A new categorization of construction materials based on sources of waste across supply chain

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Abstract: Construction industry is an important part of any economy. But it does not have an appropriate performance especially in the productivity of materials. Statistics show production of billions of tons of construction waste per year in the world, and these issues threaten all beneficiaries of this industry. Thus, convenient strategies should be founded for improving waste production. This will not be achieved unless we recognize waste sources across construction supply chain. Also each material has its own source of waste, therefore exact identification of any material and after that its source will help to develop waste minimization strategies. In this research 30 questionnaires were distributed between experts. At first we prioritized waste sources, and by following the question about impact of sources on selected material, using binominal test, it observed that a category of sources had impact on some of material and another sources on another materials. Analysis of these two types of materials showed us that this result was not accidental and those materials when use in building, their dimensions is important (like brick, block, tile and etc.), those sources have impact on their waste that emphasize design parameters of building. Those material when use in building, their weight are important (like cement, gypsum, sand and etc.), those sources have impact on their waste that emphasize purchasing level of ordering and purchasing. Therefore materials categorized by their sources of waste across supply chain.

[Mohamad Reza Parsanejad, Mansor Momeni, Ahmad Jafarnejad, Ali Mohaghar. **A new categorization of construction materials Based on sources of waste across supply chain**. Journal of American Science 2010; 6(12):1263-1273]. (ISSN: 1545-1003). http://www.americanscience.org.

Keywords: Waste, Source of waste, Construction supply chain, Non-coordination, Dimensional, Weight based.

1) Introduction:

Statistics shows us at 2008, 16.7 million tons of wastes were disposed in Tehran landfills. Also since year 1995 to 2008 it was estimated that 150 million tons of wastes were produced in Tehran and transported to wastes centers. (Report of material section of construction and housing research center, 2008), (Report of Tehran municipal recycles organization, 2008), (Omrani et al., 2008)

Based on Tehran municipal reporters, construction wastes are transported to some places like ABALI, TELO, ARDIB and so on. The most popular of these places is ABALI that 900 thousands of construction wastes are disposed there every month. This area is more than 700 square kilometers, it means as wide as Tehran city. By growing population and flourishing demands for building, lots of problems will generate near these high amounts of wastes. (Report of environmental committee of consoling Tehran city, 2008)

These statistics shows that the amount of waste production is high in Iran but with a review it could be seen that this amount is high in another countries too. Here are some researches that show this subject:

- The amount of waste is about 1 to 10% of purchased material with average of 9% (Ekanayake and Ofori, 2004),
- The amount of waste in Brazil is between 20 to 30% of material weight entered a construction site (Pint and Agapyan, 1994),
- Construction waste in Australia is from 4% for glass to 19.6% for plaster (McDonald and Smithers, 1998),
- In USA, waste in most of buildings is 20 to 30 kilograms (Chun-Li et al., 1997),
- Average waste of block in Singapore is about 13% of purchased weight (Kang, 2000),
- The amount of waste cost is about 3 to 40% of total project cost. (Katz and Baum, 2010)
- 25% of materials in construction process waste (Hamassaki and Neto ,1994),
- 20% of material entered the site are wasted (Formoso et al., 1993),
- Construction waste is about 30% of all material weight in site. (Fishbein, 1998),
- Construction waste as a percent of solid wastes entered to the site in some countries are as below: Netherlands 26%, Australia 20-30%, USA 10-29%, Germany 19% and Finland 13-15% (Bossink and Brouwers, 1996),

These statistic excited researchers to sick and develop some solutions for management and prevention of construction wastes. Among various methodologies of waste management, a categorization is more popular. It classifies waste management solutions to four categories : minimization, reuse, recycle and disposal. (Gavilan and Bernold, 1994; Franiran and Gaban, 1998; Begum et al., 2007; Silva and Vithana, 2008)

However material waste management leads to higher level of productivity in this business, but almost all researchers emphasize that minimization and elimination of waste is the best solution. (Gavilan and Bernold, 1994; Skoyles and Skoyles, 1987; Begum et al., 2006).

For development of waste strategies in construction, the waste and their types should be identified. Inherent properties of any material such as methods of usage, important parameters when use, how to supply and how to maintain, are effective in process of changing a material to final product. Since this process and properties are different for various materials, the trends of waste production and waste sources are different too. Many researchers have done so many studies about waste sources but there are no categorization based on inherent properties of materials until now. The purpose of this research is to identify material types which will be used for developing waste minimization strategies for any type of materials. For solving this problem we should find out that the sources across supply chain will effect on waste production in any material or not? After that, by this method the materials can be categorized.

