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Minimization of Non-Value Adding Activities in Irrigation Sector of Nepal

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Abstract

Construction waste is a problem worldwide. Non-value adding activities (NVAAs), the non-physical form of the construction waste, have an adverse effect on any project's outcome mainly in terms of Time, Cost, and Quality (all of which are directly related to Productivity). In this regard, a study was done to identify minimization techniques for such activities. This research is about minimization of NVAAs and uses a problem solving approach to determine the solutions for NVAA (considering NVAAs as problem; minimization techniques as their solutions). The steps of the problem solving approach were followed for this study. The population for this study were construction practitioners (client, consultant and contractor) working in the Irrigation sector.

Expert Interview was done for validation of predetermined causes and generation of new minimization techniques relevant to those causes. Questionnaire Survey was done for analysis of opinion data from sample size of the target population. This study reveals 32 causes of NVAAs and proposes 62 relevant minimization techniques (one or more for each cause) both categorized into 5 groups. Based on findings of this study the top causes of NVAAs in Irrigation sector are: 1) Delay for permits from different sectors (forestry and land acquisition); 2) Frequent transfer of key professionals; 3) Quarry site problem; 4) Poor documentation control system and 5) Bureaucracy (administrative structure and regulations to control activities while the most contributive minimization techniques recommended to solve them are : 1) Skill Training & Proper Supervision; 2) Permit Acquiring prior Bidding ; 3) Field Visit Mandate by Expert Prior Design; 4) Skilled Expert Recruitment and 5) Clear Guidelines & Experienced Team respectively. Results from this study highlight the top significant causes of NVAAs and recommends most contributive or best applicable minimization techniques relevant to those causes in Irrigation Sector. The findings from this study will help construction professionals to identify relatable causes of existing NVAAs in their field and adopt the recommended minimization techniques. This study helps in minimization of NVAAs thus making a contribution towards productivity aspect of construction projects.

Keywords

Non-value adding activities, lean thinking, lean construction, productivity, construction waste

1. Introduction

Researchers around the world point out that there are many wasteful activities during the design and construction process [1]. Most of these consume time, money and resources but add no value to the Client in construction. Construction projects have consumed more than 70% of the development expenditure [2]. However, Construction in Nepal faces issues such as poor quality, poor performance on time and cost, construction waste, low productivity, and reliance on foreign contractors [3]. Projects of National Importance are seen facing failure in terms of time and service both (or Value). For Example the National Pride Projects: Melamchi Water Supply Project (started in 1998 concluded in 2021) and Babai Irrigation Project (started in 1987 and still running) both suffer Time and Cost Overrun [4, 5]. For Babai Irrigation Project the initial estimate of cost was NRs. 2 billion, now more the value has reached more than 12.5 billion [5]. According to the Progress Report Policies and Major Programs implemented in FY 2078/79 up to the end of Poush 2078 from the Office of Prime Minister and Council of Ministers, only

4.64% of the activities have been accomplished compared to what has been targeted [6]. Only 2.27% for targeted activities from Irrigation Sector have been accomplished. Further the report published on Poush 2078, also states that only 25% of the targeted milestone has been achieved for policies and major programs for FY 2078/79[6]. Project efficiency has become a dire need in Nepal. Various studies suggest that minimization of wastes in construction have led to better Project Outcomes in terms of Time, Cost and Quality such as : Reduced Delay on Project Completion (Time); Client's Budget Saving (Cost) ; Increase Contractor's Profit (Cost) . A study in Nepal shows Effects of NVAA in the construction sector as: Cost Overrun, Time Overrun, Client dissatisfaction, Interruptions'/disruptions to activity sequence [2]. It can be inferred that the minimization of NVAAs have a positive impact on the Project Outcomes (in terms of Time, Cost and Quality). This study uses a problem solving approach with root cause method wherein the solution of any problem is determined by eliminating its root causes. Furthermore evaluation of the causes and minimization techniques was done using statistical measurements.

