INSS

DEFENCE REVIEW

2022

Volume V

Papers

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The Institute of National Security Studies (INSS) is the premier think tank on National Security establishes under the Ministry of Defence and currently functioning under the Ministry of National Security and Disaster Management. e institute established to understand the security environment and to work with government to craft evidence -based policy options and strategies for debate and discussion to ensure National Security. e institute conducts a broad array of research on National Security.

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Being the Secretary Defence as well as the Chairman of the Board of Governors of the Institute of National Security Studies (INSS), I am indeed delighted and honoured to pen this short message to be included in the fifth Volume of the Defence Review, the Annual International Research Journal of the institute.

Since the inception of this premier think tank on National Security, which is established under the Ministry of Defence, the institute has successfully published four journals up to date perceiving a diverse array of research dimensions pertaining to the National Security in order to provide essential and timely appraisals to the Ministry.

At a time where the world is moving towards unexploited frontiers in security paradigms, every stakeholder is realising the potentiality of the non-traditional threat dimensions, global security dilemmas and their impacts on National Security in the current context. Contemporary security issues are evolving rapidly and certain entities and research scholars are highly concerned at aspects such as environmental security, global and regional power equilibrium and the essential role played by intelligence during battle that have become dynamic facets of National Security. In such a context, identifying and bridging the research gaps in the aforementioned spheres are essential for defending the National Security against potential threats. It is appreciated that the desire of the institute, which adds new interpretations to the National Security dimensions and brings experts onto a platform has formed intelligent dialogues in order to assist ensuring the National Security of the country.

At this juncture, it is to be emphasised that the aim of the 'Defence Review', is to disseminate scholarly information on National Security to academics and practitioners worldwide. It encourages research relevant to scholars, academia, professionals and military Officers engaged in the field of National Security in order to allow them to exploit a plethora of knowledge on significant disciplines in their respective areas of study.

Following the tradition, this year too INSS has put its highest effort into gathering scholarly articles around the world to provide a platform for researchers to share their expertise and research findings. After a thorough and competitive double blind peer reviewing process, the fifth Volume of the Annual International Research Journal of the institute, the Defence Review 2022 has been able to bring in scholars together from diverse disciplines to publish their papers related to National Security.

Therefore, I take this opportunity to extend my immense appreciation to the authors of the Defence Review who exerted their fullest efforts for the success of publishing this invaluable collection of research papers. I further extend my sincere gratitude to every expert and stakeholder involved; including the distinguished Editorial Board, the Board of Peer Reviewers, and the Copy Editor who contributed and made this effort a success. Last but not least, I admire the INSS team for their unwavering commitment and effort in releasing the Defence Review 2022 the prestigious annual international scholarly journal of INSS.

Finally, as I wholeheartedly congratulate the INSS and its team for releasing the Defence Review 2022, I most sincerely admire them for continuing the work of excellence which brilliantly concurs towards ensuring the National Security of the Country.

General Kamal Gunaratne (Retd)
WWV, RWP, RSP, USP, ndc, psc, MPhil
Secretary
Ministry of Defence

It is an honour and a privilege to pen a foreword for this International double-blind peer reviewed journal of the Institute of National Security Studies. National security is ever evolving and is a much broader and deeper subject than what it was in the 19th or the first half of the 20th century. The era of considering a country's might with its troop strength, weapon count or nuclear throw weight is diminishing significantly as many non-traditional threats have taken over.

INSS has been able to bring out its annual journal continuously for the last three years and has been able to make key contributions to the expanding horizons of the national security, defence studies and strategic affairs. This annual publication of scholarly articles is the pride of the Institute of National Security Studies as it contains papers written on various facets of national security covering Sri Lanka, the region and beyond. The journal comes with a diversity of views from the strategic and national security studies community both from within and outside Sri Lanka. This issue contains three well researched articles that have gone through an extensive and a systematic scrutiny by an editorial board.

The lead article in this issue is titled "On Intelligence Preparation of the Battlefield Process Automation" which has been written by four authors who have had their initial graduation from the prestigious University of Peradeniya namely Hishan Adikari, Sathyanga Agalakumbura, Jayamal Jayamaha, Dr. Isuru Nawinne and Dr. Janaka Alawatugoda.

Land mines do not only kill or injure humans and animals affecting them physically and psychologically Apart from the socio-economic conditions of the personnel who are affected it has a lasting impact on the environment security as well. Taking in to account of our own experience in the three decade long separatist war this has been well explained by the next article written by K Nijamir titled 'The landmines-resulted environmental consequences: A review based on post-war scenario, Sri Lanka'

Class of Soft Power in Sri Lanka: China Vs India's view of a Buddhist Foreign Policy has been written by Punsara Amarasinghe highlighting the growing Chinese influence shifting towards South Asia and how they are attempting to use Buddhism as a soft power tool to accomplish their goal while India too is trying to use Buddhist diplomacy as a tool to achieve its influence in the region as it originated in the ancient subcontinent.

I take this opportunity to congratulate all authors for taking their time and their interest shown in writing a paper related to national security and all the hard work they have put in to make this year's publication a success. My appreciation also goes to the Editorial board including the peer reviewer who were proven national security experts in academia, think tanks and the defence who made a tremendous effort in selecting the best papers to make this year's volume of the Defence Review an interesting and worthwhile read. Last but not least a big thank you to the copy editor for polishing the content, and placing the final icing on the cake.

Happy reading!

Rear Admiral D C Gunawardena (Retd)
RWP**, RSP, VSV, USP, nswc, psc, hdmc,
MSc(DS)Mgt, MMS, MSc (NS & WS), BSc(Hons)
Acting Director General and
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Institute of National Security Studies

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ON INTELLIGENCE PREPARATION OF THE BATTLEFIELD PROCESS AUTOMATION

Mr. Hishan Adikari ‡,
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Mr. Jayamal Jayamaha ‡,
Dr. Isuru Nawinne ‡,
Dr. Janaka Alawatugoda †x *

Abstract

In military operations, armed forces have to get a better idea of the area in which they have to operate including terrain features, threats, and avenues of approach. So they gather intelligence on the location, enemy, weather, vegetation, infrastructure, and many such factors before making decisions. This process is called Intelligence Preparation of the Battlefield (IPB) where analyzing the situation and making decisions based on predictions is the main target. Usually, this process happens manually by officers using hard copy maps and it has several inconveniences described in detail in this report. In our research we developed a tool for generating terrain features on a given map, saving those maps in a database, adding more features as overlays and adding properties for them. Also, we implemented a set of algorithms and approaches for automating a set of IPB processes and we compared the approaches to each other, as well as compared results with outputs from subject matter experts and current systems. In this report, we present our methodology, design, approaches, algorithms, comparisons, and results in automating the intelligence preparation of the battlefield.

Keywords: ***IPB process, Intelligence, Automation, Algorithms, Web application***

1. Introduction

IPB is a process that starts in advance of operations and continues during operations, planning and execution. It provides guidelines for the gathering, analysis, and organization of intelligence. The purpose of this intelligence is to inform a commander's decision process during the preparation for, and execution of a mission. Therefore, IPB is a Command

and staff tool which allows systematic and continuous analysis of the enemy and the battlefield environment. It presents the results of the process in a graphical format. It is an integrated method of analyzing Enemy, Ground and Friendly Forces factors in the Estimate. Basically, there are four steps in IPB process. They are,

- Define the battlefield environment
- Describe the battlefield's effects
- Evaluate the threat
- Determine threat Course of Actions (COAs)

The resulting product of IPB is identification of various areas of the battlefield that affect COAs. The four distinctive courses of action are,

- engagement areas
- battle positions
- infiltration lanes
- avenue of approach

Any force that has the control of the key terrain has the military advantage. Key terrain areas cannot be defined by geographical features alone. The evaluation of terrain features must be fused with information about weather, enemy asset types, friendly and enemy range of fire, enemy doctrine and type of operation.

The problem with the traditional IPB process is that it is done manually by intelli- gence officers using hard copies of maps. This manual process suffers from a number of inefficiencies as described below.

- Not variable zooming to obtain desired level of detail
- Annotating the maps is time consuming.
- Notations on maps get cluttered with the risk of being misread.
- Information could be disregarded or not used effectively in the process of the IPB

To address the aforementioned problems the best solution is an automated information system which can present geographical, climate and infrastructure data on top of a base map, analyze data, present graphical representations and make users interact with the map using a flexible user interface. A detailed database with low level terrain information like buildings, vegetation, elevation slopes and topology and computational algorithms to transform this low-level terrain information to higher level information such as maneuverability of a force, threats for maneuverability from enemies are some components that should be included in the automated system. Since the IPB process is an iterative process done throughout an operation, the computational algorithms must be efficient and should work with real time data. A user-friendly interface helps to add information and see stored information on the map. So, decision support tools that automate part of the process are highly needed. In this paper, we present a set of algorithms, tools and approaches for automating Intelligence Preparation

2. Related Works

Many countries have developed an automated IPB systems. For example, army of the Czech Republic has an automated IPB system as a part of knowledge development in their conditions P.Skalicky´ and T.Palasiewicz, Intelligence Preparation of the Battlefield as a Part of Knowledge Development, 2017. New Zealand has automated IPB system for contemporary operating environment. Researchers in Robin Glinton et al., "Terrain-based information fusion and inference," Proc. Seventh Int. Conf. Inf. Fusion, FUSION 2004 1 (2004): 338–345 and Charles Grindle et al., "Automating Terrain Analysis: Algorithms for Intelligence Preparation of the Battlefield," Proceedings of the Human Factors and Ergonomics Society Annual Meeting 48, no. 3 (2004): 533–537, IssN: 1541-9312, http s : / /doi.org/10.1177/154193120404800355 have used the Compact Terrain Database (CTDB) format used by the OneSAF Testbed Baseline simulation software as the terrain representation and used grid of elevation values, as well as an associated soil type for each grid cell to continue the development of automation algorithm for IPB process. Researchers in CPT J James Donlon and Kenneth D Forbus, "Using a Geographic Information System for Qualitative Spatial Reasoning about Trafficability," Proc. QR99, 1999, 1–11 have shown that a GIS can be used to produce representations

for qualitative spatial reasoning and the geometric processing facilities of the GIS provide the capabilities in a metric diagram. They have founded that qualitative spatial reasoning can evaluate trafficablity of terrain.

Use of Geographical Information System (GIS)

Research K. K.R.P. Rowel and H. Ranasinghe, Impact of gis modelling in military opera- tional planning. have proposed a GIS model to conduct the IPB process using ArcGIS software. According to the E. D. Porter, An overview of the army gis research program, 1987, it describes the usage of GIS for geo-reconnaissance in army. And also GIS can give specific information about buildings, devices and objects on the battlefield using their geo location and field data. Moreover, it provides proper security mechanisms by using planning strategies and further management strategies. And getting information from the intelligence services for attacking and planning routes of movement is done basically with the information gained by GIS.

Terrain Analysis

Terrain analysis is a requisite part of an IPB process in a military operation. From this analysis, it is able to build an extensive databases for each and every potential area of operations. This is the foundation for the intelligence, tactical operations and decision making. Terrain features can continuously change according to the earth's surface and therefore terrain databases must also be continuously updated and revised. Authors in Washington Headquarters Department of the Army, "Terrain Analysis," Encyclopedia of Geographic Information Science, 1990, clearly say that terrain analysis is a must in decision making process. And according to this, manual terrain analysis procedures use basic doctrine as a primary source of current available information for planning, conducting and supervising the terrain analysis procedure. Authors in Major Collin A. Agee, "INTELLIGENCE PREPARATION OF THE BATTLEFIELD (IPB)," Society 1387, no. 22 (1987): 1383–1387 have explored how to fuse intelligence data with terrain data and use for IPB. According to Agee any force that has the control of the key terrain has the military advantage. Key terrain examples include road intersections and a bridge over a river or terrain. Key terrain areas cannot be defined by geographical features alone. The

evaluation of terrain features must be fused with information about weather, enemy asset types, friendly and enemy range

of fire, enemy doctrine and type of operation. It describes how the IPB process happen in battlefield using examples. Ulrich Weidmann , Mark Meeder and Tobias Aebi, "The influence of slope on walking activity and the pedestrian modal share," 20th EURO Working Group on Transportation Meeting, 2017, discuss about the influence of slope in terrain on walking activity. They have analysed terrain features like slope on the human maneuver.

IPB Algorithms

Authors in Grindle et al., "Automating Terrain Analysis: Algorithms for Intelligence Preparation of the Battlefield" have created a combined obstacle overlay using terain data and have used generalized voronoi diagrams to generate avenues of approaches and analyzed the circuit diagram using electrical circuit model to explain mobility in paths. But the example battlefield they have used is very small and hence the voronoi circuit is simple. James Donlon and Forbus, "Using a Geographic Information System for Qualitative Spatial Reasoning about Trafficability" discuss how to generate trafficability using qualitative analysis of terrain. This research has used qualitative, as well as quantitative analysis to get the trafficability. Authors in David Ezra Sidran, TIGER: AN UNSUPERVISED MACHINE LEARNING TACTICAL INFERENCE GENERATOR, 2009 has developed algorithms to find shortest route to attack and retreat, as well as to find the range of influence of the enemy and friendly units. In our research we developed the range of influence algorithm more combining the terrain features as well. In Pontus Svenson and Hedvig Sidenbladh, determining possible avenues of approach using ANT, 2003, they use ant colony optimization (ANTS) to determine possible avenues of approach for the enemy, given a situation picture. ANTS is about finding good paths through graphs. Artificial Ants stand for multiagent methods inspired by the behavior of real ants. Also a final year research group from Faculty of Engineering, University of Peradeniya, has done research about using GIS to get and draw intelligence data on terrain maps and use A* algorithm to find a shortest path between two locations excluding drawn obstacles.

3. Design and Implementation

The research was basically 'split' divided into two major sections such that each section contains three milestones.

A. Visual Support for Automating the Intelligence Preparation of the Battlefield (IPB) Process
   (a) Web-based platform to display overlays on a map.
   (b) Infrastructure to efficiently store data for overlays.
   (c) Integrating the data storing mechanism with graphical user interface.

B. Implement the Automation of Intelligence Preparation of the Battlefield
   (a) A grid based combined obstacle overlay by collecting the vector overlays to a grid.
   (b) Generating the potential mobility corridors in the terrain.
   (c) Risk evaluation of corridors to select safest avenues of approach.

Web-based Platform to Display Overlays on a Map

As the IPB need a visual tool that allows military staff to add battlefield data into the system and also visualize them as overlays, we needed to firstly develop a web-based platform

to add overlays and visualize them. So, we firstly researched about a framework that we can use to do the map-based functions. Simply from front-end side the application should work like a GIS software. Following technologies were chosen by us to be used for the web platform.

Leafletjs: Leaflet is the leading open-source JavaScript library for mobile-friendly interactive maps.

Open street Maps: OpenStreetMap is a free editable map of the whole world that is being built by volunteers largely from scratch and released with an open-content license.

