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Investigation of Contributing Factors for Smart Parking Development Projects Delay:The Case of Addis Ababa, Ethiopia

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Abstract
Considering the increase of urban population and traffic congestion, smart parking is always a strategic issue to work on, not only in the research field but also from economic interests. The existing and ongoing works on smart parking are complicated and Trans disciplinary. The construction industry is one of the main sectors that provide important ingredients for the development of an economy. However it is becoming more complex because of the sophistication of the construction process itself and the large number of parties involved in the construction process. Delay in construction project completion is a global phenomenon that occurs in the construction industry and considered as one of the most common problems causing a multitude of negative effects on the project. The objective of this study is to identify the major determinants factor smart parking project delay. Both primary and secondary data were used in this study. A survey questionnaire was structured and distributed to contractor, consultant, client and subcontractor who were working in smart parking construction projects. The questionnaire included 30 predefined factors, which were grouped into six major factors, client, contractor, and consultant, and material, external and labor factors. The relative importance index (RII) was determined and the factors were ranked within their groups and overall. The results showed that the group of client factors ranked first among the six groups. The top ten factors causing delay of smart parking projects are: delay in sub-contractors, slow in decision making by client, delay in delivering the site to the contractor, Dollar insecure in government, delay in obtaining permits from municipality, less capacity to admin the project, lack in qualified labors/shortage of qualified engineers, shortage of construction materials, late procurement of materials and Ineffective planning and scheduling of projects. Finally, recommendations have been developed for each of the contract parties' client, contractor, consultant and subcontractor where present in this research in order to minimize and avoid the delay factor and get the project completed within the planned schedule.
Keywords: Smart parking, project delay, determinant factor, Relative Importance Index (RII)
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INTRODUCTION AND LITERATURE REVIEW

Transportation is the engine for social and economic development of a country. Addis Ababa is exhibiting high social and economic development. With certainty, parking is a major problem in urban cities which has been increasing challenges both in developed and developing countries since it interlinks the transportation infrastructures and land use management. It is clear that almost every car trips are dominated by two trips parking acts (parking taking place in the origin and destination) and those cars spend over 80% of the week parked (RAC Foundation, 2004). Due to rapid rate of urbanization and increased socio-economic characteristics, the demand for transport has increased in unprecedented scale, currently; globally, the construction industry hugely influences the economy, the environment and the society. The sector is account for about six percent of the world GDP (World Economic Forum's 2016). Similarly, in Ethiopia, construction shares considerable amount of the country's scarce financial resources. In Ethiopia, the construction industry is the highest recipient of government budget in terms of government development program. Consequently, public construction projects consume an average annual rate of nearly 60% of the government's capital budget (Ministry of urban development and construction, 2006).

As study estimation shows that 14% of traffic density is created by searching for parking space and 50% of increase in congestion-related time loss on roads has been generated due to shortage of parking space (Brooke, 2015).The problem of traffic congestion in urban cities has been one of the very major stressing issues and one-third of this traffic congestion in the world is created by cars searching for parking spot due to the unbalancing of the parking demand and the availability of the space (Joseph Y.J et al, 2015). In this case the drivers to arrive a destination people may need to start their trip before their scheduled program and will be forced to spend more time on the roads. In addition, it has economic impact on the country and the government expending more money to adjusting this congestion problem due to shortage of parking space. For instance, in USA studies show that in the case of traffic congestion the government losing up to 48 billion US dollars in 1990 and in this time the government losing up to 124 billion US dollar (USD) per year with an expectation of rising the cost up to 186 billion USD in 2030 (Serugendo et al , 2017).

Parking problem becomes one of major issues in the city transportation management since the spatial resource of a city is limited and the parking cost is expensive. The transportation research on commuting has invested effort on investigating the problems of congestions, safety and environmental caused by vehicles in motion while

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ignoring the important part of parking challenges. Despite the application of parking pricing and supply restrictions to be the best technique widely accepted and readily accepted method of limiting car use (Journal of Economics and Sustainable Development, 2013) but the methods has not managed to eradicate the parking challenges occurring in many growing cities all over the World (IISTE 2013). To mitigate those challenges, cities, businesses, and property developers have tried to match parking supply to growing demand for parking spaces. It has become clear, though, that simply creating more parking spaces is not sufficient to address the problem of congestion. New approaches using smart parking systems look to provide a more balanced view of parking that better manages the relationship between supply and demand.

Smart parking can be defined as the use of advanced technologies for the efficient operation, monitoring, and management of parking within an urban mobility strategy, (Ahmed, 2017).A number of technologies provide the basis for smart parking solutions, including an integrated computer system, multiple sensors and triple safety devices , automated parking systems and data analytics. Smart parking is also made viable by innovation in areas such as smartphone apps for customer services, mobile payments, and in-car navigation systems. At the heart of the smart parking concept is the ability to access, collect, analyze, disseminate, and act on information on parking usage. Increasingly, this information is provided in real-time from intelligent devices that enable both parking managers and drivers to optimize the use of parking capacity. In addition, cities deploy smart parking services on an economic initiative basis. First, drivers can save time, resources and effort by decreasing driving time which in turn reduce environmental pollution, reduce costs with less fuel consumption and alleviate traffic congestion through information from smart parking apps. This also increases public transportation use rate and cities' revenues as well. Second, if drivers can find rapidly a parking space, the idle time for on-street parking is shorter and the parking revenues increase. Third, once the traffic is fluent, it increases traffic safety, urban mobility and expands cities' capacities. It brings more population, activities and business opportunities. It also economically efficient since it accommodates maximum cars in minimum space and cost effective in terms of maintenance over the conventional parking systems. Considering all the key factors identified above, research on smart parking appears promising and beneficial to cities' sustainable development.