Table 1: Categorization of NVAAs

S.N.	NVAA	Interpreted Definition	What's being wasted
1	Non-utilized talent	Underutilizing people's qualification	Wasted time, effort and resources
2	Defect	Efforts caused by rework, and incorrect information	Wasted effort
3	Extra processing	For the customer, when more work or more quality required	Extra effort
4	Waiting	Waiting for another step in a process.	Wasted time
5	Inventory	Excess products and excess storage	Wasted materials
6	Overpro duction	Production in excess of demand.	Wasted materials
7	Transpor tation	Unnecessary movements of material.	Wasted resources
8	Motion	Unnecessary movements of people.	Wasted time, effort and resources

2. Literature Review

2.1 Non-value adding activities (NVAAs)

Activities that use resources, time, or space but don't add value to the good or service are known as non-value adding activities (NVAAs) as per M. Becher [7].Value is what you get out of what you pay. NVAAs can be understood as non-physical waste and can be categorized as: Waiting; Non-utilized talent; Excess Inventory; Excess Motion; Transportation; Extra processing [8]. Almost 50% of the time spent in construction has been identified as a vain activity [9]. Various studies have investigated that the NVAAs prevalent in construction also come under these categories.

The categorization of NVAAs into eight categories, often known as DOWNTIME categorization of NVAAs is shown in Table 1.

2.2 Causes of NVAA

NVAAs also happened as a result of failing to notice or measure waste, complicated material movement, and lacking information [10]. Fedelis Emuze et al., (2014) identified thirty nine (39) causes of non-value adding activities in construction [11]. These causes are classified into five separate groups as per a study based in Nepal [2].

In this study, the term "causes of NVAA" refers to any work-related action, process, or event that contributes to or indirectly produces non-value-adding activities in the construction industry. Table 2 is a categorized table for a comprehensive view of classification NVAA causes prevalent in Construction based on similar previous studies done for construction [2, 12].

Table 2: Classification of NVAAs and their causes [2, 12]

Classification	Causes of NVAA
1. Related to Human Resources	Lack of appropriately skilled workers
	Lack of leadership abilities
	Poor interaction
	Bureaucracy
	Lack of cooperation among workers
	Low morale among workers
	Poor team spirit among workers
	Scarcity of workers

Classification	Causes of NVAA
2. Related to Designers (Consultants)	Repetitive revisions and changes
	Delay in design approval
	Incomplete drawings/designs
	Unclear design/details
	Slow response to RFI
	Inadequate design information
	Design revisions
	Over design
3. Related to Information and Documen tation	Late dissemination of information
	Poor document control system
	Design not requested by client
	Inappropriate construction methods
	Contradictions in design documents
	Poor decision-making abilities
	Unrealistic project execution plan
4. Related to Material/ Equipment	Error in material specifications
	Scarcity of materials
	Inadequate materials control
	Delay in material transportation
	Over/under ordering materials
	Scarcity of equipment
	Inappropriate use of equipment
	Removal of unspecified material
5. Related to Site Operations	Poor planning of construction
	Poor site layout
	Inadequate staging areas/platforms
	Poor waste management practices
	Excessive control and inspection
	External influence on operations
	Accidents due to Health and Safety
	Lack of empowerment

2.3 Minimization of NVAA

Zhao and Chua (2003) [13] demonstrated that the reduction of NVAAs has a significant contribution to productivity improvement. Minimization of NVAAs is based on a concept of creating needed value with fewer resources and elimination of waste (also known as Lean Thinking). Term waste is used to refer NVAAs in lean thinking [2]. The idea of elimination of waste was first developed and used by Toyota Company, Japan in 1988 as the core of Lean Manufacturing [8]. It is a universal management tool around the world for: improved efficiency; reduces waste; and increased productivity. Minimization of NVAAs, higher productivity and efficiency and can be used interchangeably.

Lean Techniques

A number of lean techniques have been created for the manufacturing sector, and they have also been incorporated into the construction process flow for enhanced productivity. Some of those lean construction techniques are as follows:

1. Last Planner System
   A lean technique known as the last planner is a process that involves planning and organizing various tasks and activities. It can be divided into four main categories: master planning, phase planning, make ready planning, and weekly work planning. [2].

2. Just in time
   Just in time concept is to keep the inventories to the bare minimum and order the new inventories based on the current demand [14].