Infrastructure to Efficiently Store Data for Overlays

We needed to find a data storing mechanism and also a data format to store the overlay data. As the data in overlay are spatial data with attributes, we researched about the available methods to store such data. So the available options to store those data were using a vector format or a raster format. So as our web application was JavaScript based, we choose GeoJSON which is a format for encoding a variety of geographic data structures. To store and provide the required overlay information relevant to battlefields, there should be a back-end application. As our future algorithms and models are based on python, we used Python Flask as the web framework for our back-end and decided to use REST architecture to build the back-end web service. Following were the attributes we defined for our overlays

- Building
  - No of occupants
  - Status
  - Material
  - Building Type
  - No of stories
- Vegetation
  - Vegetation Type (grassland, shrubland, woodland, medium density forest, high denisty forest, unknown)
- Water
  - Water body type (water, river, reservoir, dock, wetland, unknown)
  - Mark known points of shallow or deep
- Roads
  - Road type (tertiary, track, unclassified, secondary, trunk, primary, motorway link, trunk link, primary link, road, secondary link, tertiary link, motorway)
- Elevation
  - Elevation value

Integrating the Data Storing Mechanism with the GUI

Finally, we had to integrate the back-end we developed using the data storing mechanism and data retrieving mechanisms with the front-end developed with map overlays. So, in our first section of the project, we implemented the web application tool to perform following major tasks.

- Create and save multiple battlefields (maps).
- Automatically generate the buildings, water, roads, elevation, vegetation overlays when a new battlefield is created.
- View a battlefield on user interface graphically with a map (Satellite or Topographical)
- View the overlays generated for the battlefield graphically on the map separately.
- Add new buildings, water bodies, vegetation areas, roads on the battlefield using a drawing tool
- Add values for the defined attributes of the newly drawn shape.
- Edit values of attributes of automatically generated geographical features.
- Remove geographical features of overlays.
- Save changes to be able to access later.
- All the information are stored in the back-end.

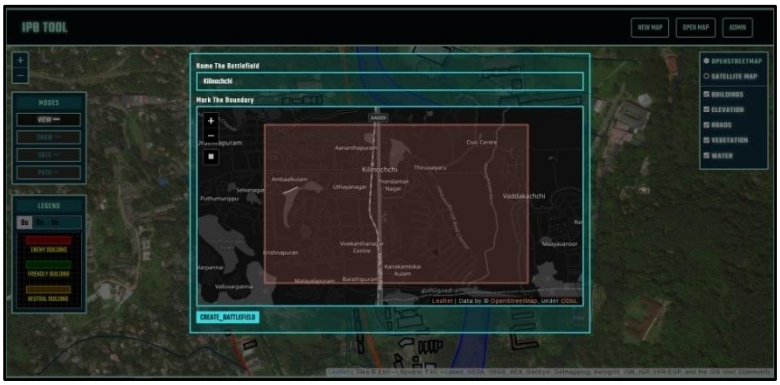

Figure 1 : Creating the battlefield

Fig. 1 shows how to select the battlefield using a map interface in the tool. The architecture implemented for the system was basically a 3-Tier Architecture. Presentation layer being our web tool using LeafletJS,

Application layer being the python web application using Flask and use REST web services to communicate with Presentation layer. Data layer is the file system which stores GeoJSON files in a hierarchical structure. Fig. 5 is the system architectural diagram.

Figure 2 : Generated overlays added on the map

The auto generation of overlays happen in IPB Service Layer, where the available geographical data for Sri Lanka stored in the server are processed in order to produce the overlays of the given boundaries. We have obtained relevant digital geographical data for Sri Lanka and pre-processed them to suit the overlays we are considering.

Figure 3 : Figure 3: Adding data to an geographic feature

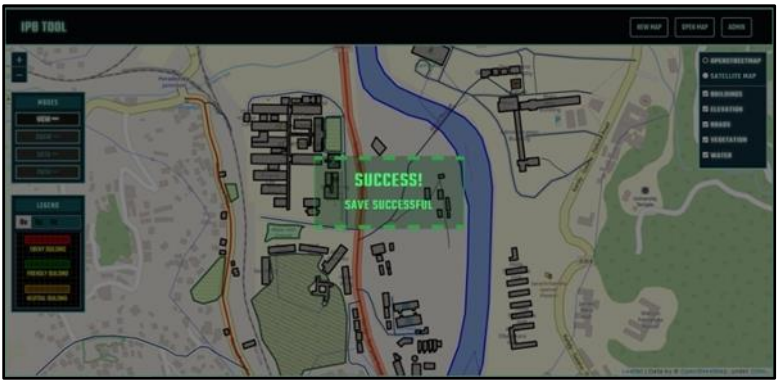

Figure 4 : Save the data insertion

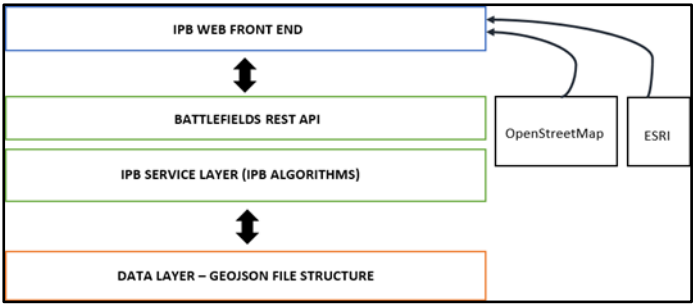

Figure 5 : System Architectural Diagram

The Elevation data for Sri Lanka have been obtained from highest-resolution topographic data generated from NASA's Shuttle Radar Topography Mission (SRTM). We generated the island wide 25m contour lines using that DEM data and that is used for creating elevation overlay. We stored the raster DEM file in server for some other functions including trafficability calculation. OpenStreetMap data were obtained via https://download.geofabrik.de/asia/sri-lanka.html, and processed to obtain overlay data for Sri Lanka.

- OSM Land Use data was used to obtain vegetation overlay by filtering vegetation and mapping their properties to our defined attributes.

- OSM Building data was processed to get building overlay such that their properties mapped into our defined building attributes.
- OSM water data was converted into water overlay.
- OSM road data was converted in to road overlay.

Grid-based Combined Obstacle Overlay by Collecting the Vector Overlays to a Grid

As we have built the overlays using a vector format with properties, we needed to convert those data overlays to grids of their properties as grid based analysis is used for the processing. We started from the elevation raster file of Sri Lanka obtained from SRTM dataset. In our program to get the combined obstacle overlay first step was to get the elevation grid. So our program was added the functionality to clip the Sri Lanka elevation raster file to the size of the battlefield firstly. The NASA's Space Shuttle Radar Topography Mission (SRTM) DEM data's resolution is about 30 meters. It has pixels (cells) of grid approximately 30m containing elevation data as shown in Fig. 6

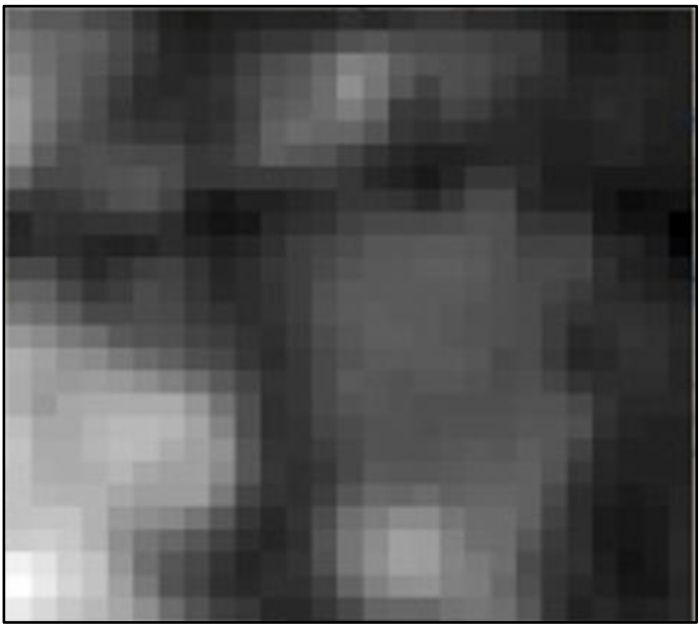

Figure 6 : DEM raster image of University of Peradeniya Area, Sri Lanka

We needed to map the elevation data to a grid of cells of size 10 times smaller than SRTM data resolution for better accuracy as 30m is not a good resolution for finding mobility. Elevation data graph was resampled using bi-linear interpolation, to reduce the resolution of the overlay grid size to about 3 meters. The elevation data raster overlay after resampling is shown in Fig. 7.

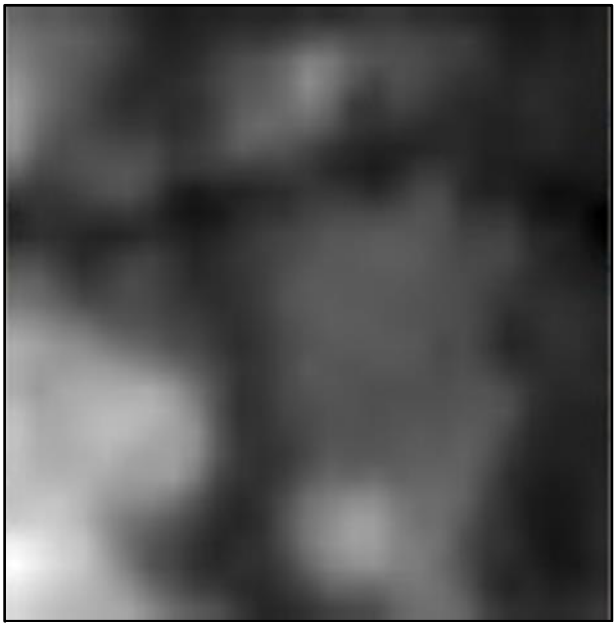

Figure 7 : DEM raster image of University of Peradeniya Area after re-sampling to 10 times smaller cells

The other overlay grids was also to be built to the same shape of the elevation grid obtained, such that they can be put one on other. So next from the elevation grid, an additional grid of slope was derived. The slope grid is produced such that slope at grid cell (x, y) is assigned the mean of the slope between (x, y) and each of the surrounding grid cells. Fig. 8 shows the generated slope overlay for above elevation example.

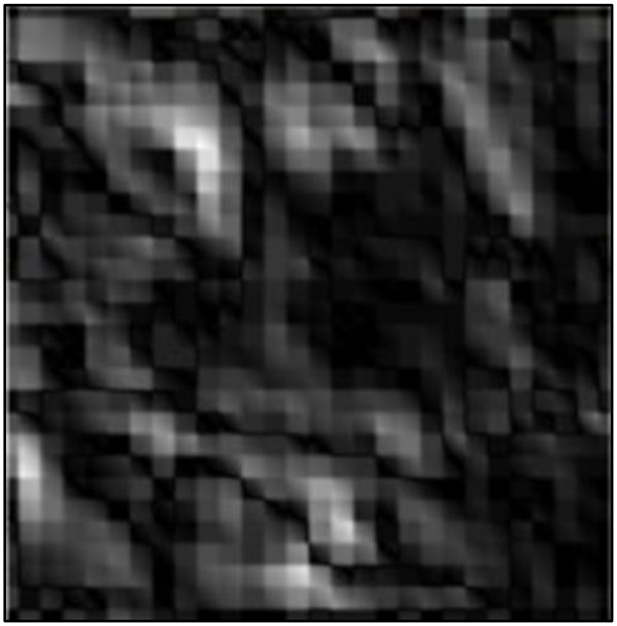

Figure 8 : Slope raster image of University of Peradeniya

Rasterization techniques were used to get the rater images of the building, water, road and vegetation overlays preserving their properties and those raster images of the overlays were converted to a numpy array for our processing.

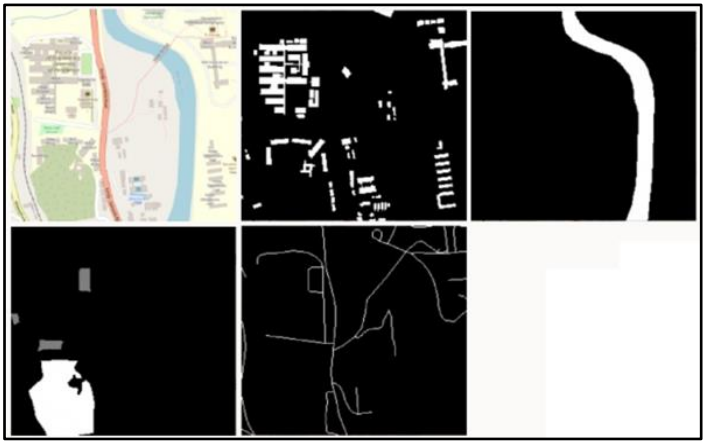

Figure 9 : Building grid, water grid, vegetation grid and road grid

Fig. 9 show the original map with the building grid, water grid, vegetation grid and road grid obtained for University of Peradeniya using our program.

Our target in this milestone was to obtain combined obstacle overlay (coo) by combining all these overlays and to construct an overlay called trafficability grid considering all those overlays (elevation, slope, building, vegetation, water, roads). Trafficability grid is a grid which has cells representing squares on land, where each grid cell represents the trafficability of the cell. In another way each cell give a value defining how much it is difficult to troop maneuver within that cell. We considered the electric flow model as a foundation of our algorithm to get trafficability grid. In electric current point of view, the electric current or the flow of electrons is determined by the resistance of the medium. The resistance is determined by the resistivity of the materials used in the medium. If the resistance per unit length is k, the resistance of 4 length medium becomes k × 4. For each property that we consider that would effect trafficability from the overlays, we defined a value denoting resistance per distance for troop maneuver. So the total resistance per distance for a given grid cell is the sum of all resistances per length of properties that belong to that cell. So the pseudo code for our algorithm used in obtaining the trafficability using the resistance model is given below.

```
function trafficability(coo):
    create empty grid trafficability
    elevation_min = minimum(coo.elevation)
    for each cell in coo:
      slope = cell.getSlope()
      isBuilding = cell.isBuildingHere()
      isWater = cell.isWaterHere()
      isRoad = cell.isRoadHere()
      vegetationLevel= cell.vegetation()
      relative_elevation = cell.getElevation() - elevation_min
      isBridge = isWater and isRoad

          // resistivity of cell
      cel_res = relative_elevation

      if slope > max_slope_threshold:
        cel_res = cel_res + resistivity_heavy_slope

      if isRoad:
        cel_res = cel_res + resistivity_road
      else if isBridge:
        cel_res = elevation + resistivity_bridge
      else if isBuilding:
        cel_res = cel_res + resistivity_building
      else if isWater:
        cel_res = cel_res + resistivity_water
      else if vegetationLevel == grassland
        cel_res = cel_res + resistivity_vegetation_grassland
      else if vegetationLevel == shrubland
        cel_res = cel_res + resistivity_vegetation_shrubland
      else if vegetationLevel == woodland
        cel_res = cel_res + resistivity_vegetation_woodland
      else if vegetationLevel == medium density forest
        cel_res = cel_res + resistivity_vegetation_medium_density_forest
      else if vegetationLevel == high density forest
        cel_res = cel_res + resistivity_vegetation_high_density_forest
      else if vegetationLevel == unknown
        cel_res = cel_res + resistivity_vegetation_unknown
      else:
        cel_res = cel_res + resistivity_vegetation_empty
      update corresponding cell in trafficability grid with cel_res
    return trafficability
```

So for the operation of this algorithm, we defined few attributes that describe the resistivity per length for different terrain features as below.