In Ethiopia, particularly in Addis Ababa, there are many smart parking projects constructed, under construction and planned to be constructed. However, smart parking construction project in city is challenged by several problems. A very common problem which is affecting almost all smart parking development projects in the city is the failure to meet the stated/planned completion period (delay). Construction delays can be defined as the late completion of work compared to the planned schedule or contract schedule. Trauner et al. (2009) defines that construction delays make something happen later than expected, to cause something to be performed later than planned, or to not act timely.

Ahmed et al. (2003) classify delays into non-excusable delays, excusable with compensable delays, excusable without compensable delays and concurrent delays. Non-excusable delays are delays, which the contractor either causes or assumes the risk for. Excusable without compensable delays are delays caused by factors that are not foreseeable, beyond the contractor's reasonable control and not attributable to the contractor's fault or negligence. Excusable with compensable delays these are compensable delays are excusable delays, suspensions, or interruptions to all or part of the work caused by an act or failure to act by the owner resulting from owner's breach of an obligation, stated or implied, in the contract. Concurrent delays occur when both owner and the contractor are responsible for the delay.

Delays in a construction project is counted as a common problem and became a cause for projects completion with huge cost overrun (requiring higher budget than estimated), extended completion time, inferior quality deliverables and contract termination. In recent time it was an accepted phenomenon to have delays in construction projects completion time. For the client, construction delay is a loss of revenue, lack of productivity, dependency on existing facilities and loses of trust from the public. For the contractor, construction delay is the higher costs, longer work duration, increased labor cost, higher material and equipment costs etc. Completion of construction projects on specified time or time agreed by the parties indicates their efficiency. The delays in construction projects happen because of various factors or causes. These causes lead to the delay in construction completion, and this delay ultimately leads to negative effects on the construction project (Tilahun, 2016).Public construction projects in Ethiopia are parts of the country's development initiative. For any public or private construction firms, upgrading the project performance can be taken as one of their main objectives. This can be achieved by reducing cost, finishing projects on schedule and increasing quality. And therefore, those chronic problems which are repeatedly happening in almost all smart parking construction projects can be minimized only when their causes are identified through research. In this regards, many researchers have studied the causes of project delays in public construction industry. For example, according to M.Haseeb, et al. (2011), the most important and highly ranked delay causes in construction industry of Pakistan is inaccurate time estimation. But in another study by Mahamid (2013), the most important and highly frequent cause of delay is financial status of the contractor. The research findings in other countries and in different project types may not be completely applicable to the nature and scope of other, as the socio-cultural, regulatory, legislative environment and project specific issues may vary from country to country and from project to project (Mbachu, 2011).Therefore each project should be managed according to its specific characteristics and environment in that particular period of time (Sawega 2015).It is important therefore to look for adaptive project management approaches that best fit our unique environment. As result, this research aims at identifying the most common and frequent factors which contribute for this problem (time overrun). The findings of different studies have been reviewed and formed a strong basis for this research (See Table 1).

Table 1: Summary of literature review

Group	Delay causes (factors)
Material-related factors	• Shortage of construction materials • Late procurement of materials • Delay in materials delivery • Changes in material types and specification during construction
Labor -related factors	• Lack in qualified labors/shortage of qualified engineers • Low productivity level of labors • Labor absenteeism • labor injures due to poor site safety
Contractor-related Factors	• Delay in sub-contractor's work • Ineffective planning and scheduling of project • Rework due to poor work/wrong materials by contractors • Lack of appropriate qualification of contractor's technical staff • Poor communication and coordination with other parties
Client-related Factors	• Slow in decision making by client • Delay in delivering the site to the contractor • Dollar insecure in government • Unrealistic contract period • Late in revising and approving design documents • Delay in progress payments
Consultant- related Factors	• Slow response and inspection • Inadequate experience of consultant /incompetence consultant • Consultant staffs are not available at site at right time • Poor communication and coordination between the consultant's staff
External- related Factors	• Delay in obtaining permits from municipality • Delay in providing services to the contractor from utilities (Such as water, electricity) • Rise in prices of resources (material, equipment and labor) • Rain effect on construction activities

Sources: Assaf et al. (1995), Tahaet.al (2016)Alaghbariet al. (2007),Al-Seraji (2010), Al-Fadhali et al., (2017,AlFadhali et al., (2018), Sweis et al. (2007) and Abdalla et al. (2002)

Research Methodology

This section will illustrate the methodology to be employed to obtain the desired results as per the stated general and specific objectives. This study is focusing on determinant factors smart parking project delay in city administration. The chapter is structured within the following topics: research design, target population, sampling techniques ad sample size, validity and reliability of the research instruments, data collection procedures and finally concludes with data analysis approach.

Research Design: This research is a practical problem developed from the observation of smart parking development projects and the research questions are designed with the purpose of understanding the planning, practice and major determinant factors of delay in smart parking project so as to investigate the cause of time overrun in smart parking development projects of Addis Ababa city administration. Information and views of respondents through questionnaire, interviews were required in order to properly address the basic questions of the study. This research can be categorized as applied and descriptive type. It is applied because the research is initiated from practical problems and finds whether there exists time overrun or not. It is also descriptive because it tried to describe the actual rate of time overrun and the variables or factors of time overrun in Addis Ababa city administration

Target Population: The population of the study comprises of the stakeholders such as contractors, consultants, clients and sub-contractors who were involved in construction process of smart parking projects taken (considered) for the study (from 2016-2019) under Addis Ababa city administration to get possible reasons for time overrun (delay). All respondents have high position; many years of experience and higher level of educational background which implies the respondents have enough knowledge of the construction industry with issues relating to smart parking development projects delay.