2) Literature review

2-1) Waste

After categorizing waste to seven types by ohno (1994), Womack and jones (1996) defined waste as any activity that absorbs sources and does not have any value adding. In another word waste is the loss of any kind of sources-materials, time (labor and equipment), and capital- produced by activities that generate direct or indirect costs but do not add any value to the final product from the point of view of the client (Formoso et al., 2002).

2-2) Construction materials waste

Construction material wastes refer to materials from construction sites that are unusable for the purpose of construction and have to be discarded for whatever reason (Yahya and Boussabaine, 2006).

In another research construction waste was defined as any material apart from earth materials, which needed to be transported elsewhere from the construction site or used on the site itself other than the intended specific purpose of the project due to damage, excess or non-use or which cannot be used due to non-compliance with the speci6cations, or which is a by-product of the construction process. (Ekanayake and Ofori, 2004)

2-3) Types of Construction materials wastes

There are many studies about kinds of materials waste that have so many overlaps.

Bossink and Brouwers (1996) first intimated to waste measuring by pinto (1989) and solbeman(1994) and pinto and agopayan(1994). They compared these studies in waste of 11 materials. Next they studied material waste in five building project in Germany in three views:

1. Construction waste of a specific material as percentage of total construction waste,
2. Construction waste of a specific material as percentage of its total amount,
3. Cost of construction waste of a specific material as percentage of total waste costs. (Bossink and Brouwers, 1996)

A study in Malaysia shows, composition and percentage of material wastes: Soil 27%, wood 5%, brick and blocks 1.16%, metal product 1%, roofing material 0.20% and plastic and packaging materials 0.05% concrete and aggregate 65.80% (Begum et al., 2006).

Jones and greenwood (2003) obtained percentage of waste in ten materials as below: plaster board 36%, packaging 23%, cardboard 20%, insulation 10%, timber 4%, cateen waste 20%, chipboard 2%, plastic 1%, electric cable 1%, and rubber 1% (Yahya and Boussabaine,2006).

In another research in 2009, material wastes have been gathered in 100 building material. It contains Earthmoving transport, Concrete reinforcement ,Piles ,Reinforced concrete foundation ,Concrete ,Concrete foundation ,Catch basins ,Collectors ,Downpipe ,Concrete slabs ,Steel reinforcement ,Reinforced concrete ,Wall(chambers) ,Wall(partitions) ,Brick exterior ,Brick interior ,Roof ,Circuits ,Electric lines and derivations ,Light points ,Electric sockets ,Ground connection, Hot water pipes ,Drains ,Cold water pipes ,Tap ,Toilet, basin and bathtub ,Thermos/heaters ,Thermal insulation ,Tiling ,Plaster ,Whitewash ,Screed, Floors, Ceiling ,Finishing ,Steel frames ,Wood doors, Shades ,Glass ,Exterior paints ,Interior paints (Guzman et al., 2009).

2-4) Waste sources

It is important to know the waste sources for applying correct waste minimization methods. There are many studies about waste sources that we mention them here briefly.

Skoyles (1987) makes a distinction between direct and indirect material waste and Gavilan and Bernold(1994) grouped the causes of direct and indirect wastes into six categories, including design, procurement, material handling, operation, residual and others such as theft (Silva and Vithana, 2008).

Bossink and Brouwers (1996), based on Gavilan and Bernold (1994) and Cranen et al. (1994), classified materials wastes to seven categories and investigated source of them. Finally they combined six sources with seven materials and reached to a table that shows any material with its sources.

Based on this categorization, among great contractors in Singapore waste sources were categorized to four categories and many subcategories. Then were scored in a likert spectrum and finally the rank of any sub category have been found. The three top subcategories in any category are as below:

- Design related:
  1) Design changes while construction is in progress,
  2) Designers' inexperience in method and sequence of construction,
  3) Lack of attention paid to dimensional coordination of products,
- Operational related:
  1) Errors by trades persons or laborers,
  2) Damage to work done due to subsequent trades,
  3) Required quantity unclear due to improper planning,
- Material handling related:
  1) Inappropriate site storage,
  2) Materials supplied loose,
  3) Use of materials which are close to work place,
- Procurement related:
  1) Ordering errors (too much or too little),
  2) Lack of possibility to order small quantities,
  3) Purchases not complying with specifications (Ekanayake and Ofori, 2004).