- max slope threshold = 0.4
- resistivity vegetation grassland = 30
- resistivity vegetation shrubland = 100
- resistivity vegetation woodland = 200
- resistivity vegetation medium density forest = 400
- resistivity vegetation high density forest = 600
- resistivity vegetation unknown = 200
- resistivity vegetation empty = 65
- resistivity building = 1000
- resistivity road = 1
- resistivity bridge = 1
- resistivity water = 10000
- resistivity heavy slope = 800

These attributes were given assumed values based on the mobility in each situation.

Generating the Potential Mobility Corridors in the Terrain

So next we moved to generating potential mobility corridors that troops can move from a given starting point to a destination. The trafficability grid that was generated in the last milestone, was used in determining the mobility corridors, or the avenues of approach. Trafficabilty grid represent a relative cost or a resistance of moving per a unit length, for each cell in grid. Here unit refer to width of a cell in the grid. To generate the potential mobility corridors, we experimented three approaches. Those were,

1. Generalized Voronoi Diagram Method
2. k-shortest paths algorithm
3. Dijkstra's based path removing algorithm

Generalized Voronoi diagram method.

The voronoi diagram method was to get mobility corridors from a voronoi

diagram drawn for a GO-NO GO terrain map generated from trafficability grid. See Fig. 10

Let P = {*p1, p2, · · ·, pn*} be a set of n distinct points or sites in the plane. The Voronoi diagram of P is the subdivision of the plane into n cells, one for each site in P, with the property that a point q lies in the cell corresponding to a site pi if and only if dist(*q, pi*) < dist(q, p j) for each p j ∈ P with j ≠ i. If the sites are replaced with polygons, the above definition holds true with a more complex distance function that represents the minimum distance between a point and a polygon in the plane. Such a diagram for polygons instead of points is called the Generalized Voronoi Diagram (GVD). This help to find avenues of approach, defensible areas, and other important tactical features of terrain. Though the optimized algorithm for voronoi diagram is Fortune's algorithm with time complexity O(*n log n*), as we need to get the Generalized Voronoi Diagram for polygons, we used the basic algorithm with O(*n2*) for that. Following is the pseudo-code for the generation of generalized voronoi diagram from GO NO-GO terrain grid.

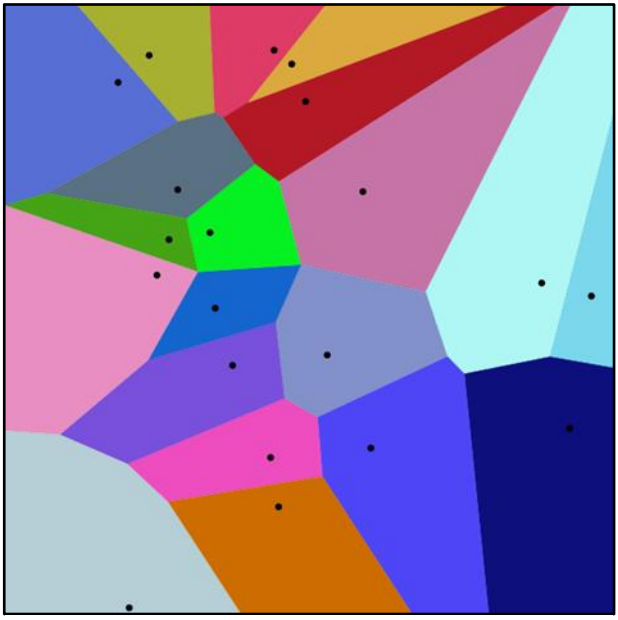

Figure 10 : An example Voronoi diagram

```
function voronoi(go_no_go_grid):
  create new grid border_grid

  for each no_go cell in go_no_go_gird:
    if any neighbor cell is a go cell:
      mark cell as a border in border_grid

 create an array of array of cells (say cell_families)
  //To store connected cells separately
 add connected cell groups to cell_families
 //Using a connected cell algorithm

  depth_map = grid of size go_no_go_grid
  color_map = grid of size go_no_go_grid
  put infinity to all cells in depth_map
  put zero to all cells in color_map

  family_id = 0

  for each family in cell_families:
    increment family_id by 1
    create a go_no_go grid sized grid (distance_map)
    get min geometric distance of each cell from cells of family
    Add min geometric distance to distance_map
    where distance_map value < depth_map value
        update the color_map , with family_id
        update the depth_map , with distance_map value

  create new grid voronoi_grid

  for each cell in color_map:
    if any neighbor cell is not equal to cell value:
      mark cell as a voronoi grid in voronoi_grid

return voronoi_grid
```

Fig. 11 is the voronoi diagram resulted for our sample battlefield. It shows the GVD drawn to the battlefield without restricted terrain (left) and with restricted terrain (right)

Figure 11 : Generalized Voronoi Diagram for University of Peradeniya

So this diagram is a network of paths, which gives many paths that avoids restricted NO-GO areas. Each edge of the Voronoi graph corresponds to a path between two restricted NO-GO features. So basically Voroni diagram gives an abstract set of paths that one can go avoiding only NO-GO areas.

So we can select set of routes that join two positions from the network as Fig. 12.

Figure 12: Set of paths selected using GVD

But the problem in this method is that only the restricted terrain is considered for path generation. The other costs of mobility like cost from elevation, vegetation, roads, slope is not considered as the trafficability grid is mapped to a binary grid of GO, NO-Go and used here. So the accuracy is low as many data are not used. Considering the time complexity of the algorithm, the algorithm we used for generating this generalized voronoi algorithm has time complexity O(n2), assuming the NO-GO feature density is linearly proportional to number of cells(n) of a battlefield grid.

k-shortest paths algorithm.

The k-shortest path routing problem is a generalization of the shortest path routing problem in a given network. It asks not only about a shortest path, but also about next k − 1 shortest paths which may be longer than the shortest path. Our approach of finding k-shortest paths in trafficability grid was actually finding the lowest cost paths, as the grid contain the cost values. We approached the k-shortest paths problem by extending Dijkstra algorithm. We have to give start and end locations to find paths here first. Following is the pseudocode for the generation of paths using k-shortest paths algorithm from trafficability terrain grid.

```
function kshortest(trafficability_grid , start_cell , end_cell):

  count = grid of zeros of size trafficability grid
  temp_paths = queue to store temporary paths
  final_paths = queue to store final paths

  add start cell to temp_paths with cost 0
  while temp_paths is not empty and count[end_cell] < k:
    current_shortest = get shortest from temp_paths
    remove current_shortest from temp_paths
    current_end = last cell of current_shortest
    increment count value of current_end by 1

    if current_end == end_cell:
```

So we generated 10 least cost paths taking k as 10, for 6 sample battlefields. Fig. 13 is an image of output paths obtained for a sample battlefield.

Figure 13 : 10 least cost paths

The problem in this result is that though there are several paths given as output in the result, they are actually represent a single path, just few small changes at few points are there. So those few changes make them the next least cost path, but there are not more different than the earlier path. But what we need is a set of paths that are different actually and go through a different area. So it is clear that k-shortest path algorithm doesn't give the best fit answer and we need not the next least cost paths, but the paths that are really different from others.

Dijkstra-based path removing algorithm.

Our third approach was a Dijkstra's algorithm-based approach that include path segment removing and path correcting functions. Dijkstra's algorithm is a least cost or least distance finding algorithm between nodes in a graph, conceived by computer scientist Edsger W. Dijkstra in 1956. Basically, for the trafficability grid, when performed Dijkstra's algorithm giving two points as start and end, outputs a path with the minimum cost, that one can go. But it just give one path and we need a set of different paths. After obtaining a shortest path, if we remove that path completely defining it as restricted, Dijkstra's algorithm will next find another path that is completely independent from earlier path. They will not have common edges. But they can cross each other in places where both routes are in diagonal directions as in Fig. 14.

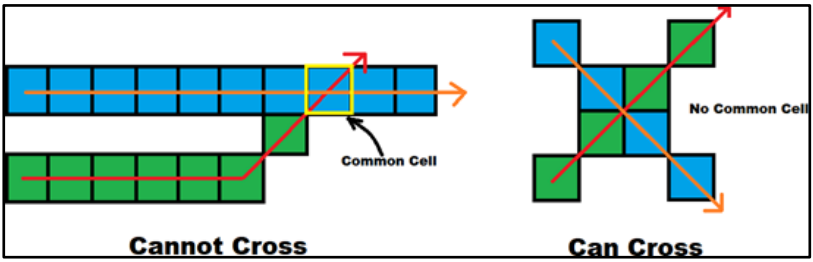

Figure 14: Path crossing occasions

Then the set of paths give much different avenues of approaches as we need, but in cases where the route lie on common areas that both can use same path, that doesn't give the correct path and have multiple parallel paths. That happens as the paths coming next after the first path cannot use the same edges used by earlier paths. More importantly when the first path use an already available road in it, next path that need to use the road to some extent cannot use it and it will go in other areas close and parallel to road. Fig. 15 shows the close and parallel path issue in this approach.

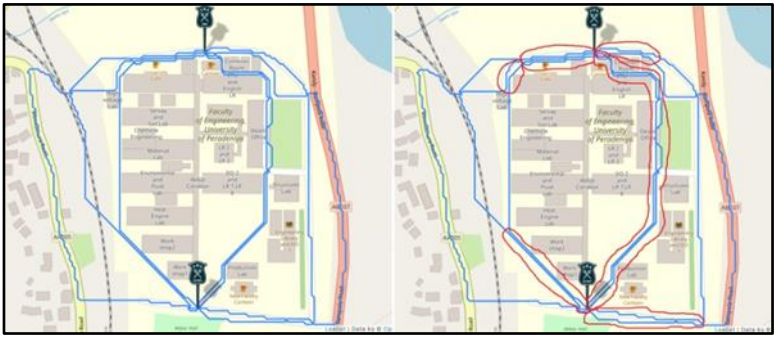

Figure 15 : Issue of having close and parallel paths (Left) and parts that need that issue to be corrected marked (Right)

So a correction had to be done to the close and parallel paths issue in common sections in routes. In the above image those places are circled with a red marker. So we developed a correction algorithm to correct that issue. When the paths generated were added to a grid, where cells belonging to paths have the cost defined in trafficability grid and other non path areas have a very high cost, the rasterized grid looks like Fig. 16.

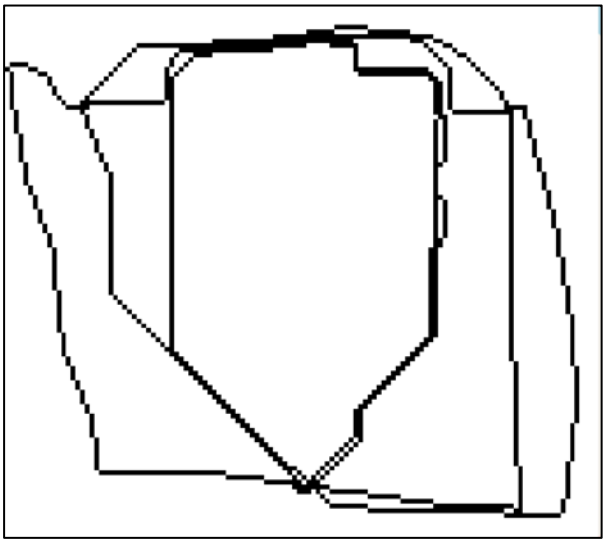

Figure 16 : Rasterized image of paths grid

So in that grid view, the close and parallel, unwanted paths can be seen merged together

as they are closer cells. Therefore in our correction algorithm, we made this grid and used Dijkstra's algorithm again to this new grid to get least cost paths out of this faulty path set. Also this correction algorithm has a path section removing mechanism, as well as a mechanism to identify which path section has to be removed before applying Dijkstra's algorithm again to avoid resulting same path.

In paths thickness is obtained for each cells using the number of surrounding path cells. When removing sections from the least cost path generated from new grid, first the segments with different thicknesses are split and we give priority to segments where, the path is thin (lowest width) and long (length with same thickness). Out of same width segments one with maximum length is chosen. Further the paths get split based on crossings as well, because in a crossing the number of surrounding path cells increase, hence taken as an increase of thickness. So following are the pseudo-codes for getting independent paths, path correction algorithm and obtaining sections to remove from paths respectively.

Pseudo-code for getting independent paths. Note: *max f actor = 5* means, only paths of cost more than 5 times of initial path will be resulted. Path correction function correct paths is explained in next section.

```
function independent_paths(trafficability_grid)
  max_factor = 5
  create paths array to store paths
  lc_path = get least cost path from trafficability_grid
  add lc_path to paths
  limit = max_factor * cost of lc_path
  while true:
    except start and end cell:
        mark cell of lc path as restricted
    lc_path = get least cost path from trafficability_grid
    if cost of lc_path > limit:
      break while loop
    add path to path
  return correct_paths(paths, trafficability_grid)
```

Pseudo-code for path correction algorithm. Note: function find section to remove is explained in next section.

```
function correct_paths(paths, trafficability_grid)
  k = a very large value
  create array new_paths to store corrected paths
  create new_grid of shape trafficability_grid
  change all cell values of new_grid to k
  for each path in paths
    for all cells of the path:
      update new_grid with value from trafficability_grid
  for each path in paths
    lc_path = get least cost path from new grid
    add lc_path to new_paths
    section_to_remove = find_section_to_remove(lc_path, new_grid)
    mark cells of section_to_remove with k in new_grid
  return new_paths
```

Obtaining sections to remove paths respectively. Note: threshold = 6 means initially cells with 6 or more neighboring non-path cells are considered as they are possible thinnest paths.

```
find_section_to_remove(path, new_grid)
  k = very large value used in new grid
  initially consider whole path as section to remove
  create array sections to store splllit sections
  threshold = 6
  while sections is empty and threshold >= 0:
      inside_section = false
      length_of_section  = 0
      start_cell_of_section = path[0]
      for cell in path:
          empty_count = number of neighboring cell with k
          if not inside_section and empty_count >= threshold:
              inside_section = True
              start_cell_of_section = cell
              length = 0
          if inside_section and empty_count >= threshold:
              length = length + 1
          if inside_section and empty_count < threshold:
              inside_section = False
              in sections array:
                store start_cell_of_section as start
                store cell as end
                store length
      max_section = maximum length section from sections
      threshold = threshold - 2
  return max_section
```

So after applying the correction the paths for above example looked like Fig. 17. Paths are shown in orange color.

So this approach could be identified as a successful one, as the more unique and different avenues of approaches could be given as output. The routes that were given as output were basically similar paths that a person who is familiar with this area would choose.

Figure 17 : Paths after correction

Limitation at choke points. In this approach, a problem that we identified was that only a single path would be given as output through a choke point. Choke points are the places where troops have to maneuver through a very narrow area, where both the left and right sides are restricted areas; for example, bridges, mountain passes, narrow areas between buildings etc. When generating paths, at initial state, when a path is there through a such choke point, though there can be another path which is not exactly similar to this path and has another approach but need to pass this choke point, it will not be given as output. For such a thing to happen, there should be close and parallel path segments for those two where there is should be common path. But that cannot happen as parallel and close paths cannot pass restricted part at choke point and the only pass-through choke point has been occupied by first path. So to resolve this issue, if there is a choke point in the path generated, before generating the next independent path the pass through choke point must be unoccupied. Fig. 18 is an image where paths are generated between two locations in the University of

Peradeniya and the limitation of paths can be seen as there are two choke points here (Akbar bridge and Peradeniya bridge) and hence the potential avenues marked in light green color are not given in output. Paths in blue color are the computer-generated paths.