Unit of analysis: The unit of analysis is the major entity that is being analyzed in a study. It is the 'what' or 'who' that is being studied. In terms of unit of analysis, this research focuses only on smart parking development projects under Addis Ababa city administration which was completed within the last four years (from 2016-2019).

Sample technique and Sample Size: According to the Ministry of urban development and construction website, currently, there are 103 electromechanical contractors registered as grade one and 62 consulting architects who involved in electromechanical construction industry of the country. Moreover, until recently there are 4 subcontractors, and 3 clients who directly involved in construction of smart parking projects. Purposive sampling technique was used to select the respondent under owner, consultants and subcontractors. According to Walliman (2005), purposive sampling is a useful sampling method which allows a researcher to get information from a sample of the population that one thinks knows most about the subject matter. Moreover, to determine the minimum sample size of contractors, we use the Slovene's formula; which states as follows:

$$n = \frac{N}{1+N(e^2)} = \ldots \quad (1)$$

Where: n is sample size, N is the population size and e is the margin of error. A level of confidence of 95% and a margin of error (e) of 0.05 were used in determining a sample size. Putting those values in formula, the sample size for the contactors is calculated as:

$$n = 81 = \frac{103}{1+103(0.05^2)} \ldots \quad (2)$$

Data Collection Instruments: According to Ahmed (2014), questionnaire is a powerful evaluation tool in behavioral sciences. If well designed, it can be a very reliable and veritable tool. The questionnaire forms were structured to facilitate easy and short answering of questions by the respondents and respondents were given enough time to give their feedback. Contractors, owners, consultants and subcontractors have been approached for their views on the causes delay for smart parking development projects by using semi-structured questionnaire. The open-ended section of the questionnaire served to explore any additional factors that they thought were important, but not included in the questionnaire. Besides that, the respondents were also asked to highlight their recommendations and comments to minimize the construction delays in dealing with construction projects through an open-ended question.

Validity of the research instruments: A research instrument is said to be valid if it measures what it is supposed to measure (Borg and Gall, 2003). Keeping in mind that respondents are engineers who represent client, consultant, contractors and sub-contractors questionnaire was developed based on past model and literature review to ensure the validity of the result. Then, this draft questionnaire was given to an expert in research to ascertain the items suitability in obtaining information according to objective of the study. This process assisted in eliminating any potential problems of the research instrument and to test the validity and workability of the instrument.

Reliability of the research instruments: Reliability of instruments concerns the degree to which a particular instrument gives similar results over a number of repeated trails (Mugenda and Mugenda, 2003). Prior to using the questionnaire, pilot test was done to check the questionnaire structure, sequence, meaning and ambiguity of questions. This was supplemented by Cronbach alpha 0.7 which have been proven to give more reliable score (cooper and Schindler, 2008). For pilot purpose, the questionnaire was administered to 15 respondents. Finally, a pre-tested translated questionnaire was available to make sure respondents who use local language are involved without any problem. The data were collected in a short period of time to guarantee of no big change happened on the related topic under close supervision of researcher.

Data collection Procedures: The data for the study was obtained from both primary and secondary sources. According to Leed&Ormrod(2005) data is said to be primary if it is collected firsthand by researcher for a determined purpose. The primary data was collected by use of questionnaires that was administered to 150 engineers representing clients, consultants, contractors and sub-contractors who expected to possess the requisite knowledge of the subject matter. 146 questionnaire were received which represent about 97% of the response rate and used in subsequent analysis. The secondary data was obtained from up to date information from journals, research, project reports, newspapers, publications, PMBoK, conference papers, and presentations as well as contract agreement, midterm-evaluation, final evaluation, annual reports. The aim of the secondary source was to interpret, offer commentary, analysis and draw conclusions about events described in primary sources.

Data analysis approach: Upon completion of the data collection exercise, all completed research instruments were assembled, coded, summarized, entered into the computer and analyzed using the Statistical Package for Social Science (SPSS version 22). As part of its aim, this study analyses the impact level of the causes of project delay in construction industry. To achieve this aim, a Relative Importance Index (RII) is chosen as an appropriate analytical method (Doloi et al. 2012). RII ranking method had been applied to determine the ranks of the different delay causes. From the ranking assigned to each cause of delays, it is possible to identify the most critical delay factors in the construction industry. The RII has been used in many domains to evaluate the comparative importance of a single item to others. Several studies such as Chan and Kumaraswamy(2002), Odeh and Battaineh (2002) used RII to rank the delay causes in their research. The RII value has a range from 0 to 1 (0 not inclusive), the higher the value of RII indicates that the more important was the delay factor to the construction industry. Additionally, the groups RII were calculated by taking the average of factors RII in each group. The equation stated below was used to compute the relative importance index for all the causes. The five-point scale ranging from 1 (strongly disagree) to 5 (strongly agree) was adopted and transformed to relative importance indices (RII) for each factor as follows:

$$RII(100\%) = \frac{5n5+4n4+3n3+2n2+1n1}{5(n5+n4+n3+n2+n1)} * 100 \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Where: RII = Relative Importance Index,

n_1, n_2, n_3, n_4, n_5 = the number of respondents who selected: (1) strongly disagree, (2) disagree (3) neutral, (4) agree, and (5) strongly agree. The weighting given to each factor by the respondents ranged from (1-5), that is, 1 2, 3, 4, 5.