In another study formoso et al. (2002) extensively studied seven material wastes and their sources. They investigated waste sources for steel reinforcement, Premixed Concrete, cement, Sand and mortar, Bricks and Blocks, Ceramic Tiles, and Pipes and Wires.

In a study in china, a widespread investigation about material wastes has been implemented. A questionnaire survey was conducted to investigate the compositions of these construction waste and their sources. One hundred and ten copies were sent to governmental officers, designers, engineers, and contractors and 84 responses are received. Findings shows concrete, cement, brick, timber, tile, steel, and aluminum wastes are the main waste sources produced on construction sites and the sources of these wastes are varied (Wang et al., 2008).

In another research waste sources investigated and categorized in seven types: 1) Lack of planning 2) unclear information 3) source quality problem 4) late information 5) lack of control 6) sources misused 7) information quality problems (Serpell and Alarcon, 1998).

Design problems in many researches are known as one of waste sources. Designers think often many wastes are because of operation in sites, whereas about one third of wastes are because of design.

Keys et al (2000) explain waste production process in design period is complicated, because of many different materials have used in building and many stakeholders that impact on waste production.

Some researchers (Bossink and Brouwers, 1996; Faniran and Caban, 1998; Chandrakanthi et al., 2002) emphasis that lack of knowledge about construction technique in design process lead to waste production. Many studies (Baldwin et al., 2006; Coventry and Guthrie, 1998; Greenwood, 2003; Poon et al., 2004a) describe that designers and architectures have an important role in waste minimization (Osmani et al., 2008).

3) Methodology

In this research for categorizing of construction materials, their sources of waste across supply chain are used.

From literature review and based on interview with experts, 32 sources of waste identified. Because of research limitations all of them cannot be investigated. Thus they ranked by specialists, by First Step questionnaires, in a five options likert spectrum, and so five top sources of waste selected for more investigations.

Through interviews, 18 most important materials have been gathered and categorized considering their waste production in 12 categories. Then impact of selected sources on material waste can be surveyed. This impact can be calculated by many methods. In this research binominal test are used. Second step Questionnaire also had five options and the question was amount of impact of source on material waste .Options "very low" and "low" impact, had been located in a group, and "mediocre", "high" and "very high" impact, in another group.

Hypothesis have been designed as below:

$$\begin{cases} H0: p \leq 0.60 \\ H1: p > 0.60 \end{cases}$$

H0 shows high level of impact and H1 shows that there is no meaningful impact. The calculations were done by SPSS 15, and with amount of significant validity of questionnaires were tested.

The whole questionnaires were sent to 30 specialists in two steps. Then with analysis of impact of source on material waste categorization will be done.

4) Results and discussion

4-1) First Step Questionnaires

Analysis of data's obtained from questionnaire are presented in this section. In this research questionnaires were sent and gathered in two steps.

First Step Questionnaires Contain respondent's properties and waste sources ranking. Second Step Questionnaires Contain impact of selected sources on material waste.

Every Questionnaires will Analyzed and the results will be used in next steps.

4-1-1) Respondents' properties

The results of Questionnaires show that 73.3 % of respondents were bachelor, 23.3 % were master and 3.3 % were PHD. Also 76.7 % of them were construction engineer, 23.3 % architectural engineer and 10% mechanical engineer, and 23.3% of them had a related background between 20-30 years, 66.7% between 10-20 years and 10% between 3-10 years.

4-1-2) Ranking sources of material waste

From literature review and interviews, 32 sources of material waste were derived.

These sources of waste were ranked by questionnaire, Fig.1 shows the results.. It exhibits that the five sources have the highest rank as below:

1. Traditional construction methods,
2. Lack of design commensurate with materials exist in market,
3. Lack of coordination between supply chain,
4. Lack of proportionate material ordering of purchasing section,
5. Lack of production of material with variant dimensions,
6. Other sources were omitted because of research limitations.

4-2) Second Step Questionnaires

Whereas investigation of all construction materials and their sources of waste are higher than the capacity of this research, by using expert's opinion, some materials which had higher importance in waste, were selected for another steps. Selected materials are: Cement, gypsum, sand, tile, mosaic, ceramic, stone, gypsum board, cement board, shard, brick, block, glass, steel, reinforcement steel, water, paint, and pipe.

Then in this section result from questionnaires were entered to SPSS. It was intended to investigation of impact of sources, so the test proportion was assumed 0.6 and cut point 2.5. This is because of the options "very low" and "low" was in one side and options "average", "high" and "very high" were in another side. Using binominal test for any material a matrix was acquired that shows significants and acceptance of assumptions. Finally Table 2 shows effective sources of waste for any material. All significants are lower than 0.05 and so all of them are valid.