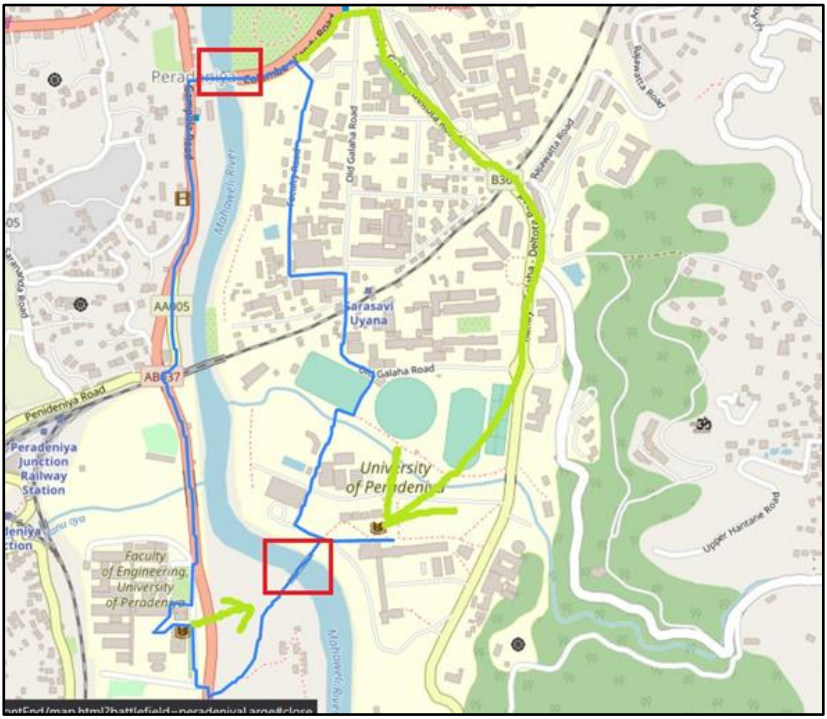

Figure 18: Path limitation due to choke points

As described above in order to resolve this issue, a modification was done to the 'Getting Independent Paths' algorithm. The identified choke points were made unoccupied after obtaining a path and before generating next independent path. For that instead of making the whole generated path restricted, the cells excluding choke points in the path were made restricted. So, to find all choke points and remove path without choke points, an algorithm was developed and it's pseudo-code as below.

```
function non_choke_points(restricted_grid, path):
  front_cell = None
  back_cell = None
  create array non_chokes_point_set
  for each cell in path:
      back_cell = front_cell
      front_cell = cell
      if back_cell is not None and front_cell is not None:
          v_d = front_cell[0] - back_cell[0]
          h_d = front_cell[1] - back_cell[1]
          directions = None
          is_diagonal = False
          if (abs(h_d) - abs(v_d)) == 1:
              directions = (1, 0, -1, 0)
          else if (abs(h_d) - abs(v_d)) == -1:
              directions = (0, 1, 0, -1)
          else if(h_d * v_d) == 1:
              directions = (1, -1, -1, 1)
              is_diagonal = True
          else if(h_d * v_d) == -1:
              directions = (1, 1, -1, -1)
              is_diagonal = True
          is_choke = scan() // start scanning two sides
          if not is_choke:
              non_chokes_point_set.append(back_cell)
  return non_chokes_point_set
```

Note: choke threshold = minimum distance to an obstacle for a cell to be a choke point.

```
function scan(restricted_grid, cell, directions, is_diagonal):
  restricted_1_found = False
  restricted_2_found = False
  distance_traveled = 0
  distance_step = 1
  if is_diagonal:
      distance_step = square root of 2
  while distance_traveled <= choke_threshold:
      distance_traveled = distance_traveled + distance_step
      current_cell1 = (cell[0] + directions[0], cell[1] + directions[1])
      current_cell2 = (cell[0] + directions[2], cell[1] + directions[3])
      if not restricted_1_found and restricted_grid[current_cell1] == 1:
          restricted_1_found = True
      if not restricted_2_found and restricted_grid[current_cell2] == 1:
          restricted_2_found = True
      if restricted_1_found and restricted_2_found:
          return True
  return False
```

The scan function scan of each cell i in left and right directions up to the distance defined as choke threshold to find a obstacle, it there are obstacles in both directions within that limit, that cell is a choke point. We defined choke threshold as 4 units, that will approximately equal to 12 meters. So see the below Fig. 19 of computer generated output of above scenario after applying the fix to the 'Getting Independent Paths' algorithm.

Figure 19: Computer generated paths after removing choke point effect

So now the result seems very similar to a human generated output.

Risk Evaluation of Corridors to Select Safest Avenues of Approach

As we get set of distinct easiest avenues that can be used for troop maneuver, there might be some risks in using the paths due to enemy locations. So in this milestone we developed an algorithm to define the range of threats for the enemy locations annotated by user and then use that range of threats to find threat for routes generated. The general approach to get a range of threat was, the threat decreasing a uniform amount when going away from the enemy location or building. So, as we can define buildings as enemy ones in our tool, the value must start decreasing from the wall of the building to outside. As our representation of terrain was using a grid of cells, we defined two 2d arrays of the shape of terrain grid called Enemy threat grid and Threat decrement grid. In here Threat decrement grid has a value for each cell defining how much threat will loss in this cell. The amount is the loss of threat per grid cell unit. Using that, we created the enemy threat grid that will finally have a value of threat for each cell in the terrain. The value is between 0 and 10. In here, what

would decrease threat was only distance from the enemy building. So, the threat decrement grid has uniform values. So the threat range that is resulted is a circular area around the building where threat last only to a maximum fixed distance from borders of the building. When a same cell in threat array get values from two threat locations, the maximum out of the threats at the cell due to all threat locations is kept. So, the rasterized image of threat variation from an enemy building is as Fig. 20 when only distance is considered. Fig. 21 is the flow of the code we developed to get threat grid.

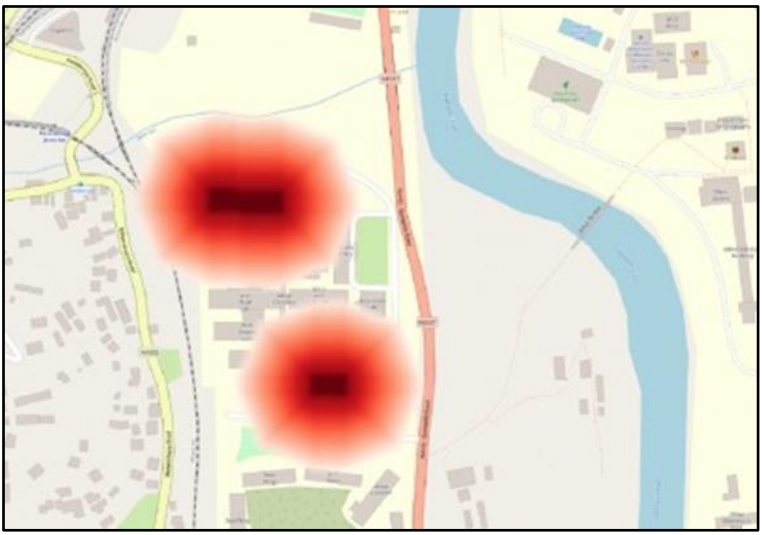

Figure 20 : Threat variation from an enemy building

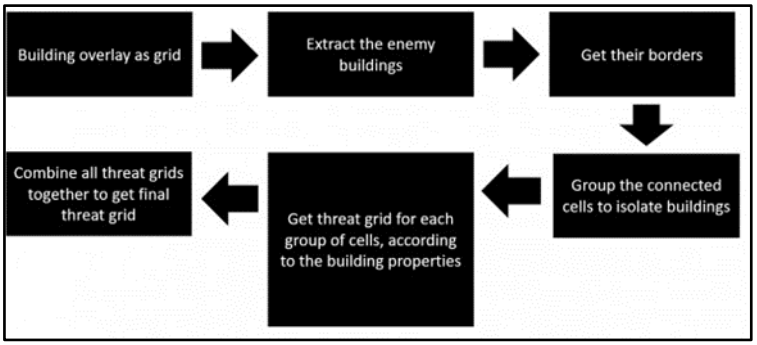

Figure 21: Flow of the code

So, the pseudo-code of the algorithm used to get the threat grid from a building when given the border cell list, which is the list of cells in the buildings border is given below;

```
function threat_grid(border_cell_list, threat_decrement_array)
  define starting threat for this building as T
  create new grid threat_range
  for each cell in border_cell_list:
  visited = new grid to store whether the cell visited or not
  q = new queue to store scanned cells with threat
  add cell to the q with threat T
  mark threat of cell in threat_range as T
  while q is not empty:
      current_cell = get cell with maximum threat cell from q
      remove current_cell from q
      mark current_cell as visited in visited
          let d is current_cell_threat_decrement
      d = threat_decrement_array_cell[current_cell]
      threat = threat_range[current cell]
      for each unvisited neighbor cell of current_cell:
              let n is neighbor_cell_decrement
        n = threat_decrement_array_cell[neighbor]
        if neighbor is in diagonal direction:
          threat_decrement = square_root(2) * (d + n) /2
        else
          threat_decrement = d + n) /2
        neighbor_cell_threat = threat - threat_decrement
        if neighbor_cell_threat > threat_range[neighbor]:
          update threat_range with neighbor_cell_threat
          add neighbor to q
  return threat_range
```

Then we studied how the terrain features would effect the threat and how to introduce those effects to our automated tool. From the features we have for terrain grid we identified following features that would effect threat range of an enemy building.

- Enemy building height
- Height of surrounding buildings
- Level of vegetation
- High elevation than enemy building height in surround area
- Low elevation than enemy building ground.

So to add enemy building height to the code functionality we defined the starting threat T of the algorithm according to the enemy building height. As the threats will be mapped to range between 10 and 0 at the end, increasing starting threat at enemy building is not an issue. The best way to add the effect of surrounding features to the threat grid, we automatically change the Threat decrement array according to the features. For example, in the cells where there is a building, the threat decrement will be higher than normal cell. So we defined the following

attributes that affect threat decrement array and assigned some sample values for them and fine tuned the variables until for a good result.In a normal flat terrain with no features like building or vegetation given, threat from 1 storied enemy building decrease uniformly up to 100m from border of the building. So the average width of a cell in our grid ≈ 3m. So the range is about 33 units.

- threat decrement building max, this is the threat decrement at places where a building blocks visibility, normally it is a building with same number of stories or more than the enemy building.
- threat decrement grassland, this is the threat decrement at places where there is a grassland
- threat decrement shrubland, this is the threat decrement at places where there is a shrubland
- threat decrement medium forest, this is the threat decrement at places where there is a medium forest
- threat decrement high forest, this is the threat decrement at places where there is a high forest
- threat decrement elevation increment, this is the value which the available threat decrement increase when the elevation is higher than the estimated building height
- threat decrement elevation decrement , this is the value which the available threat decrement decrease when the elevation is lower than the enemy ground level.
- building floor height average, this is the multiplying factor to get estimated building height from the number of stories of it.
- range increment per floor, normally range of the single storied building is 33 units, but it increase when the number of stories of enemy building increase. This is the value in which the range increase per single storey.

following figures in Fig. 22 are images of the threat array generated in enemy buildings by changing the terrain features.

Figure 22: When all buildings are single floor (LEFT), when top enemy building was made two story (MIDDLE) , when a close building of it also made two story (RIGHT)

When all buildings are two story, the threat range of enemy building is blocked by surrounding buildings as in first image. So when the enemy building is made a two story one, it's range of threat is not blocked by single floored buildings around. That is why the range has not changed in middle image. So when a nearby surround building also made two story as in right image, the range of enemy building will get effected from that.

Figure 23: Variation of threat with elevation

Fig. 23 shows the variation of threat with elevation right side of the building, the elevation is high, it is higher than the height of the building, so

the threat from building has been limited to right side. Also to left of the building, there is an increase of Threat because the ground level to that side is lower than building ground level, as well as the vegetation is grassland, that cause more spread of threat towards that side.

Basically, vegetation level effect threat range, in Fig. 24 to left side of the building, there is a heavy density forest, so the threats have been limited towards that side. Finally obtaining the threat grid for the whole battlefield, we decided threats for the routes generated between given coordinates. So the paths were colored in IPB tool using the threats obtained for each routes as below. In the threat representation of the map, the colors change from green to red to represent threat from 0 to 10 respectively. Fig. 25 is an image from IPB tool when potential mobility corridors were generated and paths are colored according to threat level due to the enemy locations marked in red.

4. Results and Analysis

Comparison of Approaches

We created 6 sample battlefields with different sizes in the same location, where it can be assumed as a uniform restricted terrain is there. Then we used the algorithm to compare time take for each. Fig. 26 shows the 6 sample battlefields created.

Times for each approach of paths generation was measured and plotted for each battle- field as below.

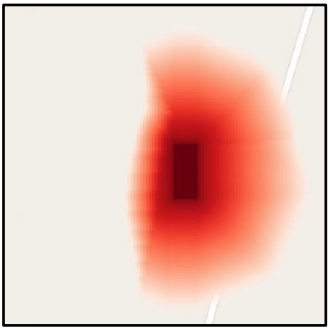

Figure 24: Variation of threat with vegetation

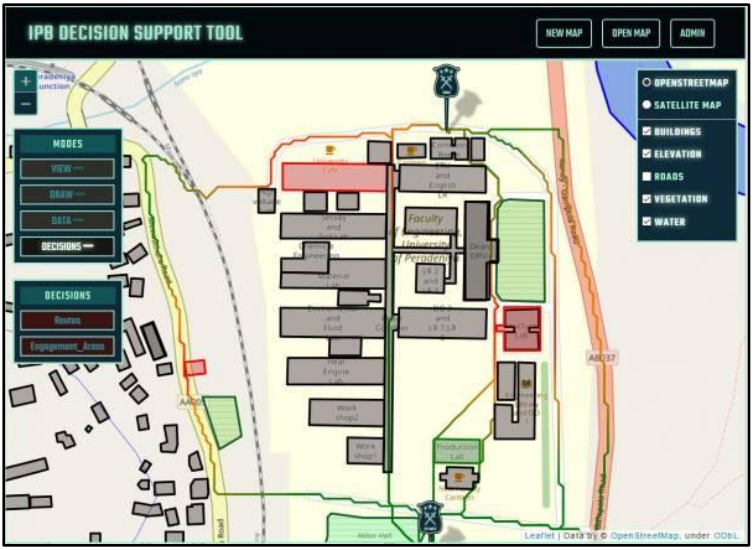

Figure 25: Mobility corridors in Faculty of Engineering map

Generalized Voronoi diagram method.

Table 1 shows the times for the algorithm of generation of paths for each battlefield using generalized voronoi diagram method and Fig. 27 shows the graphical representation of the time variation with number of cells in the battlefield.