3. Daily Huddle Meetings
   It is a rapid start-up meeting held as part of the improvement cycle [15]. This consists of a brief daily start-up meeting was conducted where team members quickly give the status of what they had been working on since the previous day's meeting, especially if an issue might prevent the completion of an assignment [16].

4. 3D Models
   This concept consists of use of 3D models for improving constructability has typically included model based design and coordination by combining multiple models into one and running clash detection [17]

5. Increased Visualization
   It is based on a concept that workers can remember elements such as workflow, performance targets, and specific required actions if they visualize them [18].

6. Value stream mapping
   A value stream map is a comprehensive model of the project that reveals issues hidden in current approaches [14]. It consists of use of process flow charts.

7. Stopping the line
   Stopping the line in manufacturing prevents the release of defective work downstream. Planning at the assignment level is the place to "stop the line" in construction to assure a reliable flow of work and no defective assignments are released downstream [14].

8. Reverse Phase Scheduling (RPS)
   RPS is a pull technique used to develop a schedule that works backwards from the completion date by team planning [14].

9. Make it flow
   In construction, this may mean repackaging work so that parts of the project can proceed without completion of others. [14].

10. Kaizen
    Kaizen is a system of continuous improvement in quality, technology, processes, company culture, productivity, safety and leadership [19].

11. Five S
    5S is a set of techniques that has five levels of housekeeping that can help in eliminating wasteful resources [19].

12. Fail Safe Quality
    The creation of concepts that alert for potential flaws is essential to fail safe for quality [19].

13. Offsite manufacturing (OSM) Prefabrication
    OSM is largely seen as offering the ability to produce high-volume, high-quality products based on the efficiencies of general manufacturing principles common to many industries [20]

14. Target Value design
    In order to deliver value, TVD is a management technique that aims to make customer constraints design drivers. An approach for waste reduction and ongoing development, TVD ensures that consumers receive what they need (in which it is appreciated by customers) [21].

3. Research Methodology

The study in this research mainly focuses on determining the techniques for NVAA minimization referred to as Minimization Techniques (MTs). A problem solving approach was followed using the root cause method assuming the problem in this case as NVAA and solution as MTs. Root Cause Method (a problem solving approach) was followed in this study to determine solutions for NVAA in the form of MTs. The five steps of Root Cause method followed for this problem solving were:

1. Defining problem [in this case NVAAs]
2. Determining the Cause of the problem [in this case Causes of NVAAs]
3. Identifying Solutions [in this case Minimization Techniques, MTs]
4. Prioritizing the cause of the problem and solutions (causes of NVAAs and MTs)
5. Selection of alternatives for Solutions by prioritizing. (Prioritizing/ranking of MTs)

3.1 Defining NVAAs

This was done by literature Review for NVAAs
Literature Review
Literature Review was done to define NVAAs, their causes and possible solutions in construction all around the world by rigorous study of various researches.
Following lists were generated from the Literature Review
a) List of causes generated from Literature Review (39 causes grouped in 5 categories) [12, 2]
b) List of Standard General Techniques generated from Literature Review (15 Techniques)

3.2 Determining the Causes of NVAAs

This was done by Expert Interview for Causes.

3.3 Identifying Minimization Techniques

This was done by an Expert Interview for Minimization Techniques.
For determining the causes of NVAA in Irrigation sector and minimization techniques for NVAA, an Expert Interview was conducted after the literature review of the subject.

Expert Interview
(For determining the Causes and Minimization Techniques of NVAA in Irrigation Sector of Nepal)
Expert Interview was conducted among Client, Consultant and Contractors involved in Irrigation

Construction in Nepal. The personnel having more than 10 years of experience in Irrigation Project were termed as Expert in this study. The interviews of 11 experts (4 Pilot Interview and 7 Expert Interview) were taken personally and the approach paper was completely explained to the experts. Interview Questions were designed the following way:

a) Design of Interview Worksheet

b) Pilot Survey

c) Design of Cause Checklist (For validation & recording additional cause specific to irrigation sector)

d) Design of Interview Question worksheet (For recording techniques specific to irrigation sector and validation of standard techniques)