The Spearman's rank correlation coefficient (Fellow and Liu, 2008) indicates that the level of agreement on the ranking among groups of respondents participating in the study. It can be calculated using the equation:

$$\rho = 1 - \frac{6\sum d^i}{n(n^2-1)} \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Where ρ = Spearman rank correlation coefficient between two parties, d is the difference between ranks assigned to variables for each cause, and n is the number of pairs of rank. The correlation coefficient varies between +1 and −1, where +1 implies; a perfect positive relationship (agreement), while −1 results from a perfect negative relationship (disagreement). It might be said then that sample estimates of correlation close to unity in magnitude imply good correlation, while values near zero indicate little or no correlation.

The reliability of the data can be referred to the consistency or dependability of a measure over time, over questionnaire items, or over observers/raters (Allen and Bennett, 2010). The Cronbach alpha (Cα) coefficient is a measure of the inner consistency. The reliability test depicts the consistency degree of the data collected. Some past studies carried out by Memon et al. (2010), Enshassi et al. (2009) and Abdullah et al. (2010) also chose to use the Cα to calculate the accuracy of the data obtained. Cα value can be calculated as:

$$Cronbach\ (C\alpha) = \left(\frac{k}{k-1}\right) * \left[1 - \frac{\sum(.5_i^2)}{s_{sum}^2}\right] \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

Where:s^2_i is the Variance for the current sample of respondents; k is the total number of delay factors and s2sumis the variance for the sum of all respondents. In this study, to examine the reliability of the factors, Cα test was carried out on each group of factors to view if they were integrated. The values of Cα should have a range between 0 and 1. The lower values represent lower internal consistency and larger values represent greater internal consistency. The criteria introduced by (Nunally, 1978 cited in Kiiru, 2015; Cooper and Schindler, 2008) for the interpretation of this coefficient was considered to evaluate the results of the analysis. Cα> 0.8, 'Excellent'; 0.7< Cα <08 'Good'; 0.5< Cα<0.7 'Satisfactory' and Cα <0.5 ' Poor'.

Results and Discussion

This section discusses the results obtained by analyzing the delay factors for the sake of acknowledging the most significant causes leading to the delay overarching issues in order to achieve a successful implementation of construction projects. Accordingly, as part of the aim of this study, causes of project delay in smart parking project in construction industry are identified, evaluated and categorized under six major groups (client , contractors, consultant, material, external and labor related factors). These identification and evaluation are carried out through the primary and secondary data collection methods as well as validated via statistical techniques. On the basis of ranking of the causes it was possible to evaluate the most important ones that influenced project time. To this end, the RII of the 30 factors causing delay in the smart parking projects in Addis Ababa are determined and presented (refer to below table& figure), and in order to validate the results, they are compared to the findings of the relevant researches conducted in other countries. The results are discussed in the subsequent sections.

The ranking of smart parking project delay factor by respondents

Causes of client related factors

The survey included seven (7) delay factors related to this group (figure 1). From the figure 1 with a RII of 81.3% "Late decision making" is ranked first cause in this factor group and the second among all causes investigated. With a RII of 77.9% "Delay in delivering the site to the contractor" is ranked the second in this group and third among all causes. And this followed by "Dollar insecure in government" which is ranked third in this group with a RII of 77.1% and forth among all causes. Similarly, with a RII of 73.9%, "Unrealistic contract period" which ranked fourth within this group and eleventh in overall causes. With RII of 71.4%, 69.1% and 65.4% "Late in revising and approving design documents", "Delay in progress payments" , "Change and variation orders by client during construction" are ranked 5th , 6th, and 7th in this group and 15th,19th and 22nd in overall causes respectively. Finally, with the average RII of 73.73 %, the client related factor group is ranked first among the six factor groups.