4-3) Analyses of Second Step Questionnaires

Here impact of five below sources on material waste are analyzed.

- Source number1 (S1): lack of design commensurate with materials exist in market,
- Source numbe2 (S2): traditional construction methods
- Source numbe3 (S3): lack of coordination between supply chain
- Source numbe4 (S4): lack of proportionate material ordering of purchasing section
- Source numbe5 (S5): lack of production of material with variant dimensions.

Some new results were achieved with observation of questionnaire as demonstrated below.

- First result: new classification of material based on waste sources, weight based material and dimensional material,
- Second result: presence of source number 3, lack of coordination between supply chain in both categories of materials effective waste sources,
- Third result: presence of source number 3, lack of production of material with variant dimensions, in both categories of materials effective waste sources,
- Forth result: presence of two incongruous sources number 1 and 4 with source number 5 in waste sources of one material, named pipe.

4-3-1) Result 1:

It was achieved that, there are separate effective sources of waste for any kind of materials. In another word in some materials the weight is the most important parameter while using.

In these materials sources number 2, 3 and 4 affect waste production. Also in some other kind of materials the dimensions is the most important parameter while using. In this case the sources number 1, 2, 3 and 5 affect waste production.

When the material is type1, source 1 and source 5 (traditional construction methods, lack of design commensurate with materials exist in market) are not effective on their waste production, and another sources like lack of proportionate material ordering of purchasing section, is effective instead of that. Vice versa if a material be type1, lack of proportionate material ordering of purchasing section is not effective.