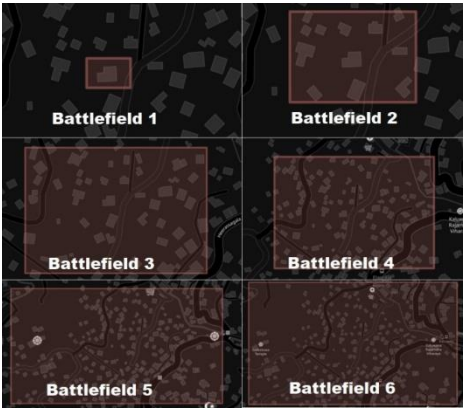

Figure 26: Sample battlefields for time comparison

Table 1: Time taken for Generalized Voronoi Diagram Method

Battlefield	No. of cells	Area (square meters)	time for algorithm (ms)
1	100	1014	0.998
2	1200	8910	30.926
3	1800	28600	134.635
4	7000	65100	874.651
5	20900	193800	5266.941
6	25200	234000	10767.204

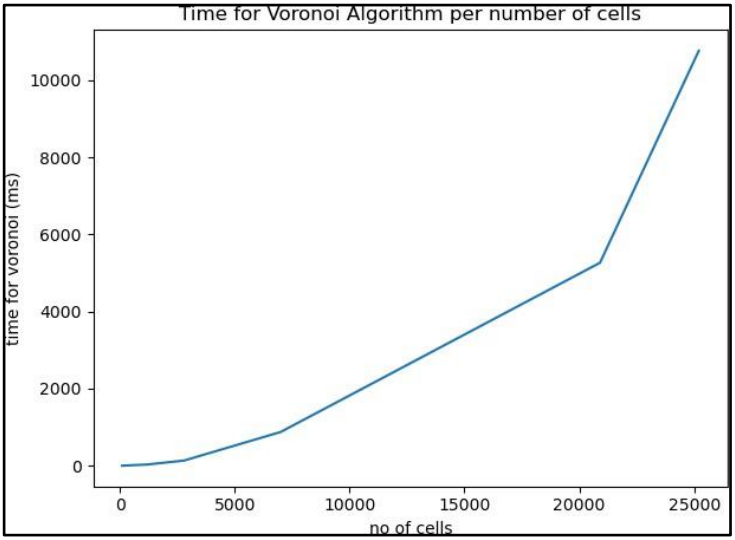

Figure 27: Plot of time taken for voronoi diagram vs number of cells

k-shortest paths algorithm.

Table 2 shows the times for the algorithm of generation of paths for each battlefield using k-shortest paths algorithm method and Fig. 28 shows the graphical representation of the time variation with number of cells in the battlefield.

Table 2: Time taken for k-shortest paths algorithm Method

Battlefield	No. of cells	Area (square meters)	time for algorithm (ms)
1	100	1014	781.912
2	1200	8910	29459.84
3	1800	28600	90515.703
4	7000	65100	378904.164
5	20900	193800	1548674.855
6	25200	234000	5015944.969

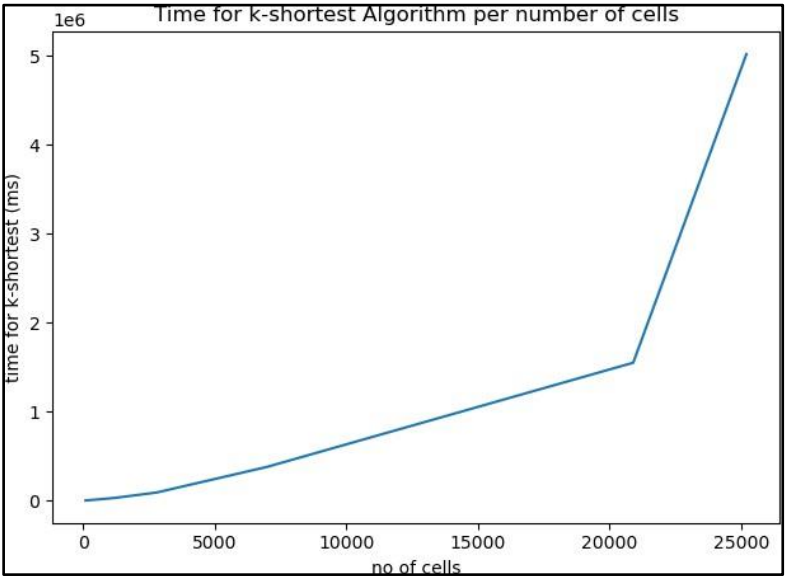

Figure 28: Plot of time taken for k-shortest paths algorithm vs number of cells

Dijkstra-based path removing algorithm.

Table 3 shows the times for the algorithm of generation of paths for each battlefield using Dijkstra's based path removing algorithm method and Fig. 29 shows the graphical representation of the time variation with number of cells in the battlefield.

Table 3: Time taken for Dijkstra's based path removing algorithm Method

Battlefield	No. of cells	Area (square meters)	time for algorithm (ms)
1	100	1014	13.963
2	1200	8910	32.913
3	1800	28600	38.897
4	7000	65100	41.888
5	20900	193800	121.674
6	25200	234000	191.484

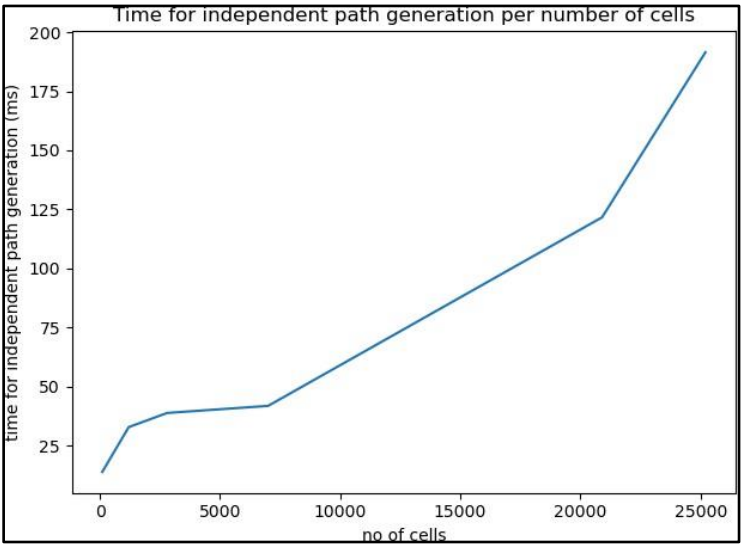

Figure 29: Plot of time taken for Dijkstra's based path removing algorithm vs number of cells

Comparison Results

Chart in Fig. 30 compares variation of time taken for three approaches with number of cells. Fig. 30 suggests that compared to time consumption, Dijkstra's based path removing algorithm is more time efficient than other two approaches. k-shortest path approach is not good as it's time consumption is much high, as well as increase exponentially with number of cells. Following Table 4 is a qualitative comparison between outputs of the three approaches. Considering these factors, it was decided to use Dijkstra's based path removing algorithm in our tool.

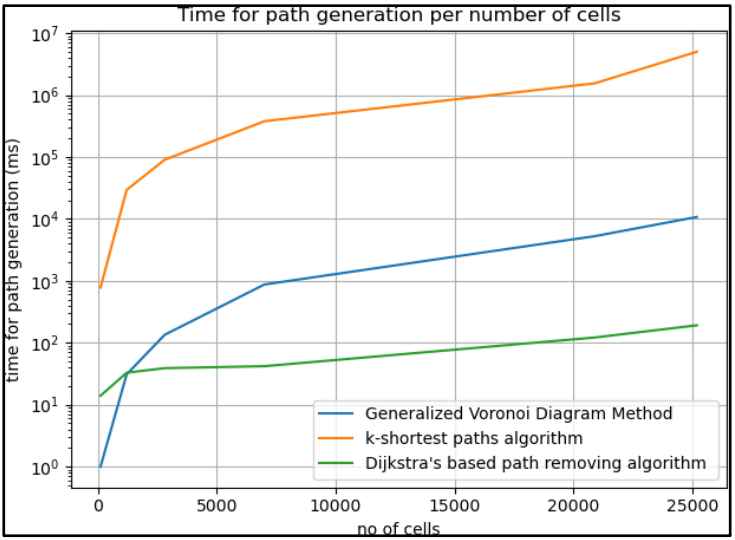

Figure 30: Variation of time taken for three approaches

Table 4: Qualitative comparison between approaches

Generalized Voronoi Diagram Method	**k-shortest paths algorithm**	**Dijkstra's based path removing algorithm**
Only GO, NO-GO terrain is used	Trafficability grid is used with all features	Trafficability grid is used with all features
Paths does not depend on cost of traveling	Paths depend on cost of traveling	Paths depend on cost of traveling
Different possible paths are resulted, but some mismatch is with paths	paths are not spread, mostly same path with small differences is resulted	Much spread can be seen in paths, actually different possible paths are resulted
Time taken for algorithm is low (not the lowest)	Heavy time consumption	Very low time taken (it is the lowest out of three approaches)

Comparison with Available Systems

Google map directions.

Basically, the platform normally used to find paths to travel from one place to another place is Google Map directions. Fig. 31 shows the comparison of the avenues of approaches generated between two positions separated by a river and the Google direction result for those two positions.

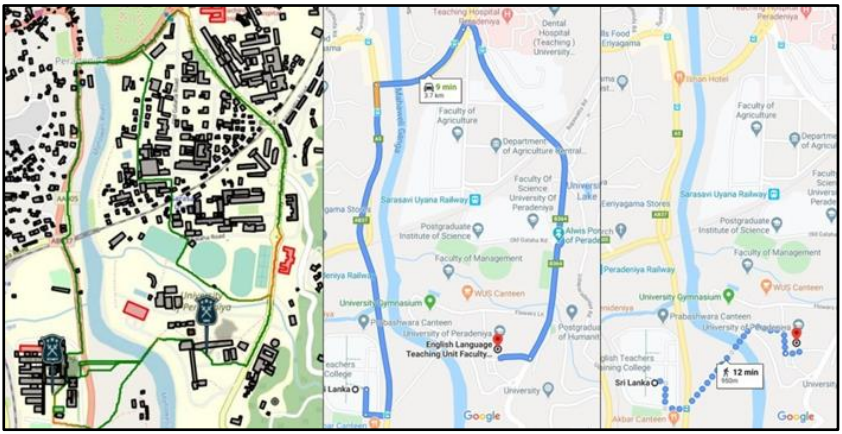

Figure 31: Comparison with Google direction, Our System generated paths (LEFT) Google Directions for vehicles (MIDDLE) and Google directions for walking (RIGHT)

Basically, direction API considers only available routes to generate the paths. Sometimes they give multiple paths possible but not too much deep level. So, it doesn't consider the terrain features or any additional information we give on terrain in generation paths. Also, it does not suggest paths to maneuver through non road areas. So, in case of avenues of approaches our implementation is much successful towards obtaining avenues of approaches for troop maneuver.

Comparison with result from related works.

In Grindle et al., "Automating Terrain Analysis: Algorithms for Intelligence Preparation of the Battlefield" the researchers have developed algorithms to generate avenues of approaches for a small map using a trafficability

array and generalized voronoi diagram. Also, they have evaluated the avenues of approaches of that map by a subject matter expert (SME). So, we recreated the map they have used in the research drawing similar terrain data. Then obtained avenues of approaches for the two locations they have used and then compared it with the result generated by their system and manual result by SME. Fig. 32 shows the avenues of approaches for that map given by algorithms used by the researchers and the SME.

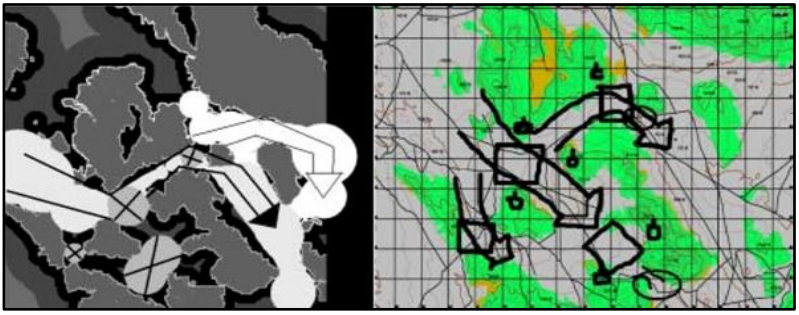

Figure 32: Avenues of approaches by researcher's algorithms (LEFT) and subject matter expert (RIGHT), (C. Grindle, M. Lewis, R. Glinton, J. Giampapa, and K. Owens 2004, Fig. 5 and 6, p. 4)

Then Fig. 33 shows the our IPB tool generated avenues of approaches for the same map created by us on our tool.

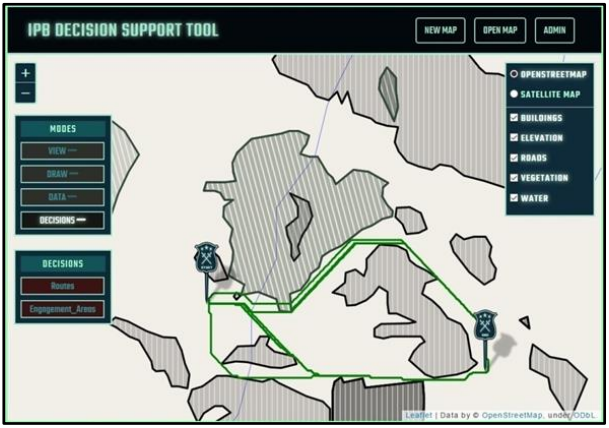

Figure 33: Avenues of approaches by our IPB tool

So, the avenues of approaches generated by our tool seems much similar to the avenues drawn by subject matter experts in the given research. There is basic three avenues suggested by the SME, as well as our system. In the referenced research's output, only two avenues are suggested. Also, our result contains a risk estimation value for the avenues as well if enemy locations were annotated. Also, the algorithm used by the referenced research is based on a voronoi diagram method. So that approach is giving a complex scenario when comes to larger maps, as well as much time as concluded in Fig. 30. So, for larger maps with more details like buildings, water bodies the voronoi diagram become complex and give very high number of paths. So, removing unwanted paths is difficult. So, for each larger and smaller maps with any amount of features the approach taken by our algorithms is good.

5. Conclusions and Recommendations

Building a tool for battlefield area evaluation, storing and visualizing information, and supporting decision making for troop maneuver planning is the primary objective of this project. In the IPB process the objective is to build the combined obstacle overlay to use for troop locating and maneuver planning. Avenues of approach, Engagement areas, Defensible terrain are some final high-level information obtained through the combined obstacle overlay. In this research we could develop algorithms and the tool to generate and display avenues of approach successfully.

We looked at the low-level environmental factors such as ground, and environment data. We developed a database of predefined terrain features data like building, elevation, vegetation, water and roads for any location. In this project we included data for only Sri Lanka. So, any default terrain data for a battlefield are automatically obtained by the tool. Then we build a mechanism to display in on the map as overlays. Also implemented method to put user defined features to overlays. We could develop a backend to store, edit and give the battlefield data separately. Using a REST API, we connected the backend with frontend IPB tool to enable operations on overlays.

We obtained trafficability grid using a grid-based model for processing overlay data. In the decision support development part, we explored three

different approaches to use trafficability grid to generate avenues of approach, which was a main requirement in IPB process. Finally, we compared and further developed the best and more practical approach from those three. We finally developed the algorithms for the avenues of approach generation. Then we developed algorithms to find threat level for paths due to enemy. Finally, we compared our output avenues with available paths generating platforms like Google maps and the avenues suggested by subject matter experts in related researches.