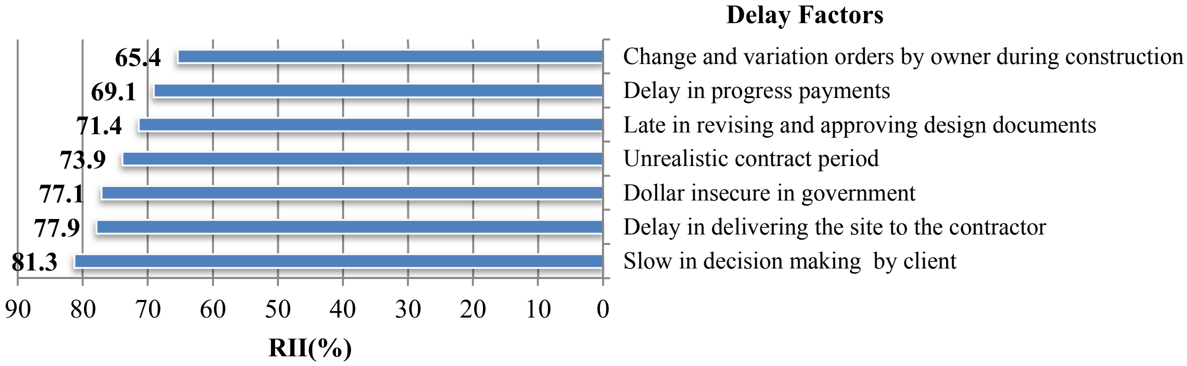

Figure 1: RII (%) ranking of client related delay factor

Causes of contractor related factors

The results of the five (5) causes of contractor related delay factor group presented in Table 2, shows that "Delay in sub-contractor's work" is ranked first within this group and first in overall causes with a RII of 82.1%. Thus, it is considered the most important cause of the delay impacting smart parking construction projects. This followed with a RII of 74.1% by "Ineffective planning and scheduling of project" which is ranked second within this group and tenth in overall causes. On the other hand, with RII of 73.1%, 71% and 66.8% the causes "Rework due to poor work/wrong materials by contractors", "Lack of appropriate qualification of contractor's technical staff" and "Poor communication and coordination with other parties" are ranked third, fourth and fifth in this group and twelfth, seventeenth and twenty-first among all causes respectively. Finally, with the average RII of 73.56 %, the contractor factor group is ranked second among the six factor groups.

Table 2: Importance and ranking of Contractor related delay factor by RII value

Delay factor	Significance /Frequency					RII	Ranking
	1	**2**	**3**	**4**	**5**	**(%)**	
Delay in sub-contractor's work	1	6	20	62	57	82.1	1
Ineffective planning and scheduling of project	0	15	37	64	30	74.1	2
Rework due to poor work/wrong materials by contractors	1	20	34	53	38	73.8	3
Lack of appropriate qualification of contractor's technical staff	2	21	35	65	23	71	4
Poor communication and coordination with other parties	6	22	46	55	17	66.8	5
The overall contractor related factor of average						**73.56%**	

Causes of consultant related factors

The survey included six delay factors related to this group. It can be noticed from table 3 that "Less capacity to admin project" is ranked first within this group with a RII of 76.6% and 6th in overall factors. This followed by a RII of 73.4% by "Inadequate experience of consultant/incompetence consultant" which is ranked second within this group and 13th among all causes. While "Consultant staffs are not available at site at right time" is ranked third factor in this group and 18th among all causes. With a RII of 63.9%, 63.1%, and 62.6% the causes "Poor communication and coordination between the consultant's staff", "errors and discrepancies in design and contract documents", and "Unclear and inadequate details in drawings" are ranked fourth, fifth and sixth in this group and 25th, 26th and 27th in overall factor groups respectively. Finally, with the average RII of 68.18%, the consultant factor group is ranked fifth among the fifth factor groups.

Table 3: Importance and ranking of Consultant related delay factor by RII value

Delay factor	Significance /Frequency					RII (%)	Ranking
	1	2	3	4	5		
Less capacity to admin project	1	10	25	80	30	76.6	1
Inadequate experience of consultant /incompetence consultant	3	14	38	58	33	73.4	2
Consultant staffs are not available at site at right time	3	22	40	59	22	69.5	3
Poor communication and coordination between the consultant's staff	5	32	48	46	15	63.9	4
errors and discrepancies in design and contract documents	4	37	46	45	14	63.1	5
Unclear and inadequate details in drawings	4	32	64	28	18	62.6	6
The overall consultant related factor of average						**68.18%**	

Causes of delays due to material factors

The survey included four (4) material related factors. Table 4 reveals that "Shortage of construction materials" is ranked first with a RII of 75.7% and 8th in overall causes. Closely, with a RII of 75% "Late procurement of materials" is ranked second with the group and 9th among all causes. With a RII of 71.2% "Delay in materials delivery" is ranked third in this group and 16th among all causes. The cause "Changes in material types and specification during construction" is ranked fourth and the last in this group and 23rd among all causes with a RII of 65%. Finally, with the average RII of 71.72%, the materials factor group is ranked third among the six factor groups.

Table 4: Importance and ranking of Material related delay factor by RII value

Delay factor	Significance /Frequency					RII (%)	Ranking
	1	2	3	4	5		
Shortage of construction materials	3	9	30	70	33	75.7	1
Late procurement of materials	1	12	32	72	29	75	2
Delay in materials delivery	1	17	42	65	21	71.2	3
Changes in material types and specification during construction	3	35	43	47	18	65	4
The overall material related factor of average						**71.72%**	

Causes of delays due to external factors

The results of the (4) causes of external factor group presented in Table 5, shows that "Delay in obtaining permits from municipality" is ranked first within this group and 5th in overall causes with a RII of 76.8%. This followed with a RII of 73% by "Delay in providing services from utilities (Such as water, electricity)" which is ranked second within this group and 14th in overall causes. In the end of this group, with a RII of 68.3%, "Rain effect on construction activities" is ranked fourth in this group and 29th among all causes. Finally, with the average RII of 68.78%, the external factor group is ranked fourth among the six factor groups.

Table 5: Importance and ranking of External related delay factor by RII value

Delay factor	Significance /Frequency					RII (%)	Ranking
	1	2	3	4	5		
Delay in obtaining permits from municipality	2	12	33	53	46	76.8	1
Delay in providing services to the contractor from utilities (Such as water, electricity)	2	22	30	61	30	73	2
Rise in prices of resources (material, equipment and labor)	4	34	49	41	18	64	3
Rain effect on construction activities	8	36	45	47	10	61.3	4
The overall external related factor of average						**68.78%**	

Causes of labor related factors

Table 6 shows the ranking of the four causes listed under the labor factor group. With a RII of 76.1% "Lack in qualified labors" is ranked first within this group and 7th in overall causes. This followed with a RII of 67.4 % by "Low productivity level of labors" which is ranked second within this group and 20th in overall causes. On the other hand, with RII of 59.3% & 43.6% both causes "Labor absenteeism" and "labor injures due to poor site safety " is ranked are ranked third and fourth in the last of this group. Moreover, both causes are ranked 29th and 30th and the last among all causes. Finally, with the average RII of 68.6%, the Labor factor group is ranked sixth among the sixth factor groups.