Fig 1: Ranking of 32 sources of waste

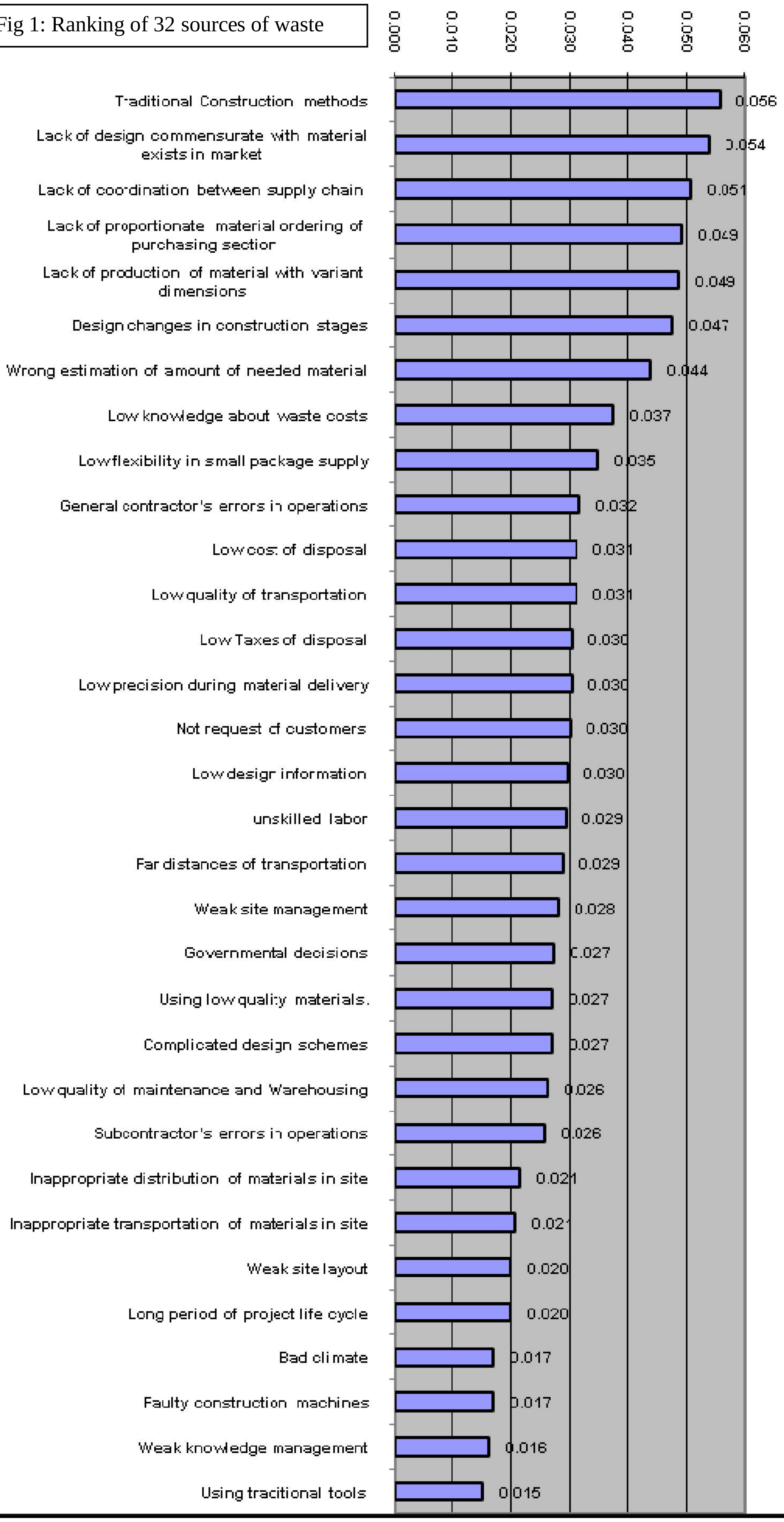

Table1: weight based and dimensional materials

Materials types	Important parameters when use	Effective sources	Non-Effective sources	Measurement units	Example of materials
Weight based materials	Material weight	2,3,4	1,5	kilogram	Cement, gypsum, sand, water and paint
Dimensional materials	Material dimensions	1,2,3,5	4	Meter	Brick, adobe , block, Tile, mosaic, ceramic, stone , steel, reinforcement steel, glass, gypsum board, cement board

Table 2: questionnaire results about Impact of selected sources on waste production of material

☐ When sources is effective in waste production

sources	Tile, mosaic, ceramic, stone	Gypsum and cement board	Brick, adobe , block	glass	steel	reinforce ment steel	cement	gypsum	sand	water	paint	pipe
S1	.001 √	.003 √	.000 √	.000 √	.000 √	.000 √	.000	.000	.002	.000	.002	.000 √
S2	.000 √	.000 √	.000 √	.000 √	.017 √	.006 √	.000 √	.000 √	.000 √	.006 √	.000 √	.006 √
S3	.003 √	.000 √	.000 √	.000 √	.000 √	.000 √	.000 √	.000 √	.000 √	.006 √	.000 √	.000 √
S4	.000	.002	.044	.017	.006	.017	.000 √	.000 √	.000 √	.000 √	.000 √	.000 √
S5	.008 √	.021 √	.000 √	.000 √	.000 √	.000 √	.044	.006	.006	.000	.006	.003 √
Effective sources	1,2,3,5	1,2,3,5	1,2,3,5	1,2,3,5	1,2,3,5	1,2,3,5	2,3,4	2,3,4	2,3,4	2,3,4	2,3,4	1,3,4,5
Non Effective sources	4	4	4	4	4	4	1,5	1,5	1,5	1,5	1,5	2
Materials type	Type2	Type2	Type2	Type2	Type2	Type2	Type1	Type1	Type1	Type1	Type1	Type 1 ,2

Table3: questionnaire results about Impact of selected sources on waste production of Pipes

pipes	Important parameter when used	Non-Effective sources Of waste	Effective sources Of waste	Materials type
Looped pipes	dimensions	3,4	1,5	Type1
Branch pipes	dimensions	1,3,5	4	Type2

It is important in explanation of locating two sources 1 and 5 close to each other, that these two sources are inherently similar. These two sources are two side of a subject and their both goal is description of non alliance between design and products of market.

If materials with variant dimensions be available in market, contractors can build any complicated design without any waste. Because they can reach to the design with selection of a module and correspond materials, and therefore there is no need to cutting and breaking materials in end of building items and elements.

In another hand if designer accepts that suppliers cannot produce materials in any variant dimensions because of economies of scale, contractors will not be enforced to do cutting works on material on site. Hence it is emphasized that sources 1 and 2 are supplement.

Thus with these analysis new categorization of material are obtained. The First category is weight base material that sources 2, 3 and 4 affect their waste, and second category is dimensional materials that sources 1, 2, 3 and 5 affect their waste. This categorization can be summarizing in Table 1.

Weight based material are materials like cement, gypsum, sand, water and paint that from contractors view, their weight are important when using them in building, and basically their dimensions are not important in their usage. For example in foundation concreting of a building, A kilogram sand with B kilogram of cement and C kilogram of water should be mixed and never be told A meter of cement or B meter of sand. Because their unit is kilogram not meter and effective parameter of their usage is their weight, not their dimensions.