As planned in milestones we implemented only avenues of approaches finding using trafficability grid. So, there are few other high-level terrain information such as key terrain, defensible terrain and engagement areas. So as a future work those goals must be accomplished. Also, there are few other terrain information that need to be fused with terrain data like weather and soil type. So we couldn't combine those data due to lack of those data. If those data also got fused, then we could obtain more accurate results. So that needs to be done as a future target. Also when considering the threat from enemy we developed the algorithm to change the enemy range of threat according to elevation, vegetation, surrounding buildings and height of enemy building. So in future works, enemy must be more customized like several types of enemy like snipers, normal ones, scouts so on. Then that type also will effect the enemy range. Currently, we are obtaining the threat from enemy to the avenues. So in future version when there is a considerable high threat from an enemy location to a path, that path should be minimized to avoid that threat making a new path.

Project Resources

- Project web page is available at: https://cepdnaclk.github.io/e14-4yp-ipb/
- A video description is available at the Youtube: https://www.youtube.com/watch?v=6brEHjMxTvk
- Source code of the project is available at the Git repository: https://github.com/cepdnaclk/e14-4yp-ipb

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THE LANDMINES-RESULTED ENVIRONMENTAL CONSEQUENCES: A REVIEW BASED ON POST-WAR SCENARIO, SRI LANKA

K. Nijamir

Abstract

End of the war is not meant to be a real end of damages, dangers and hazards since the presence of landmines and other unexploded ordnance in war-torn regions pose major threats to the human and non-human environment. Landmines cause physical, psychological and socio-economic impacts to the human and on the other hand, they have environmental ramifications which need to be identified properly. Whenever wild animals come into contact with landmines, they tend to explode and, result in loss of biodiversity. Likewise, the chemical contents in the landmines can mix with soil and water resources which have the potential to cause long-term complications to the environment. Therefore, the objective of this paper is to survey the environmental concerns of landmines and their fragments in the postwar period with the systematic literature review process and envisage the experiences from other countries with the view to alert and awaken the stakeholders concerning the landmines-resulted environmental conservation in post-war Sri Lanka.

Key words: ***hazard, landmines, environment, biodiversity, soil, post-war***

1. Introduction

Globally in 1992 alone, around 26,000 people were victimized due to the landmines and other ordnance's explosion (Surrency et al. 2007, 197-201). It is estimated that in 70 countries, approximately 60 to 70 million landmines are buried and so these victimize around 24,000 civilians every year according to Bilukha et al. (2003). Further, the Landmine Monitor (2019) points out that approximately 80 - 120 million landmines have been planted in 90 countries, of which 26 are in African continent. Each year, landmines kill or maim more than 15,000 people and most of them are innocent civilians and children (Strada 1996).

Landmines are normally considered as the small explosive devices which are buried purposefully to cause fatalities, dismemberment of body parts, cripple human and cause damage to vehicles and animals (Kasban et al. 2009; Bello 2013; Cardona et al. 2014) and yet, landmines pose several threats to the economy of the nations in multifaceted ways (Bilukha et al. 2003). During war period, landmines are laid to restrict the movement of the enemy troops and at the end of the war or ceasefire, during the resettlement process in war-torn areas, the people are accidentally victimized by the landmines which result in disabilities and loss of lives (Hemapala 2006).

The landmines are not exceptional to Sri Lanka and the presence of landmines even after the post-war period is a major challenge where the people are unable to move freely or resettle in their native habitats. According to The National Strategy for Mine Action in Sri Lanka (2010), the landmines were placed by the Sri Lankan security forces and the Liberation Tigers of Tamil Elam (LTTE) during the wartime. Further, it is reported that the Indian peacekeeping forces also had set landmines during their presence in Sri Lanka from 1987 to 1990.

Moreover, the prevailed civil war in Sri Lanka disrupted the physical, mental and socio-economic condition of the people and their routine life as a whole. It can be highlighted that the landmines have caused psychosocial effects to the people in north and east where they live in panic and vigilance thinking that they might be trapped to landmines (Gunaratnam et al. 2003). In fact, placing landmines is an easy task and takes few minutes during the war or pre-war period; however demining process requires long term period with labor and economic costs.

Demining activities are common during the post-war period in view of resettling the people and for the reconstruction of damaged or destroyed infrastructure. Several organizations such as Humanitarian Demining Unit of Sri Lankan Army, The Halo Trust, Foundation Suisse de deminage, Danish Demining group, Sarvatra, and Delvon Assistance for social harmony and many others engaged in humanitarian demining activities in the post-war period of Sri Lanka (Abhayagunawardena 2011).

It is a tragic fact that 22,193 people have died by landmines and other explosives since 1980s in Sri Lanka (The Diplomat 2020) As of 2019, the remaining areas to be freed from landmines were estimated as 23.3 Km2. Since the end of the war in 2009, 35 million square meters of land was declared as safe zone in Sri Lanka in which more than 42,000 landmines were removed (The Diplomat 2020). Still, the demining process is underway which would take time to accomplish.

It is important to trace the environmental concerns detonations and chemical contents since numerous environmental consequences have been reported due to the landmines and their remnants during the post war period in several countries. Leaching the toxic chemicals and heavy metals released from the landmines through the soil and retaining in water bodies are major threats to the environment, biodiversity and finally to human beings when they consume such waters for a long period of time. Even after the resettlement process in Sri Lanka, the environment should be kept clean and the chemical concentration need to be traced with the view to minimize the long-term health issues of the people and other organisms.

2. Objective

To find the environmental ramifications due to landmines from various experiences and to suggest ideas to minimize the environmental issues of landmines in post-war Sri Lanka.

3. Methodology/Analysis

The paper targets to survey the landmines-resulted environmental issues from various experiences from global context to Sri Lankan potentiality. The landmines into the land is a major hazard where people day by day live with fear and threats in the nearby of minefields. It is a hazard whenever anyone accidentally interacts with landmine, since it has the potential to affect the parts of the body or lives. In this circumstance, systematic literature review was processed with several published research papers and other sources in order to find the environmental consequences due to the landmines and to identify in what ways the landmines posed threats to the environment in the world. It is believed that the review would give an in-depth awareness to the need of landmine clearance highlighting the

essential environmental conservation since the landmine clearance and resettlement process are underway in Sri Lanka.

4. Literature review

Albeit, the end of war in any country results in landmines it results in landmines to particular battlefield in which they cause fearful hazard to the community and the surrounding environment. It is evident that the Mozambique became independent after around 12 years of war, consequently, wartime and the prevailed drought in 1991 severely affected the economy, health, and education system. Even after the election in 1994 following the peace accord, development and rehabilitation were hampered because of the landmines. It is also evident that from 1980 to 1993, landmines victimized around 7,000 people in Mozambique (Ascherio et al. 1995).

Further, the two decades war in Afghanistan resulted in an abundance of landmines and 571 people were affected by landmines and other ordnance in Kabul city in the period from 1996 to 1998, (Surrency et al. 2007) is another case to be highlighted. Similarly, landmines and other ordnance have affected around 720 million Km2 in southern Tripoli district in Libya which affected many people leading to migration since 2019 according to Reliefweb (2022).

Besides the deaths, socio-economic loss and the psychological impacts, landmine poses major risks and complications to the environment. It is can be noted that many countries particularly, Yemen, Afghanistan, Chad, Angola, Ethiopia, Iraq, Zimbabwe, Sudan, Somalia, Niger, and Congo, are highly vulnerable to the landmines' detonations because of the dependency on agriculture and livestock rearing for subsistence (Njeri 2020). Many researchers have revealed that the landmines' vulnerability to the environment is serious and need deep concern on it. From the environmental perspective, the landmines cause threats to the surrounding plants, the wildlife crossing over, and the soil through which the contents of landmines leach, as well as the water resources connect with the chemicals.

Moreover, Traboulsi and Alaib (2021) have studied on phytotoxic effects of soil contaminated with explosive residues of landmines. Accordingly, the non-biodegradable chemicals into the landmines such as trinitrotoluene (TNT) and Royal Demolition eXplosive (RDX) constitute copper, zinc, nickel, cadmium, chromium, iron, lead mercury, manganese and uranium which can severely pollute the soil. Also, whenever, any landmine explodes or damages, toxic pollutants released from the landmines, mingle with soil whereby the plants growth is also affected due to the chemical concentration into the plants' roots. They also have proved that the phytotoxic heavy metals were abundant in the closed approximation of the exploded areas than the areas far from the explosion. This finding has highlighted that the landmines have the potential to cause health complications to the plants and weaken the plants' development in the vegetative environment.

Also, the hazardous heavy metals pose serious threats to the environment and human being because of their toxic features (Parameswari et al. 2014) and they affect the microbial communities present in the soil (Xie et al. 2016). The wild animals are directly vulnerable to the landmines (Kopke 2021) and according to Jha (2013) the landmines severely affect biodiversity and poses threats to several endemic and endangered species. Barking Bears, Leopard species, Tigers which are considered as the rare species, were killed by landmines' detonation in India. In the context of Bosnia and Croatia, brown Bears are the common victims of landmines. Also, the World War II has resulted in myriad landmines in Libya by which the Gazelles were affected and consequently disappeared. Silver beaked Gorilla in Rwanda and the Tigers in Cambodia were fatal to death by landmines' explosion. Also, in Zimbabwe, Mozambique and South Africa, the landmines in the field over a long period of time threaten the endangered wildlife such as Lion, Elephant, and wild Dogs (Reliefweb 2020).

Hemapala (2006) has studied regarding the consequence of landmines in Sri Lanka. He has mentioned the landmines' clearance processes such as manual clearance, dog-aided clearance and mechanical clearance with the cost estimation for landmine clearance process. However, the paper did not focus on the environmental impacts of landmines. According to Gunaratnam et al. (2003), it has been observed that the landmines have

caused psychosocial issues to the community. Landmines-detonated injuries have caused post-traumatic stress disorder which has been statistically proved. People have also been affected by depression, psychiatric disorder, alcohol dependence, functional disability and so on. Nonetheless, their study has focused only on psychosocial issues.

Gunawardena et al. (2016) have reviewed on humanitarian demining and sustainable land management in post-conflict setting in Sri Lanka. Accordingly, the paper has partially mentioned the landmines threats to the biodiversity, and the vegetation cover. It also highlights the damages to the soil and its stability by landmines' detonation. When the landmines detonate, it has the potential to cause soil structure destabilization which can induce soil erosion. It can be suggested that deep researches should be conducted concerning the environmental repercussions of landmines since the related literatures are lacking in Sri Lankan context where we are heading towards the final stage of landmines' clearance process.

5. Discussion

The paper has found many experiences and evidences from various countries and situations explored through a systematic literature review process. It has been identified that the landmines have the potential to seriously harm the environment in multifaceted ways. In Sri Lankan context too, there are possibilities to the environmental complications and many of which have been discussed due to the presence of widespread landmines in north and east.

Furthermore, the antipersonnel landmines cause injuries and deaths by which the enemy troops are weakened and intimidated or diverted hindering to reach their targets. Even after the war, some of the planted landmines remain active which tend to pose many environmental ramifications. Moreover, the landmine explosion cause soil instability, loss of biodiversity and environmental pollution (Berhe 2007; Gunawardena et al. 2016).

In the postwar period, the humanitarian demining process is in progress under the patronage of respective agencies from national or international communities. During the demining process, proper management is needed

since the imminent explosive landmines contain a large number of adverse materials which can severely harm the environment (Conflict and Environmental Observatory 2020). In the east and north of Sri Lanka, civil war resulted in innumerable landmines in the wilderness which adversely affected the wildlife roaming for food and other activities. Many instances have occurred in such regions where the wildlife particularly, animals cross their range through the landmines-planted zones. Mostly, when the elephants cross through a corridor, they face lethal incidents by landmines where many elephants have so far died and lost their limbs.

It has been reported that during the wartime too, several elephants had died and got injured which resulted in loss of limbs (New Scientist 1994). After the end of the warfare, the tragic incidents of elephants because of the landmines' detonation have been documented with several cases. It can be explained with evidence that according to Sunday Times (2011), several elephants fatally succumbed to death when they were accidentally interacting with landmines during their ranging. When the landmines detonate, their sole and feet are injured for which they attempt to heal themselves by dipping their injured limbs into the mud and in turn, it again causes fresh wounds. Then, due to the consequent blood poisoning, elephants finally fatal to death.

Further, the landmines cause impacts to the vegetation in another way. In the forested areas, the landmines removal process and the detonation impact the surrounding vegetation. Demining process has also altered and fragmented the native habitats of many species (Jamhoor 2020). Rabbits, Rats, and other reptiles normally living in bushes are highly vulnerable during the landmine's removal process.

Systematic approaches are needed to conserve the environment of landmine zones where several hazards and threats are rife because of the landmines and their remnants. The chemicals from the landmines can be mixed with the runoff during the rainy seasons and transported to nearby waterbodies. Therefore, there are possibilities for water contamination in the particular zones. Also, according to Jamhoor (2020), the explosive weapons and their compositions can harm the natural resources such as soil and ground water with the ingredients of the RDX, TNT and other active materials. The landmines' presence in the agricultural lands is a

major challenge to engage in agricultural activities and the farmers accidentally have to face injuries or deaths due to the detonation (Jamhoor 2020). Further, the pasture land of the cattle and livestock are also under threat whenever the livestock interact with the landmines, since it causes loss of limbs or death incidents.

The heavy metals released from the landmines are very dangerous which can degrade the soil and pollute the water resources in the landmine zone in Sri Lanka. Over the years, it can cause health implications to the human, plants and animals. The chemicals released from the landmines should be traced in the mine fields even after the completion of the demining process where the people have to interact with the land for various needs. The chemical concentration in water resources can also pose threats to the wildlife and livestock in another way when they consume the water from the water bodies contaminated by landmines-released chemicals.

6. Conclusion

Post-war landmines have caused issues not only to human beings but also poses threats to non-human aspects such as the water, soil and wildlife resources in the particular environ. In Sri Lanka, the civil unrest which lasted for around three decades has resulted in countless landmines being added to the productive lands, considered as a fundamental natural resource where agriculture, water resources, and other human, and animals interact directly. Though the humanitarian landmine clearance process is underway, there are possibilities for environmental threats by landmines in several ways. This review thus has found that landmines have caused several environmental ramifications in many parts of the world are possible dangers in the Sri Lankan context since the presence of landmines. The review has also found that several countries have been facing environmental challenges and issues by landmines' detonations and chemical contents which need to be considered in Sri Lanka to ensure and maintain the environmental security and sustainability.

7. Recommendations

It is hard to restraint the threats of accidental landmines' detonation in the landmine hazard zones to the wildlife, since they are roaming through

hard-to-reach areas. But, if the areas are declared as the landmine field, off-limits should be established to control the wildlife movement and intrusion into the particular area.

Also, it is vital to test the soil having selected samples to detect the chemical concentration of explosive materials and other remnant to conserve the soil resource.

Further, the groundwater and surface water resources should be tested from time to time with the view to find the chemical concentration to curtail the health issues to human and wildlife. To do so, small ditches around the landmine-released land can be dug and during the rainy season, runoff would be stagnant in such ditches. Then, the samples can be collected and undergone for chemical testing whether to find the landmines-led chemical concentration particularly the heavy metals.

Awareness programs and grassroots level education in connection with the landmines to the public are pivotal since they are more common to interact with the landmines in their environment. During the rainy season, extracting water from open waterbodies should be avoided in the landmines-freed zone.

Reforest the landmine released lands as much as possible in order to reduce the chemical impacts to the land and to shelter the animals and birds to maintain the biodiversity.