The interview uses a checklist of predefined Causes of Non-value Adding Activities in Construction for validation by Experts in Irrigation sector and was asked if they had specific causes from Irrigation Sector to add to the list to generate a new list of Causes of NVAAs in Irrigation Sector. The Expert Interview mainly focused on generation of Minimization Techniques NVAAs which was discussed in detail. Few of the standard techniques were also validated in the process. The data and valuable in-depth suggestions were collected. The following data works were collected from the expert:

a) Validation Check (inclusion of the relevant and omission of the irrelevant) of the predefined list of 39 Causes of NVAAs in Irrigation Sector of Nepal.

b) Identification of new causes specific to Irrigation sector.

c) Identification of Minimization Techniques specific to Irrigation for those causes (1 to 4 for each).

d) Validation Check (inclusion of the relevant and omission of the irrelevant) of the Standard General Techniques if applicable to Irrigation Sector of Nepal.

e) Development of Final list of Causes (32) from above (a to d).

f) Development of Final list of MTs (1 to 4 MTs for each cause) above (a to d).

3.4 Prioritizing causes of NVAAs and MTs

For initiating the prioritization of the causes of NVAA in Irrigation sector and minimization techniques for NVAA based on the opinion, Key Respondents' Questionnaire Survey was conducted after the Expert Interview on the subject. The population studied included Client, Consultant and Contractors having experience of Irrigation Sector of Nepal. Sample size determined for the Survey was calculated to be 32 for Client, 30 for Consultant and 30 for Contractor.

Questionnaire Survey
(For prioritizing Causes and Minimization Techniques of NVAA in Irrigation Sector of Nepal)
The survey was designed in three sections. The first section consisted of demographic questions. The second had questions relating to the causes of NVAAs and Minimization Techniques (MTs) of NVAA in the Irrigation Sector of Nepal. The third section consisted of questions evaluating the contribution of MTs over NVAAs reduction and evaluation of contribution of NVAA reduction over Project Outcomes.

The respondents were provided with five different scales:(1)Strongly Agree; (2)Agree; (3)Neutral;(4)Disagree; and (5)Strongly Disagree in Section 2 for relevancy of causes in Irrigation Sector of Nepal and the three scales for contribution of the MTs for those causes(1)High ; (2) Average and (3)Low.

For Section 3 five different scales:(1)Strongly Agree; (2)Agree; (3)Neutral;(4)Disagree; and (5)Strongly Disagree for questions about contribution of MTs over NVAAs reduction and the five scales for contribution of NVAA reduction over Project Outcomes (1) Very High ; (2)High ;(3) Average ;(4)Low and None (5).

One Hundred Fifteen (115) sets of questionnaires were distributed to Client, Consultants and Contractors. Respondents having less than 1 year of experience or 2 projects were excluded. Thirty Seven (37) valid responses were received from Clients, thirty three (33) valid responses were received from Consultants and thirty (30) valid responses were received from Contractors. The total valid responses received were One Hundred (100), which is more than the sample size needed for this research.
Majority of questionnaire data collection was done through an online portal Kobo Toolbox attached at the end of this paper.

Research instrument-reliability test

For instrument reliability tests, Cronbach's Alpha was used. It is a coefficient that indicates internal consistency of items in a scale. It is the statistical measurement that estimates the reliability of questionnaire data based on Likert scale by determining a coefficient for internal consistency of items in a scale. For respondents, the closer it is to 1, the greater the internal consistency reliability of the criteria in the scale.

Relative Importance Index:
Relative index analysis is used to rank the requirements in accordance with their respective weight or grade. To calculate RII, the formula below was used.

Relative Importance Index $RII = \frac{Sum(W)}{A*N}$

Where,
W= each respondent's weighting on a scale of 1 to 5 for NVAAs Causes with 1 implying the least and 5 the highest
And weighting assigned by each respondent for NVAAs Minimization Techniques on a scale of 1 to 3 with 1 implying the least and 3 the highest
A=the highest score (i.e. 5 for NVAAs Causes and 3 for NVAAs Minimization Techniques in this study) and
N=the sample size of the questionnaire.
The value of RII ranges from 0 to 1.RII for each cause and minimization techniques was computed based on this.