In a good condition these materials are purchased in pallets or sacks and are transported to site. Often purchaseing department does not buy the required amount of material in the site and its amount is more than need. In this case some part of sacks that are semi used or none used, will be mixed with the site floor soils and will be wasted often as a powder, because of lack of packaging, poor maintenance and traditional mixing methods. Since this act repeat several times in project lifecycle, role of purchasing department is very important in coordination between orders and needs.

In a bad condition that takes place more often in projects, some of these materials are bought in mass volumes, and transported to the site with big trucks and spilled in a corner of site. Unusing materials confidently will be mixed with site floor soils and wasted. Thus source 4 is one of the effective waste sources of weight based material and sources 1 and 5 that are involved with design term are not effective in their waste.

Dimensional materials are materials like brick, shard, block, tile, mosaic, ceramic, stone, steel, reinforcement steel, and glass that in the view of contractors, when using in building, their dimensions are important and their weights don’t have significant role. For example in walls it is used bricks with dimensions A*B*C meters and it isn't apply F kilogram brick, because its unit is meter not kilogram and effective parameter of its usage are its dimensions not their weight.

In usage of these materials, contractors will use products available in market and if dimensions and their modules were not accordant with building dimensions, need for cutting will browse. Here two works can be done, production of material with variant dimensions, requisition from designer to design commensurately with market’s products. Thus source1 and 5 are effective sources of waste in dimensional material and sources4 are not effective in their waste.

4-3-2) Result 2:

This result is supplement of result1. It was observed that source3, lack of coordination between supply chain, is in two categories of sources of both weight based and dimensional materials. It should be noted that source3 are a general state of sources 1, 4 and 5. In another word when designers don’t design commensurate with material available in market; failure happens in coordination between supply chain. This failure itself can be because of lack information, lack of willing or lack of experience and knowledge in coordination of sketch with materials available in market.

In another hand when purchasing section of a project does not coordinate with construction section of project, indeed failure in supply chain has happened. This failure also itself can be due to lack of willing or lack of experience and knowledge or lack of accurate calculation of need amount. Also when producers and suppliers cannot produce any variant dimensions of materials, failure in coordination happens between supply chain, and this failure is itself due to economic of scale. Indeed with above analysis it can be known that source3 is a general concept of all sources 1, 4 and 5.

Source3 is along with source1 and 5 in production of waste in dimensional materials, and contemporary with source4 in production of weight based materials waste. The reason is that respondents believe coordination between design section and suppliers between many coordinations in supply chain, is effective in production of waste inmaterial type2, and coordination between purchasing section and construction section is effective in production of waste in material type1. Thus source3 conceptually are effective in production of both material type1 and.

2. With summering above analysis Fig .2 and 3 will be achieved

There is some important point about Fig.2 and 3: First point is that Fig .2 and 3 shows position of any sources in supply chain, conceptual relation between sources 1 and 5, partition between sources 1 and 5 with source 4, and position of sources 1, 4 and 5 under general source3.

Another point is non-effectiveness of other non-coordination in production of waste.

Another important point is that, source4 have also its supplement like source 1 and 5. Its supplement is miss-approximation of amount of need for materials. This source had seventh rank in production of waste in material and was deleted from interring to another step. Its inducement is construction section. It means that source4 is happen in the side of purchasing section and source7 in the side of construction side.

The final point is that, source1 and 5 are kind of non- coordination between organizations and source1 and 5, are kind of non- coordination among an organization.

4-3-3) Result 3:

Presence of source2 in production of waste in both two material types should be described in other way. This presence is not similar to presence of source3. Presence of source3 was due to generality of that in comparison with sources 1, 4 and 5.

But source2 are effective in waste of all types of materials because of change in the production paradigm. In traditional construction methods amount of pre-engineering is low and often building activities are done in the construction site. But using industrialized methods, many activities are done in factory and building parts are produced in production line and transported to site to install and Montage. In this method project managers can increase portion of pre- engineering and also quality control can be done in factory.

Over above cases, since parts are produced in firm and all of them are distinct where will be used, design Sketch is completely compatible with produced parts. Thus every part are produced by contractor orders and based on design Sketch and are known where it will be used. (Jaillon et al., 2009; Silva and Vithana, 2008;Tam, 2008; Tam et al. 2007). In this way there are no needs to lots of adjustments in construction site.