Avoid digging shallow wells immediately after the resettlement in the minefield to prevent the heavy metals' concentration in the well water. And, frequently test the well water after the construction.

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INSS
DEFENCE
Review

CLASS OF SOFT POWER IN SRI LANKA: CHINA VS INDIA'S VIEW OF A BUDDHIST FOREIGN POLICY

Punsara Amarasinghe

Abstract

The notion of soft power plays an important role in the current realm of international relations. In such a context, the usage of Buddhism as an ideological impetus in a dominant Theravada Buddhist country like Sri Lanka is a crucial element for any foreign power-seeking opportunities. Given the vastness of its influences, China seems to have aptly used "Buddhism" as a soft power strategy in the island nation. This paper seeks to examine how China has grasped the importance of utilizing Buddhism to reach its strategic goals in Sri Lanka. The objective of this paper is rooted in China's geopolitical shift towards South Asia and its specific interest in Sri Lanka under Belt and Road Initiative. The cardinal argument stemming from this paper proves how China has used a long-standing civilizational relationship with Sri Lanka based on Buddhism for their geo-political goals. This paper further discusses its impacts upon India's strong cultural link with Sri Lanka, which is also strongly based on Buddhism. This paper has taken a doctrinal approach to develop the main arguments. In conclusion, the recommendations emerging from this scholarly work would suggest that there should be a proper study in understanding how China is attempting to project Buddhism in its presence in Sri Lanka as a soft power tool.

Key Words: ***Buddhism, China, India, Soft Power***

1. Introduction

The notion of power in global history has been mainly viewed through realist lenses showing how states used coercion, deterrence and invasion to manifest their superior status. Machiavelli emphasizes that men are by nature prone to violence and combat; they are inherently antisocial. [1] This

[1] *Nicholai Machiavelli, "The Prince", Tran. George Bull (London: Penguin University Press,2003), p.11.*

parochial reading on the idea of power changed at the end of the Cold war era, especially with Joseph Nye's conceptual creation of "Soft Power". According to Nye, soft power is the ability to get what you want through attraction rather than coercion or payments. [2] Since Nye's coinage, the idea of Soft Power has received the attention of International Affairs scholars as a tool that palpably shows how state interests oscillate.

Both China and India have developed a proclivity towards soft power as a core feature in their international affairs. [3] From a vantage point, both countries possess a legacy that aggrandizes idiosyncratic values as two old civilizations on earth. Indeed, it can be an interesting study to observe how China has been striving to increase its soft power diplomacy in Sri Lanka, where Beijing has invested heavily as a crucial destination in their most ambitious global governance project "Belt & Road Initiative". This paper seeks to examine China's soft power strategy in Sri Lanka by utilizing the historically rooted links to the island nation and how it would assist in forming a favourable stance towards China in Sri Lanka. Moreover, this paper will investigate the concept of Buddhist diplomacy as China's most astute mechanism in Sri Lanka with the island nation's national identity with Buddhism. The usage of Buddhism as a soft power tool in Sri Lanka is akin to Beijing's grand plan initiated by President Xi Jinping in 2011 at the 17th Central Committee of the Chinese Communist Party, which was mainly devoted to the issue of culture. In 2014, a year after China embarked on Belt and Road Initiative, President Xi announced "We should increase China's soft power, give a good Chinese narrative and better communicate Chinese message to the world". [4] Notwithstanding the Communist party's anathema to religion driven by Marxian stances, Xi Jinping views religions as parental values which would bolster the realization of "Chinese Dream". As a pragmatist, he has pointed out that China's historical role as a civilization was not entirely attributed to military power or conquests, but rather on profound appeals that resonated with China's rich culture. In particular, President Xi seems to have taken Buddhism as a more

[2] Joseph Nye, "SoftPower: The Means to Success in World Politics", (NewYork: Public Affairs, 2005).

[3] David M Malone,"Soft Power in Indian Foreign Policy", Economic Political Weekly, Vol.46, No.35(2011).

[4] David Shambaugh, "China's Soft Power Push: The Search for Respect", Foreign Affairs, Vol.94, No.4 (2015).

convenient tool to express the Chinese message, with its intrinsic connectivity echoes from China's past, to the modern world. The ancient Silk Route, the former avatar of modern BRI, was mainly a road of different religious and cultural beliefs where Buddhism thrived in the heyday of Tang dynasty in China.

In the backdrop of Xi's "Chinese Dream" or the rejuvenation of China, the projection of Buddhism became a crucial soft power mechanism. In 2015, parallel to Beijing's interest in building its soft power globally, the Buddhist Association of China (BAC) acknowledged the relevance of promoting Buddhism as a key activity. [5] BAC encouraged Chinese Buddhist monks to go out of China to share China's unique Buddhist legacy with the world. Objective of restoring Chinese Buddhism was an embodiment of three elements, "soft power" (ruanshili), "public diplomacy" (gongyi Waijiao), "person to person diplomacy" (renjianwaijiao) and this triangle was intended to be linked to BRI.

2. Purpose and Research Question

The geographical proximity of Sri Lanka and India so as to lose its insular character and the indomitable Buddhist inheritance that Sri Lanka received from India during the period of emperor Asoka, have always played as the two indispensable factors that carved Sri Lanka's relations with India throughout the history. In the closing years of the British raj in India, the policymakers in Delhi knew the strategic importance of Sri Lanka to the Indian Ocean governance, since they were well aware of the island's imbued destiny with the Indic civilization. Post independent India's strategist K.M Panikkar was fascinated with the idea of forming the centrality of India in Indian Ocean as "Mare Nestrum" and he was one of the first few Indian strategists who predicted a possible Chinese intention on embarking on a large-scale naval expansion, because Panikkar believed in China's historical role in Indian ocean through the ancient maritime Silk Road. [6]

[5] *Ibid., 12.*

[6] *T.S Bannerjee, An Examiniation of EK Pannikar's Theory of Western Unity against Asia, "Proceedings of the Indian History Congress", Vol.30, (1968).*

In order to understand Beijing's Buddhist diplomacy in Sri Lanka, one has to realize that China's affinity with the island nation based on Buddhism dates back to 5th century A.D. Chinese scholar monk Fa Xian visited Sri Lanka during the reign of king Dhatusena in Anuradhapura kingdom in search of Vinaya texts of Theravada Buddhism. But, he witnessed the great schism between Mahavihara which represented the Theravada tradition and Abayagiriya which was the leading centre of Mahayana learning in Anuradhapura kingdom in the 5th century Sri Lanka. Fa Xian stayed two years at Abayagiriya in Sri Lanka and he copied some important Mahayana texts such as "Dirgagama", Samyuktagama and Sannipata, all of which were new to China. [7] Also, it's an interesting fact to observe that all the Chinese scholar monks Fa Xian,Hiuen-Tsang and then I-ching in the 6th century A.D had mentioned the veneration of Buddha's Tooth Relic and how the monks in Abayagiriya acted as its custodians. Memoirs from these Chinese monks who visited Sri Lanka in the 5th and 6th century A. D's denote the Mahayana tradition of Buddhism that prevailed in the island. Another important aspect stemming from the history of Chinese traveller monks to Sri Lanka is that their visits coincided with the Chinese commercial activities in the island. The spiritual purpose of Buddhism drew parallel to the mundane matters like trade and Sri Lanka's crucial position in the maritime silk route in the past intensified Chinese interest in the island. At the end of his stay in Anuradhapura, Chinese monk Fa Xian returned to China in a large merchant vessel. After Fa Xian, Xuan Zang was the next important Chinese monk who had left some important description on Sri Lanka in his memoirs after spending fourteen years in India studying various schools in Buddhism. Despite the vivid description that Fa Xian compiled on Sri Lanka, he was not able to visit the island due to the political instability that prevailed in the Kingdom of Anuradhapura in the 7th century A.D. Xuan Zang's elucidation on Sri Lanka provides a vast array of information regarding the genesis of Sinhalese nation and the expansion of Buddhism in the island. By all means it is not an easy task to provide a description on a place without visiting it, yet Xuan Zang clung to the challenge of studying about Sri Lanka and its Theravada practice of Buddhism while residing in Kanchipuram in South India. To this day, the description compiled by Xuan

[7] *L. Lahiri, Ceylon and China: The Account of Ceylon in the dynastic history of the Tang period, "Proceedings of the Indian History Congress", Vol.35, (1974), pp. 388-391.*

Zang has been regarded as one of the comprehensive and acute historical sources studying the political and religious history of Sri Lanka. [8]

In addition to the predilection shown by both fa Xian and Xuan Zang regarding Buddhism in Sri Lanka, fa Xian and Xuan Zang they had a genuine enthusiasm on the socio-political structure in Sri Lanka. It should be underlined without any ambiguity that the writings of both monks continued to aspire Chinese understanding of Sri Lanka from antiquity to present day. In his visit to Sri Lanka in 2014, Chinese president Xi Jinn Ping pointed out how Buddhism played as indispensable role in strengthening the historical affinity between China and Sri Lanka, which was created by Chinese traveller monk Fa Xian.

The sacred Tooth Relic of Buddha was the paramount element for the relations between Sri Lanka and China in the medieval past. Both counties revered Buddha's Tooth Relic, where as it was considered a symbol of statehood in Sri Lanka. The Chinese interest in the sacred Tooth Relic can be traced to the Yuan dynasty as its Mongol founding emperor showed ardour in acquiring the Tooth Relic for the cause of Chinese unification. In year 1282 Kublai Khan commissioned Venetian traveller Marco Polo to begin his voyage to Sri Lanka and the main intention of this voyage was to obtain the tooth relic. [9]In his memoir, Polo recalls that Khan asked the Tooth Relic in return for the value of a city, but the then king of Sri Lanka stated that he would not sell it for all the treasure of the universe. Polo states how Chinese emperor was confounded by this answer, yet he admitted the verdict. Two hundred later, during the heyday of Ming dynasty Sri Lanka was visited by Admiral Cheng Ho as a part of his famous seven voyages. His first visit to Sri Lanka was pacific as he arrived in the island with "perfumes and flowers" symbolizing typical Confucian diplomacy. According to Chinese source Pien-i-tien, Cheng Ho persuaded the ruler of Kotte kingdom Alakeshvara to give up his heretical practice and follow the path of Buddha. Nevertheless, the ulterior motive of the first visit of Admiral Cheng Ho was deeply rooted in the firm ambition of obtaining the Tooth Relic. Another Chinese source named His-Yu-chi Fu-chi indicates that Cheng Ho requested the Sacred Tooth Relic of Buddha from

[8] . *Ibid*

[9] *Jackson, Marco Polo and his travels, Bulletin of the School of Oriental and African Studies, University of London, Vol.61, No.1, (1998).*

Alakeshvara and he resented that suggestion firmly. Furthermore, Chinese sources have lampooned the ruler of the Kotte kingdom in Sri Lanka "Alakseshvara" as a barbaric tyrant who showed no sense of civility to the Chinese. [10] From the Chinese perspective, this was a blatant act against Ming supremacy with its imperial projection as the middle kingdom. But, on the other hand, Alakshevara's denial of handing over the tooth relic was a justiciable act due to its both religious and political significance to the Kotte kingdom. Any attempt to take it away was seen as an act to usurp the political sovereignty of the ruler. In his third expedition around 1409 A.D Admiral Cheng Ho touched the Galle harbour where he displayed exotic Chinese goods to the natives. Moreover, this expedition was a monumental one that embodied China's strategic Buddhist diplomacy and the Ming dynasty's imperial ambition of spreading its hegemony across the oceans. Following the tradition of setting up the commemorative tablets, Admiral Cheng Ho erected a trilingual inscription in Galle, which highlighted the pomp and benevolence of the Ming emperor. Moreover, the Chinese version of the inscription has made an offering to Buddha. [11]

It should be noted, Chen Ho's visits to Sri Lanka was not seen by the local ruler in the Kotte kingdom from a friendly perspective. Cheng Ho's previous efforts to obtain the Tooth Relic, the vastness of his fleet and the way he installed an inscription bearing the name of Ming emperor would have agitated Alakshevara. Indeed, the objective of Cheng Ho was akin to a pure imperial mission to gain the allegiance of the Kotte kingdom to the Ming emperor. [12] Nevertheless, it is important to understand that the diplomacy that Cheng Ho adhered was not a hostile one and his methods were driven by Confucian-Buddhist ethics. This act was completely different from the Europeans who followed the Chinese to the Indian ocean a century later. Both Europeans and Chinese essentially focused on commercial success. The Chinese clung to more pacific methods such as influencing the locals and offering gifts to the people. Most importantly, the

[10] Bruce A Elleman, The Making of the Modern Chinese Navy: Special Historical Characteristics, (Chicago: Anthem Press), (2019).

[11] Lorna Devaraja, Cheng Ho's Visits to Sri Lanka and the Galle Trilingual Inscription in the National Museum in Colombo, Journal of the Royal Asiatic Society of Sri Lanka, Vol.52, (2006), pp.59-74.

[12] Prasad Fonseka, The Ancient city of Kotte and its Fortification, Journal of Royal Asiatic Society of Sri Lanka, Vol56, (2010), p.56.

projection of Buddhism played a pivotal role in Chinese diplomacy during the Ming dynasty. Compared with the behaviour of the Portuguese, the first European nation who ventured into the Indian Ocean whose trade policies were equated with plunder. [13] China's attitude to the "use of force" arose from the notion of self-defence and necessity. In the case of Sri Lanka, Admiral Cheng Ho did not forget the outrage of Alakshevara in his previous visit. Under the imperial order of the Ming emperor, Cheng Ho subdued the ruler of the Kotte kingdom Alakshevara in 1409 A.D after six battles which resulted in the capture of Alakshevara, and royal family as prisoners. The Chinese sources have affirmed that Royal prisoners from Sri Lanka were pardoned by the Ming emperor and treated honourably. It is said that the Chinese emperor advised the captives from Sri Lanka to choose a virtuous person as their ruler according to Buddha's teachings. [14]

Overall, the historical encounters that China had with Sri Lanka was primarily shaped by Buddhism as the common thread. More generally, alongside the analysis above on China's historical role in Sri Lanka, the current geopolitical strategies that Beijing determines to implement denote the power of Buddhism as a civilizational factor.

3. Analysis

The fans of Dan Brown indeed adore the protagonist Prof. Robert Langdon and his imaginary subject called "religious symbology", which does not exist in reality at Harvard or any other university. But Brown's fans might be really curious, if they fathom the usage of Buddhist symbols behind Chinese investment projects in Sri Lanka. In modern soft power diplomacy ideas and practices of the glorification of nations have been frequently presented by their intrinsic ways such as food, sports and the projection of cultural practices. Given such a wide array of soft power strategic manures, Chine seems to have embraced a unique way of blending Theravada Buddhist culture with Mahayana tradition as a soft power innovation propelled by its civilizational saga with Sri Lanka.

[13] Lorna Devaraja, Cheng Ho's Visits to Sri Lanka and the Galle Trilingual Inscription in the National Museum in Colombo, Journal of the Royal Asiatic Society of Sri Lanka, Vol.52, (2006), pp.59-74

[14] GV Somarathne, 1969, "Political History of Kotte Kingdom", PhD thesis, University of London, SOAS.