Prioritization of the causes of NVAA in Irrigation sector and minimization techniques for NVAA was achieved by analysis of data using Relative Importance Index (RII):
1. RII calculation and ranking was done for NVAA Causes by Client, Consultant and Contractor grouped in five categories.
2. RII calculation and ranking was done NVAA causes with their respective Minimization Techniques (one or more)
3. RII calculation and ranking was done for NVAA Minimization Techniques by Client, Consultant and Contractor grouped in five categories.
4. RII calculation and ranking was done for NVAA Minimization Techniques with their respective causes.

Ranking of the top causes and minimization techniques for NVAAs in Irrigation Sector was done using RII and is shown in Table 4 and Table 5 respectively.

3.5 Selection of alternatives for MTs by prioritizing.

This was achieved by analysis of data using RII. Ranking of the top contributive minimization techniques was done using RII and is shown in Table 5.

ANOVA Test
ANOVA is an abbreviated form for Analysis of Variance. It is a statistical test and was developed by Ronald Fisher in 1918. ANOVA tells us if there are statistical differences between more independent groups. Statistical Package for Social Sciences (SPSS) software was used to test the hypothesis.
Based on a previous study [2], the data from various categories can be converted to continuous values for testing of hypotheses on a factor scale (Likert Scale). The 5p Likert scales were used for NVAA Causes; Contribution of Minimization Techniques on NVAA reduction and Contribution of NVAA reduction on Project Outcome. 3p Likert scale was used for NVAA Minimization Techniques. The Likert Scale as a whole can be converted to scaled values based on the maximum possible score as shown below [2].
Group score $= \frac{sum(q)}{I} * 100$
Where:
q=scores in questions
I=Maximum possible score

4. Result and Discussion

4.1 Demographic Data

This gives the information of the diversity of the respondents. The study's demographic information is shown in Table 3.

Table 3: Demography Data

Respondent's Characteristics	Percentage (%)
Gender	
Male	90
Female	10
Organization	
Client	37
Consultant	33
Contractor	30
Experience	
1 - 10 yrs	79
11 - 20 yrs	17
Above 20 yrs	4

Experience for Consultants/Contractors		
	Consultants	Contractors
less than 5 no. of Projects	2	11
5- 10 no. of Projects	25	15
Above 10 no. of Projects	6	4

4.2 Causes of Non-Value adding activities

Thirty two reasons of non-value-adding activities were listed in the questionnaire, which was divided into five groups. The categories cover NVAA-related factors pertaining to site operations, information and documentation, materials and equipment, designers, and human resources.

Causes related to "A. Information & Documentation"
It is observed that "Poor Documentation Control System" is ranked as the first among other reasons of NVAA for this category.
Minimization Technique:
1. Budget Allocation (for Proper Data Collection and Management by using IT)
2. Transfer of Existing Condition of Work (When employee turnover - by a week meeting (about knowledge, problems and information system)

Causes related to "B. Human Resources"
It is observed that "Frequent Transfer of Key Professionals" is ranked as the first among other reasons of NVAA for this category
Minimization Technique:
1. Strict Staff assignment for defined Phase

Causes related to "C. Consultant"
It is observed that "Delay in Design Approval" is ranked as the first among other reasons of NVAA for this category
Minimization Technique:
1. Dedicated design unit
2. Work division and Authority delegation
3. Guidelines & Timeline for Process of approval

Causes related to "D. Site Operation"
It is observed that "Delay for permits from different sector (Forestry and Land Acquisition)" is ranked as the first among other reasons of NVAA for this category
Minimization Technique:
1. Permit Acquiring prior Bidding

Causes related to "E. Material/Equipment"
It is observed that "Quarry site problem" is ranked as the first among other reasons of NVAA for this category
Minimization Technique:
1. Local Government Regulation for Quarry Site
2. Identification of Quarry Site prior Bidding