Therefore changing production paradigm from traditional to industrialized construction will hold feasibility of mistake occurrence. Sometimes if it be happened any mistake in production line or in ordering, the part will not be used in that project never, because of non-feasibility of correction or cutting works. In this case all of building part that has produced is waste unless using that in another project and because of cost and transportation problem it is not rational. For example in prefabricated concrete elements there is no chance for correction if there is any misalliance.

Hence until the construction is in traditional paradigm, feasibility of waste production is high in any material. With these analyses presence of source2 among sources of waste in both material types is reasonable.

4-3-4) Result 4:

A new result was presence of source 1, 4 and 5 with source3 in production of waste in one material, named pipe. From result 4 it was shown that S4 is specific for waste production of material type1 and S2 and S5 are specific for waste production of material type2. Question is that how they can be among sources of waste in both material waste sources. The single reasons are that some kinds of pipe are material type1 and some others are type2. With a watchful observation it can be seen that there are two kind of pipe.

Pipes for transmission of water are in loop form in the market. Contractors can cut it in any size. In these pipes there will be no waste because of cutting works and indeed S1 and S5 are ineffective in their waste and just S4 are effective. In another word in purchase section over order, more than need, remain part will be unused and because this ordering will happen so many times in a project, feasibility of control, maintenance and management of these remained part is not easy.

In another word although important parameter in usage in these pipes are their dimensions, but because their waste sources is S4 and S1 and S5 are not effective, it will be material type1.

In another hand Pipes for transmission of sewerage and city gas are in branch form in the market. If designer does not design commensurate with existing materials in market or there are not variant materials in market, Contractors should cut pipes. In this kind of pipes remained parts of cutted pipes are waste. It cannot be used again because of technical consideration and leakage. So S1, S5 are effective waste sources thus branch pipes because of important parameter in usage of them are their dimensions, and because their waste sources is S1 and S5, and S4 are not effective, it will be material type2.

Also S3 is a generality state of S1, S4 and S5 then it will be among effective sources. By these analysis it will known that why S1 and S5 are contemporary waste sources of pipes. Table 3 summaries these analyses.

5) Conclusions

Construction wastes have a great spread, and any of them have its source . To recognize that sources, impact of selected sources on waste of selected