Table 6: Importance and ranking of Labor related delay factor by RII value

Delay factor	Significance /Frequency					RII (%)	Ranking
	1	2	3	4	5		
Lack in qualified labors/shortage of qualified engineers	9	32	58	40	7	76.1	1
Low productivity level of labors	9	29	34	41	33	67.4	2
Labor absenteeism	8	37	57	35	9	59.3	3
labor injures due to poor site safety	19	65	39	13	9	43.6	4
The overall labor related factor of average						**61.60%**	

As Tables (2-6) and figure 1, shows, the results obtained demonstrate that all groups of factors have approximate average relative importance indices. The client factor group is ranked first with the highest average RII of 73.73%. This is followed by contractor factor group, which is ranked second with an average RII of 73.56%. The contractor factor group was ranked first in research conducted by Sambasivan and soon (2007). Moreover, the groups of Materials, external and consultant factor groups are ranked third, fourth and fifth with an average RII of 71.72%, 68.78% and 68.18%, respectively. The last group ranked is labor factor with an average RII score 61.6%.

Top Delay Causes

Based on the above discussion, a total of 30 factors that contributed the causes of delays in smart parking development project were identified, ranked and analyzed. To identify the most important factors that contribute to the causes of delay, analysis was carried out to determine the top ten factors of overall ranking factors. The top ten factors that contribute to time overrun in smart parking construction project are summarized in Table (7). As shown, the top ten factors listed in the ranking indicate their corresponding RII. Among the top 10 factors that causes delay in smart parking development project, there are two factors of contractor-related delays, three factors of owner-related delays, two factors of material-related delays, one factor of external-related delays, one factor of consultant- related delay and one factor of labor- related delay. The analysis shows that 30% of the most important factors are client related delay and 20% are caused by consultant and material related delays.

From the result shown in table 7, respondents ranked that "delay in sub-contractors work" as a first that the most significant factor of smart parking construction projects. The factor of delay from the contractor side could be more important because smart parking project should be managed and controlled by the contractor which significantly affects the project activity. This result is consistent with the result of the research conducted by Takukhaba (1999) in Kenya. However, in research done by Durdyev et al.(2017)in Cambodia and Haseebet al.(2011) in Pakistan the cause "delay by subcontractor" ranked as the ninth most significant factor that contribute to project delay. The second most significant factor responsible for project delays in smart parking projects is "Slow in decision making by client". The factors of delay from the client side could be critical because decision made by project client affect other. In study conducted by Alaghbari et al. (2018) in Yemen and Pourrostam and Ismail (2012) in Iran the cause "Slow decision making and instruction" ranked fifth. Closely, the cause "Low speed of decision "ranked sixth in research done by Wong and Vimonsatit (2012) in Western Australia. Studies such as Chan and Kumaraswamy (2002) and Alwi and Hampson (2003) found that, client's low speed of decision was the most critical factor that contributes project time overrun. In most projects, clients and consultants are blamed for slow in decision making, while many contractors waste resources waiting for the decisions. This slow response inevitably delays work on site. In order to overcome this, deadline has to be made and met at all times to shorten the waiting time for the decisions from the client or consultants.

"Delay in delivering the site to the contractor "ranked as the third in this research which linked to the poor preparation to the project initial phase that related to client and the city land management authorities. In the research conducted by Taha et al. (2016) in Egypt, this cause ranked 13^{th} among the top 20 most important factors that contribute to the cause of project delay in construction project. Respondents ranked "dollar insecure in government ", as the fourth. This is linked to shortage of Letter of credit (LC) in the country. Most of the smart parking project needs an imported materials and equipment but the contractor doesn't have enough LC to import necessary materials and equipment to the project. In contrast, government still not takes a proper intervention to solve the problem. In the study conducted by Wong an Vimonsati (2012), Alaghbari et al. (2007),El-Razek et al. (2008), Sweis et al. (2008), and Tumi et al. (2009) the cause "Financial difficulties faced by clients" was ranked second. Similarly, in researches done by Alaghbari (2018) the cause "Lack of sufficient cash for project implementation" was ranked fourth in Yemen and eighth in the study conducted by Albogamy et al. (2012) in Saudi Arabia."Delay in obtaining permits from municipality "ranked as the fifth in this research. However, this cause was ranked first among the top ten causes by the study conducted by Takukhaba (1999) in Kenya.

Factor named "less capacity to admin project" ranked as the sixth in this research which linked to inadequate experience of consultant. Smart parking projects in their nature are a new technology, on the other hand, local contractor, consultant and sub-contractor doesn't have enough experience to similar projects. Al-Seraji, (2010) in

Yemen ranked the cause “inadequate project management" as fifth cause that contributes to the project delay. Closely, the cause “Poor contract management” was ranked 10th by Al-Emad1et al (2016). Similarly, the cause "Weak planning, control, and management by contractors" was ranked seventh in research done by Alaghbari et al. (2018) in Yemen and Fugar and Agyakwah-Baah (2010) in Ghana. Respondent ranked "Lack in qualified labors/shortage of qualified engineers" as the seventh in this research. However, the cause “Shortage of skilled labor” ranked fourth in the study conducted by Durdyev et al. (2017) in Cambodia, ninth in the study conducted by the Alaghbariet et al. (2018) in Yemen, first in study conducted by of Wong and Vimonsatit (2012) in Western Australia, sixth in the study conducted by Islam et al. (2015) in Bangladesh, third in study conducted by Tahaet.al (2016) in Egypt. In addition, in the study conducted by Al-Emad et al.(2016) the cause "Unqualified workforce" is indicated as one of the significant contributors to the construction delay in Saudi Arabia and ranked 9th. Similarly, in the study conducted by Samarah&Bekr (2016) in Jordan the cause “Low level productivity” was ranked 10th and Awuor (2015) identified ‘unqualified workforce/low skilled labor’ as a top construction delay factor.