Table 4: Ranking of the top causes of the NVAAS Irrigation sector

Rank	RII	NVAA CAUSES
1	0.93	D.7 Delay for permits from different Sectors (Forestry and Land Acquisition
2	0.9	B.9 Frequent Transfer of Key Professionals
3	0.88	E.5 Quarry Site Problem
4	0.87	A.1 Poor documentation control system
5	0.87	B.6 Bureaucracy(administrative structure and regulations to control activities)
6	0.87	C.1 Delay in design approval
7	0.85	B.8 Improper O and M
8	0.85	C.2 Drawings/design/details (Unclear, Incomplete, Inadequate)
9	0.85	A.2 Late dissemination of information
10	0.84	E.4 Inadequate materials control

4.3 Minimization Techniques of NVAAs

The questionnaire included one or more Minimization Techniques (MTs) relevant to each cause of non-value adding activities, altogether sixty two (62) grouped in five categories, listed as an output of both the literature review and pretesting of Expert Interview, final Expert Interview and pretesting of Questionnaire. The five categories include factors that lead to NVAA that are connected to site operations, information and documentation, materials and equipment, designers, and human resources.

MTs related to "A. Information & Documentation"
"Skill Training & Proper Supervision" is observed to be the most contributive minimization technique in this category used in minimizing NVAAs caused by "Inappropriate construction methods".

MTs related to "B. Human Resources"
"Attractive & Socially Comparable Salary" is observed to be the most contributive minimization technique in this category used in minimizing NVAAs caused by "Low Morale among workers" and "Lack of appropriately skilled workers".

MTs related to "C. Consultant"
"Field Visit Mandate by Expert Prior Design" is observed to be the most contributive minimization technique in this category used in minimizing NVAAs caused by "Unclear, Incomplete and Inadequate drawings/details".

MTs Related to "D. Site Operation"
"*Permit Acquiring prior Bidding" is observed to be the most contributive minimization technique in this category used in minimizing NVAAs caused by "Delay for permits from different Sectors (Forestry and Land Acquisition)".

MTs Related to "E. Material/Equipment"
"Proper planning" is observed to be the most contributive minimization technique in this category used in minimizing NVAAs caused by "Scarcity of equipment".

Table 5: Ranking of the top minimization techniques of the NVAAS in Irrigation sector:

Rank	RII	NVAA MINIMIZATION TECHNIQUES
1	0.88	Skill Training and Proper Supervision
2	0.87	Permit Acquiring prior Bidding
3	0.87	Field Visit Mandate by Expert Prior Design
4	0.86	Skilled Expert Recruitment
5	0.86	Clear Guidelines and Experienced Team
6	0.86	Knowledge sharing and Real scenario meeting
7	0.86	Clear provision in the Bid and Contract document
8	0.86	Proper planning
9	0.85	Expert Consultation and Verification System
10	0.85	Work division and Authority delegation

4.4 Test of Hypothesis

Respondents' opinion for NVAA causes, NVAA Minimization Techniques, Contribution of Minimization Techniques and Contribution of NVAA reduction on Project Outcome at significance level a= 0.05 was tested.

Null Hypothesis (Ho): There is no significant difference between opinions of Client, Consultant and Contractors on: NVAA Causes; NVAA Minimization Techniques; Contribution of Minimization Techniques and Contribution of NVAA reduction on Project Outcome.

Alternate Hypothesis (H1): There is significant difference between opinions of Client, Consultant and Contractor on causes, Minimization Techniques and Outcome after Minimization Techniques of non-value adding activities.

According to statistics, the null hypothesis is accepted when the F coefficient of the ANOVA test is less than the crucial value or the p-value from the ANOVA test is more than 0.05 and smaller than the significance threshold.
Acceptance of Alternate Hypothesis (H1) means that null hypothesis was rejected meaning there is significant difference in opinion from all groups (client, consultants and contractors).
Acceptance of Null Hypothesis (Ho) means that null hypothesis was accepted meaning there is no significant difference in opinions from all groups (client, consultants and contractors).
A one-way ANOVA significance level a = 0.05 was used to test the hypothesis. Results are presented in Table 6.

