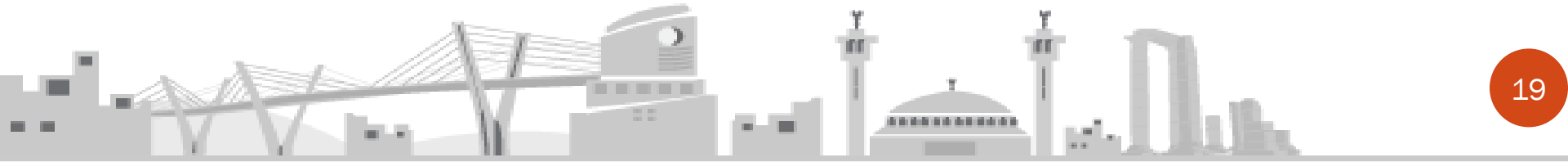
Potential Benefits of Waste Management

- Reduce project cost and enhance profit
- Enhance their competitive advantages in the market
- Demonstrate their clients about waste management and environmental protection
- Enhance quality and performance within the construction industry at large
- Reduce resources and energy consumption and decrease soil and air pollution
- Save last user money because of cost saving resulted from minimizing construction waste.
- Promote workforce skills and productivity
- Enhance sustainability aspects (economic, environmental and social



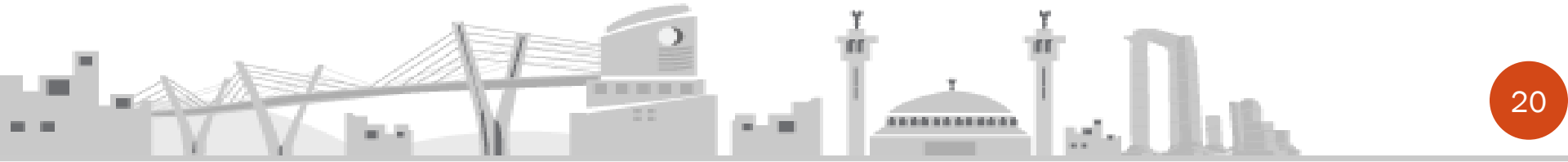
A proposed strategy to waste management

- Develop clear solid waste management regulations
- Identifying the responsibility of each party
- Identifying types and quantities of waste that could be generated from construction activities
- Implementing onsite construction waste sorting procedures
- Adopting prefabricated building components to enhance quality and reducing waste onsite
- Improve project contractors' onsite construction management
- Identifying necessary training required for project stakeholders
- Measuring waste and comparing it with ex-determined targets to identify and handle with potential sources of waste.
- Reviewing the results and updating the strategy for continuous improvement.



Conclusions

- Most of construction companies do not seem to be concerned about material waste.
- The most significant factors contributing into construction waste can be categorized mainly into two groups:
  - Management related
  - Workforce related.
- A considerable emphasis should be placed on the management factors of greater importance.
- Significant attention should be paid on building up workforce skills through training and education.
- The actual waste in some construction items such as concrete and steel are higher than expected. Therefore, managing such factors that cause this waste is of great importance in minimizing construction waste



Thanks for Listening

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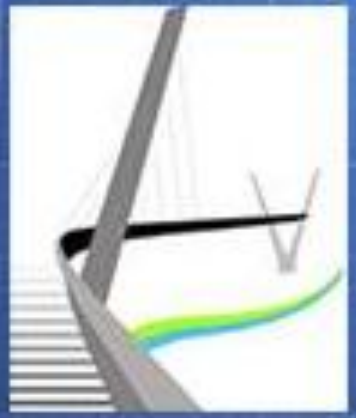

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