“Shortage of construction materials" ranked as the eighth in this study. However, it ranked first in study conducted by Durdyev et al. (2017) in Cambodia, second in the study conducted by Chala (2017) in Ethiopia and seventh in the study conducted by Sambasvian and Soon (2007) in Malaysia. In research conducted by Fugar and Agyakwah-Baah (2010) in Ghana, this cause ranked as one of the most influencing causes of construction project delay. Smart parking development projects in Addis Ababa are dependent on the imported steel and electromechanical equipment mainly from China which cause materials shortage in market and ultimately the availability of materials on site. It is clear that in order to supply construction material on time, provision of material plays a significant role. “Late procurement of materials " ranked as the ninth in this study and reported as fourth important factor in the study conducted by Chala (2017) in Ethiopia. Closely, in the research conducted by Kog (2018) in Kenya the cause “Late delivery/shortage of construction materials” ranked as the second most important factor.

Finally “Ineffective planning and scheduling of project” was ranked as a tenth in this research. However, in the study conducted by Durdyev (2017) in Cambodia the cause “unrealistic project scheduling” ranked second. The results of this research agrees with the findings of several researches conducted in different countries to evaluate the most significant causes of project delays (Frimpong, Oluwoye, & Crawford, 2003; Ren, Atout, & Jones, 2008).Closely, the cause "Weak planning, control, and management by contractors" was ranked seventh in the study conducted by Alaghbari(2018) in Yemen; however, this cause was ranked third by Cûlfiket al. (2014) in Turkey, sixth by Fugar and Agyakwah-Baah (2010) in Ghana and 5th by Al-Emad et al. (2016) in Saudi Arabia. Similarly, in the study conducted by Wong and Vimonsatit (2012) in Western Australia the cause “Unrealistic deadlines for project completion” ranked fourth. In addition, Assaf & Al-Hejji (2006) and Abdalla et.al. (2000) found in their research work “Ineffective planning and scheduling by contractor” is the significant causes of delay in construction project. Planning and scheduling is the basic for every construction work. It should be developed from the start of the project until completion of a project. The reasons why contractors are not able to follow the planning and scheduling effectively may be due to inexperience staff and shortage of workers at the site, financial problem, and poor site management.

Table 7: The top ten smart parking project delay factors

Delay factor	RII (%)	Rank	Responsible for delay
Delay in sub-contractor’s work	**82.1**	**1**	Contractor
Slow in decision making by client	**81.3**	**2**	Client
Delay in delivering the site to the contractor	**77.9**	**3**	Client
Dollar insecure in government	**77.1**	**4**	Client
Delay in obtaining permits from municipality	**76.8**	**5**	External
Less capacity to admin project	**76.6**	**6**	Consultant
Lack in qualified labor/shortage of qualified engineers	**76.1**	**7**	Labour
Shortage of construction materials	**75.7**	**8**	Material
Late procurement of materials	**75**	**9**	Material
Ineffective planning and scheduling of project	**74.1**	**10**	Contractor

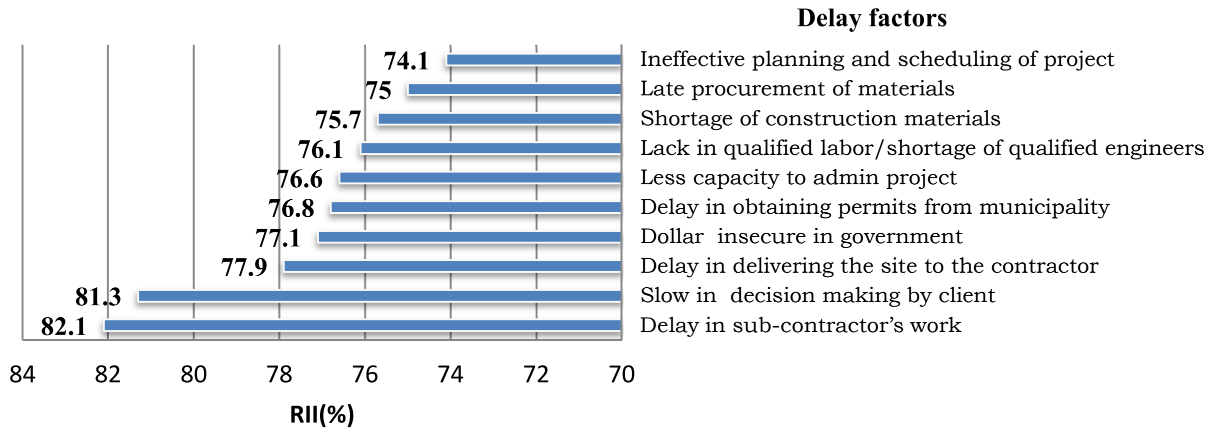

Figure 2: RII (%) of the overall ranking of the delay factors.