Table 6: One-way ANOVA test for difference in opinions

Variable	F	p-value	Remarks
All NVAA Causes	5.158	0.007	H1 accepted (p less than 0.05)
All NVAA Minimization Techniques	3.274	0.042	H1 accepted (p less than 0.05)
Contribution of Minimization Techniques on NVAA reduction	1.699	0.188	Ho accepted (p greater than 0.05)
Contribution of NVAA reduction on Project's Outcomes (Time, Cost and Quality)	1.689	0.19	Ho accepted (p greater than 0.05)

The H0 is, therefore, accepted, for Contribution of Minimization Techniques and Contribution of NVAA reduction on Project Outcome so there is no difference in from all groups (client, consultants and contractors). However, H1 is accepted for the case of NVAA Causes and NVAA Minimization Techniques, showing significant difference in opinions from all groups (client, consultants and contractors) and between the groups.

So, Dunnett T3 test for was done in SPSS to check how the difference in opinion was obtained between the groups (client, consultants and contractors) for both NVAA Causes and NVAA Minimization

Techniques. The results from Dunnett T3 test for Multiple Comparisons for NVAA Causes and NVAA Minimization Techniques are shown in Table 7 and Table 8 respectively.
For NVAA Causes, the results from the Table 7 show that the p-value for Client-Contractor case has always been less than 0.05 meaning Contractors' opinions were very different from that of Clients.
The mean value obtained from Descriptive Statistics for NVAA Causes from Client, Consultant and Contractor are 80.34, 80.72, and 88.14 respectively, giving a mean of 82.81 (On a scale of 0 to 100, 100 meaning strong agreement). This shows that Contractors seem to have agreed more with the relevancy of causes in Irrigation than other two groups (client and consultants).

Table 7: Dunnett T3 Test Results for NVAA Causes

(I) Type		Sig.	Lower Bound	Upper Bound
Client	Consultant	0.999	-6.9676	6.2056
	Contractor	0.006	-13.6607	-1.955
Consultant	Client	0.999	-6.2056	6.9676
	Contractor	0.06	-15.0943	0.2406
Contractor	Client	0.006	1.955	13.6607
	Consultant	0.06	-0.2406	15.0943

For NVAA Minimization Techniques, the results from the Table 8 show that the p-value for Consultant-Contractor case has always been less than 0.05 meaning Consultants' opinions were very different from that of Contractors.
The mean value obtained from Descriptive Statistics for NVAA Causes from Client, Consultant and Contractor are 74.96, 69.46 and 81.16 respectively, giving a mean of 75 (On a scale of 0 to 100, 100 meaning strong agreement). This shows that Contractors seem to have agreed more with the contribution of Minimization Techniques in Irrigation than other two groups (client and consultants).

Table 8: Dunnett T3 Test Results for NVAA Minimization Techniques

(I) Type		Sig.	Lower Bound	Upper Bound
Client	Consultant	0.503	-5.1936	16.1865
	Contractor	0.351	-16.3072	3.9072
Consultant	Client	0.503	-16.1865	5.1936
	Contractor	0.081	-24.4359	1.043
Contractor	Client	0.351	-3.9072	16.3072
	Consultant	0.081	-1.043	24.4359

5. Conclusion

Non-Value adding activities are wasteful and they need to be eliminated to improve performance of any process. This study focuses on causes of non-value adding activities and minimization techniques for NVAAs in Irrigation Sector of Nepal by considering opinions from experts in the field and perceptions of client, consultants and contractors from the same. The results from this research indicate that the major causes of NVAA in Irrigation Sector are: Delay for permits from different Sectors (Forestry and Land Acquisition), Frequent Transfer of Key Professionals, Quarry Site Problem, Poor documentation control system, Bureaucracy(administrative structure and regulations to control activities), Delay in design approval, Improper Organization & Management (O&M), Drawings/design/details (Unclear, Incomplete, Inadequate), Late dissemination of information, Inadequate materials control.

The minimization techniques that are believed to be most contributive in minimizing NVAAs are: Skill Training & Proper Supervision, Permit Acquiring prior Bidding , Field Visit Mandate by Expert Prior Design, Skilled Expert Recruitment, Clear Guidelines & Experienced Team, Knowledge sharing & Real scenario meeting, Clear provision in the Bid & Contract document, Proper planning , Expert Consultation and Verification System, Work division and Authority delegation and Dedicated design unit (to facilitate decision making). The standard solutions proposed have been ranked low and have low scores. The reason may be unfamiliarity with the standard lean techniques.

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