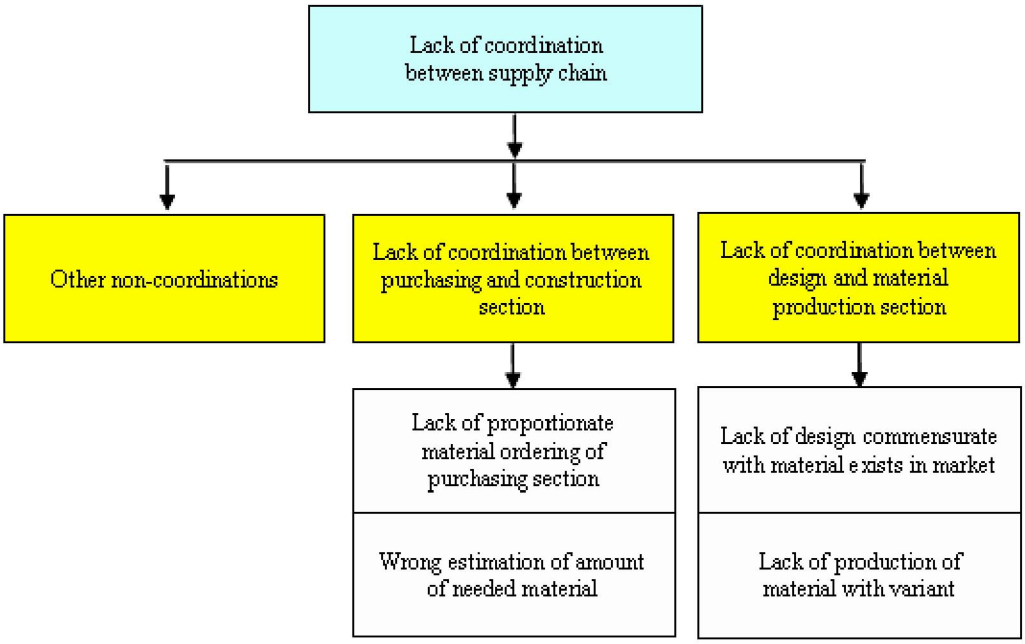

Fig. 2: non-cooardinations between supply chain

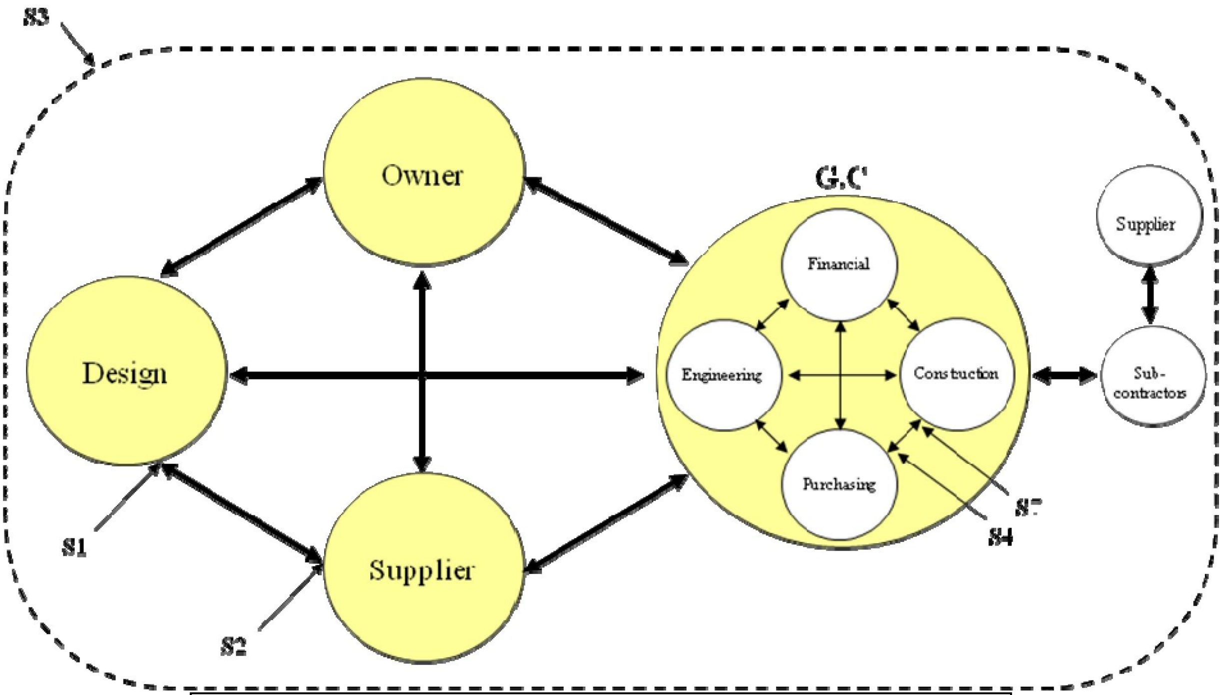

Fig.3: Position of waste sources in a typical construction supply chain

materials were investigated. Some new results were yielded. First it was clarified that materials have their specific waste sources based on their inherent properties.

Materials inherent properties are such as, methods of usage, important parameters when use, how to supply and how to maintain, measurement units, that impact on process of row material conversion to final product and therefore impact on methods that wastes are produced in any material.

With investigation of questionnaire it was identified that those material which their dimensions are important in their usage, some sources are effective in their waste that related to building design. In these materials if there were no coordination between design and materials exist in market, it will lead cutting in dimensional non-coordinations and thus waste will be produced. Whereas dimensions are the main aspect of inherent properties in these materials, their names will be dimensional materials.

Also in weight based materials, that their weight is important in their usage, some sources are effective in their waste that related to amount of purchasing. In this materials if exist any non-coordination between site need and amount of purchasing material, because of remaining material and repetition of this act in project life cycle, and lack of protection of material in site, it result in waste production. Whereas weight is the main aspect of inherent properties in these materials, their names will be weight based material. Non-coordinations between supply chain, cover both

Non- coordination between design and materials exist in market, and Non-coordination between site need and amount of purchasing material, it is effective in waste production of both two types of materials. Using traditional construction methods in contrast with industrialized methods is effective in both two types of materials too. If construction managers change their paradigm to industrialized methods, because of non-feasibility of errors in design and amount of purchasing, the feasibility of waste production will reach zero.

Acknowledgements

The authors like to thank Mapsa Company for providing relations between us and practitioners to contribute them through questionnaire and Interview. We would particularly like to acknowledge all practitioners and specialists that help us in making a good framework for data gathering and their rapid responses to questionnaires.

We also gratefully thank the comments from Dr.Jahangir Darvish and Ahmad Ghanaatian for their helpful comments in the research process.

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11/19/2010