In addition to the 30 delay causes documented in the questionnaire, some respondents nominated a range of other delay causes, which are:

a. For some project contractor selection doesn't gave equal chance to all interested to participate in the project (selection system not open bid rather directly selected this kind of selection leads to unfairness and one factor for delay).
b. Lack of a proper project monitoring and evaluation system.
c. Turnover of politically assigned management staffs.
d. Lack of sufficient experience for local contractor and consultant on similar project.

Further investigations are required to determine the significance of these causes compared to the 30 other listed causes.

Reliability of factor analysis

The reliability analysis of the questionnaire was tested so as to find out whether it was capable of yielding similar score if the respondent used it twice**.** Accordingly, table 8, shows that the results of Cronbach alpha (Cα) for all the groups. For consultant, external, labor, client, contractor and material related factors the Cα was found to be 0.799 (Good), 0.733 (good), 0.732(good), 0.719 (good), 0.687 (Satisfactory) and 0.611(Satisfactory) respectively. The Cα for all factors was found to 0.897(excellent). Therefore we concluded that our test and questions were reliable.

Table 8: The Cronbach's Alpha reliability test

Factors	Cronbach's Alpha	Reliability status
Consultant-related factors	0.799	Good
External-related factors	0.733	Good
Labor- related factors	0.732	Good
Client- related factors	0.719	Good
Contractor-related factors	0.64	Satisfactory
Material-related factors	0.611	Satisfactory
overall Cronbach alpha value	0.897	Excellent

Spearman's correlation between respondents

To see the level of agreement (significant relationship) between the four parties in terms of their view to rank the hypothesized factors which can contribute for time overrun under this study is presented in table 9. From the table 9, the test of significance indicates that with P-value= 0.00 <0.05 we can reject the null hypothesis which states "there is no significant agreement between the respondents in ranking of single factor of delay". That means, there is a significant agreement between parties in ranking factors contributing for time overrun in smart parking construction projects in city of Addis Ababa. In contrast, the correlation between each party and the overall respondents is very low and insignificant. The table 9 also shows that the highest correlation (55.5%) was found between the consultant and client. The second highest correlation (54.5%) was found between the consultant and sub-contractor while the lowest correlation (29.6%) was found between the contractors and Sub-contractor. In general, it can be concluded that there is strong there is a high degree of agreement between the attitudes of the parties.

Table 9: Spearman's rank correlation coefficient between parties

Parties	R- value	P-value	Interpretation
Contractor vs Consultant	0.50	0.00	Positive and significant
Contractor vs Client	0.30	0.00	Positive and significant
Contractor vs Sub-contractor	0.30	0.00	Positive and significant
Consultant vs Client	0.56	0.00	Positive and significant
Consultant vs Sub-contractor	0.55	0.00	Positive and significant
Client vs Sub-contractor	0.53	0.00	Positive and significant
Overall vs client	0.02	0.83	Positive and insignificant
Overall vs Contractor	0.04	0.662	Positive and insignificant
Overall vs Consultant	0.05	0.552	Positive and insignificant
Overall vs Sub-contractor	0.01	0.985	Positive and insignificant

Conclusions and Recommendations

Conclusions

- delay in sub-contractors, slow in decision making by client, delay in delivering the site to the contractor, Dollar insecure in government, delay in obtaining permits from municipality, less capacity to admin project, lack in qualified labors/shortage of qualified engineers, shortage of construction materials, late procurement of materials and ineffective planning and scheduling of projects are the top ten influencing factors of smart parking project.
- Delay in sub-contractor's work is most important cause of delay impacting smart parking development projects.
- The client factor group is ranked first among all factor groups. This followed by contractor, materials, consultant and external factors group which are ranked 2nd, 3rd, 4th and 5th respectively. Labor factor is the last group ranked influencing smart parking project.
- Demographic background of the respondents and previous studies within the similar scope justifies the reliability and validity of the design and the findings of this research. Internal consistency of the causes of project delays was also tested and validated via Crobbach's alpha. Results of the tests confirmed the reliability and validity of the research design and the findings
- The find of this research is very helpful by taking care of these potential causes in their present and future projects, construction participants can reduce and control the extent of delays. All stakeholders such as the client, consultants, contractors and subcontractors can have chances to discuss the trends of the projects to take care of next constructions.

Recommendations

- Client should ensure that adequate funds are available before the projects are started, pay progress payment to the contractor on time and employ experienced and competent consultant and contractor.
- Client should approve design, additional works; variation orders etc. on time as per the contract agreement and determine the required duration of project and impose realistic duration to avoid time and cost overruns.
- Client should set an intervene mechanism to solve LC problem
- Municipality's Authorities should give building permission certificate on time.
- Consultant should capacitate themselves through education and training, apply effective site management system, ensure efficient time management through proper resource and time planning and also take attention to the material specifications of the project.
- Consultant should prepare always clear and adequate detail drawing and BOQ (Bill of quantity) by taking into consideration appropriate risk and escalation factor and respond quickly to contractor and client questions and requests for clarification.
- Contractor should prepare proper and achievable plan, hire enough number of qualified, competent and skilled labors and motivate them to improve their productivity, choose qualified and experienced subcontractor and briefed about the scope of their work and properly managed, develop on time order culture, strong and proper material procurement and set up stores for construction materials especially for scarce, ensure timely delivery of materials on construction site and apply effective site management system.
- Proper coordination and communication channels between project parties should be established and producing design documents should be on time.
- Contractor should creating an activity based plan and schedule those activities which are suitable to be carried out outside during the rainy season period, train workforce about construction site health and

safety regulations.

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