The Architectural depiction of the Chinese invested skyscraper "Lotus Tower" in Colombo, Sri Lanka, unfolds the gravity of Buddhist symbology that Beijing has reckoned on as a crucial element in its strategic interests in Sri Lanka. The choice of Lotus as an idiosyncratic feature of the tallest skyscraper in Colombo, that has been built as Chinese investment is a palpable embodiment of China's novel strategy of blending its historic Mahayana Buddhist values under Sri Lanka's Theravada Buddhist doctrine. From a vantage point, Lotus is an intrinsic icon for both Theravada and Mahayana Buddhists. Lotus is often used as a metaphor in Theravada tradition to describe the extraordinary life of Buddha. [15] As how lotus blossoms in the depth of the impure mud while remaining pure, Buddha's character was narrated in Theravada Buddhist tradition as a sage who lived in a mundane society with no attachment. In Mahayana Buddhism, there is a Buddhist discourse named "Lotus sutra", which is considered one of the most influential Mahayana sutras and it was translated into Chinese during the era of the Western Jin dynasty by monk Dharmaraksa, one of the prominent Chinese Buddhist monks in the 2nd century A.D. [16] Having known Sri Lanka's Theravada Buddhist legacy rooted in the island's every socio-political corner, China utilized a mutually significant symbol in its soft power projection in Colombo. Apart from, "Lotus Tower", Nelum Pokuna Mahinada Rajapaksa theatre in Colombo Sri Lanka is another iconic edifice built under Chinese donation where the significance of "Lotus" remains visible. The image of Lotus as the overarching architectural design of NelumPokuna Mahinda Rajapaksa theatre has brought to the fore a powerful historical representation of "Nelum Pokuna" a pond built by Sri Lankan monarch Parakramabahu the Great during the 12th century in Polonnaruwa kingdom. But beneath this embodiment, China's Mahayana Buddhist relevance of Lotus "莲花" stands firm displaying Beijing's successful attempt to harmonize Chinese Buddhist presence with Sri Lanka's historic roots.

[15] Patrick Mendis, China's Buddhist Diplomacy: Why do America and India entangle with tiny Sri Lanka? Columbia University, Journal of International Affairs, 2013.2.22, https://jia.sipa.columbia.edu/online-articles/china%E2%80%99s-buddhist-diplomacy-why-do-america-and-india-entangle-tiny-sri-lanka (Accessed date : 2021.05.16.)

[16] Whalen Lai, "Why the Lotus Sutra? On the historical significance of Tendai", Japanese Journal of Religious Studies, Vol.14, No.2, 1987.

While the world still remains culturally "Americna" based on American ideals from food to architecture, China's attempt to uplift its soft power strategies still stands in the infancy stage. Nevertheless, it is important to recognize that China's enthusiasm to project their civilizational legacy through BRI distinguishes Chinese way of soft power diplomacy from the Americans.

By now the "Colombo Port City" project has become a news making topic with its unique nature and it is by all means the biggest infrastructure undertaking in Sri Lanka's history with $1.4 Billion by state owned Chinese engineering firm China Communication Construction Company (CCC). Built on 665 acres (2.6 sq km) of land being reclaimed from the Indian Ocean, the city is designed to be a smaller Singapore, with its own business-friendly tax regime and regulations and possibly a different legal system to the rest of Sri Lanka. Artistic impressions of the future Port City show a brightly lit cityscape comparable to Dubai or London's Canary Wharf.

Developers say 1.5 million sq. meters of office space will be available and private investment could reach $13bn. Dense high-rises give way to lower-slung residential areas, crisscrossed by parks and canals. A marina and beach line the city's edges. Within a few years, however, Port City will be the site of glass skyscrapers, a busy financial district, hospitals, hotels and even a theme park.

Although the above explanation represents the essential message of the Chinese mode of globalization in Sri Lanka, the underneath presentation that China has portrayed in the construction of the Port City project is indispensably relevant to fathom how China has clung to the notion of Buddhist diplomacy. The geometric positions chosen by the Chinese investors and the numerical values given to the reservation of the land implicitly connote China's sheer civilizational projection behind the Port City.

It should be noted that China's sudden interest in restoring its Buddhist heritage is strongly linked to its rivalry with India. India is the land where Buddhism was born and flourished before it reached its gradual ebb. But, under the colonial yoke, Indian nationalists were deeply moved by the shared Buddhist values between India and China to strengthen Indo-Sino

relations as a Pan-Asian league. [17] The Hindutva view of Buddhism was mainly based on portraying it as a reformed school of Hinduism and leading Hindutva leaders like Vinayak Damodar Savarkar considered Buddhism as the unifying identity marker of Asia: the Hindu-Buddhist religion". [18] But this romanticized Indian tutelage as the country that introduced Buddhism to China has been widely critiqued by modern-day scholars. According to Tansen Sen, China's interaction with India based on Buddhism was confined to the 2nd and 3rd centuries as Chinese Buddhist doctrine saw its own development; moreover, after the 4th and 5th centuries Chinese Buddhism took a critical stance in Indian Buddhist doctrine. [19]

In the present day, India has again looked for Buddhism as a key element in its global soft power projection with its relations with the Asian countries. Especially Indian premier Modi was quick to gauge the relevance of Buddhism as a key aspect of his foreign policy by stating "Without Buddha, this century cannot be Asia's century". [20] It was a profound appeal that emerged from New Delhi to uplift it's Buddhist legacy as India's greatest gift to the world. When it comes to Indian-Sri Lankan relations in the recent past, India seemed to have relied on projection of Buddhism as a pivotal factor.

In his visit to Sri Lanka in 2015, Prime Minister Modi invoked the Buddhist links in his address to Sri Lanka parliament, promising "We will bring our shared Buddhist heritage closer to you". [21] But, in realty modern India's cultural and political space does not adequately provide a nourishing

[17] CarolienStolte, Harald Fischer-Tne, "Imagining Asia in India: Nationalism and Internationalism, Comparative Studies in Society and History, Vol.54, No.1, (2012), pp. 73.
[18] CarolienStolte, Harald Fischer-Tne, "Imagining Asia in India: Nationalism and Internationalism, Comparative Studies in Society and History, Vol.54, No.1, (2012), pp. 73.
[19] Tansen Sen, Buddhism, Diplomacy, and Trade: The Realignment of Sino -India Relations, 600-1400, (Hawaii: University of Hawaii Press,2003).
[20] KadiraPethiyagoda, Modi deploys his culture skills in Asia, Working Paper Series 41, Brooking Institute, 2016.
[21] Bhavana Aurora, PM Narendra Modi keen on projecting India as a "soft power", uses Buddha connect in foreign policy, The Economic Times, 05th of May,2015, https://economictimes.indiatimes.com/news/politics-and-nation/pm-narendra-modi-keen-on-projecting-india-as-a-soft-power-uses-buddha-connect-in-foreign-policy/articleshow/47155267.cms?from=mdr, (Accessed date: 2021.05.03).

ground for Buddhist diplomacy. The moral foundation of Buddhism is embedded in Buddha, Dhamma (Doctrine) and Sangha (the priesthood) commonly known as the "ThrividaRathna" in Pali, but the practice of this concept has been extinguished from India mainland although Buddhism was born there. In reality, the status of Buddhism in modern India is no more than aggrandizement from the past, thus Modi's grand ambition of presenting Buddhism as a soft power tool is likely to become a bemused project. On the other hand, Modi's prime obsession with "Hindutva" consists of some doctrinal anathema to Buddhism as modern-day pioneer of "Hindutva" concept Savarkar had lampooned Buddhism as a weakening force which became disastrous to the national virility. [22] Hence, it appears to be a paradoxical move that Modi attempts to focus on restoring Buddhism as a key soft power tool while admiring Savarkar's "Hindutva" ideology. Now what is puzzling about Delhi's projection of Buddhist diplomacy is the structural defects it contains to proceed as a key pillar of India soft power. Notwithstanding India's portrayal of herself as the cradle of Buddhism, present-day India does not have a considerable Buddhist population, also it lacks think tanks or renowned Buddhist teachers to spread Buddhism.

This conspicuous lacuna of India's attempt to use Buddhism as a strategic tool has paved the path to China. Beijing is possessing all the necessary capabilities to utilize its identical Buddhist heritage as the country which is the home for the largest Buddhist population in the world. China has witnessed a steeping growth of Buddhism under the leadership of the president Xi Jinping, who himself took a keen interest to uplift China's Buddhist heritage in the global sphere as a formidable strategy. Indeed, the policy that Xi Jinping has harbored in promoting Buddhist diplomacy has altered the face of Buddhism from its Indic roots to a Chinese version of Buddhism (Zhongguofojiao) and this policy clearly stands to counter India's hegemony in Buddhist diplomacy. [23] For instance, the Nanhai Buddhist Academy was opened in 2017 in People Republic of China under state patronage as a rival institute to India's recently revived Nalanada Buddhist University. In addition, the certain policies adopted by China in

[22] RC Heredia, Gandhi's Hinduism and Savarkar's Hindutva, Economic and Political Weekly, Vol.44, No.29, (2009).

[23] GV Raymond, Religion as a tool of influence: Buddhism and China's Belt and Road Initiative in Mainland Southeast Asia, Contemporary South East Asia, Vol.42, No.3, (2020).

promoting "Chinese projection of Buddhism" in specific countries are strongly aligned with that country's Buddhist history and it's civilizational link to China. In the policy paper authored by Yoshiko Ashiwa and David. L Wank to the Brookings institution, authors have indicated that China strives to utilize its global promotion of Buddhism as an influencing factor in Asia and the image of Buddhism that China promotes is a pure aggrandizement of Sinocentric Buddhist values embedded with the ideals that Chinese civilization. [24]

Xi Jinping's alacrity on Buddhist diplomacy and promotion of Buddhism globally resembles the imperial Japanese tradition widely used in the early 20th century which legitimized Japan's interventions in East Asian countries. But, history has clearly shown us the Japanese military ventures in East Asia met with strong Anti-Japanese resistance regardless of Japan's depiction of herself as the protector of the Buddhist creed.

Given China's lack of global soft power image, "Buddhist diplomacy" has been captured by Beijing as the last resort of building Chinese pacifism globally and the most notable salient feature in this wide Chinese global Buddhist diplomacy lies in the manner how China distinguishes herself from Indian Buddhist traditions. The remarks made by president Xi in 2014 regarding Buddhism's paramount importance in China with Chinese features was a reminder that arose from the political apparatus of Beijing on the novel strategy of promoting a Sinocentric Buddhism in the global sphere. In his speech at UNESCO headquarters Xi Jinping emphasized "Buddhism originated in ancient India. After it was introduced into China, the religion went through an extended period of integrated development with the indigenous Confucianism and Taoism and the finally became Buddhism with Chinese characteristics. The Chinese people have enriched Buddhism in the light of Chinese culture and developed some special Buddhist thoughts. Moreover, they also helped Buddhism spread from China to Japan, Korea and Southeast Asia and beyond". [25]

[24] Yoshiko Ashiwa, David L Wank, The Chinese State's Global Promotion of Buddhism, Berkley Centre for Religion,Peace and World Affairs, Brooking's Institution, November, 2020.
[25] Ian Johnson, What a Buddhist Monk taught Xi Jinn Ping?, The New York Times, 24th of March 2017, https://www.nytimes.com/2017/03/24/opinion /sunday/chinas-communists-embrace-religion.html, (Accessed Date: 2021.05.05).

David Scot has analyzed Xi's vision of promoting Chinese vision of Buddhism as a reflection of China's past, where China was the "Middle Kingdom" and rest of the of neighboring states appeared under the orbit of China. [26] Thus, the Chinese characteristics that president Xi mentioned were rooted in the belief that China should hold the helm in world Buddhist diplomacy.

4. Results

As this paper has examined, the Chinese strategy of using Buddhism as a soft power tool in Sri Lanka has seen a rapid growth with the increasing presence of China in the island nation. Nevertheless, it is rather undeniable that the spiritual debt that Sri Lanka is owing to India stands as the biggest setback before Chinese Buddhist projection. Especially, the Sinhalese Buddhists in the island still maintain a spiritual connection with India as the land where Buddha was enlightened, carried out his dhammaand finally attained "nibbana". The strong Theravada tradition that has been nourished for more than two thousand five hundred years of affinity with India still plays a profound role as a catalyst factor in the relations between the two countries. Despite the constant invasions that came from the Indian mainland in the course of history to the integrity of the island, the reverence toward India has been continuing as India lingers in the Sinhalese Buddhist psyche as a spiritual shrine. From a theoretical point of view, the bulk of India's strength in deploying Buddhist diplomacy was ahead of the curve in the post-independent India under its first premier Nehru, who patronized first Buddhist Congress in Sanchi in 1954. [27]

It is within that context that one needs to understand how China attempts to utilize Buddhist diplomacy in Sri Lanka, which is a place where strong Indic oriented Theravada Buddhist tradition remains unshaken regardless of the political discontents of the two countries. Above all, revival of China's interest in Buddhism and its global promotion appears to be paradoxical with the avowedly aesthetic nature of Chinese Communist party.

[26] D Scot, Buddhism in current China-India diplomacy, Journal of Current Chinese Affairs, Vol 44, No.1, (2016).

[27] UpaliThero, Nehru's Statement on Buddha and Buddhism, 2011.03.01, https://www.buddhistdoor.net/features/jawaharlal-nehrus-statements-on-the-buddha-and-buddhism, (Accessed Date: 2021.05.03).

Furthermore, the past atrocities committed during the cultural revolution in China against the Buddhist monks are another strong grim memory which can question the sudden rejuvenation of China's interest in global Buddhism.

Alongside this historical burden that has been chasing China's present endeavours, the success that Beijing has gained in Sri Lana on Buddhist diplomacy is rather impressive. As discussed in this paper, the historical projection of Mahayana Buddhist links with Sri Lanka that derived from the time of Fa Xian carried a legacy rooted in Chinese characteristics of Buddhism and the current strategies adopted by Beijing in Sri Lanka represent the same ethos.

One of the notable manifestations of China's practical approach to using Buddhist diplomacy in Sri Lanka is that its rapid success in making a rapport with the local Buddhist monks. China is well aware of the fact that making any hostility toward local Theravada Buddhist monks is inimical for its public diplomacy in Sri Lanka. Therefore, Beijing has aptly adhered to forming an amicable alliance with leading Sri Lankan Buddhist monks and this strategy is grounded on retrospection of the island's historic ties with Chinese civilization to buttress the overarching success of China's Buddhist diplomacy in Sri Lanka. According to some sources, Beijing played a crucial role in harboring former president Sri Lankan Mahinda Rajapaksa's election campaign during the 2015 presidential election. [28] The reports indicate that a huge amount of money was given by the Chinese to Rajapaksa's campaign through a Chinese company named "China Harbor" which is a state-owned entity that built the Hambantota port in Sothern Sri Lanka. The report has further unveiled that out of these funds, $38,000 were donated to a popular Buddhist monk who took Sinhalese Buddhist chauvinist and pro-Rajapaksa stance. [29]

[28] RajpalAbeyanayake, China's Buddhist Diplomacy in Sri Lanka: the motorway to enlightenment? South China Morning Post, 02/06/2018, https://www. scmp.com/ week-asia/geopolitics/article/2148443/chinas-buddhist-diplomacy-sri-lanka-motorway-enlightenment, (Accessed date: 2021.05.04).

[29] Palki Sharma, as pools approach in Sri Lanka, China begins cultivating Buddhist clergy, WION, 2020.07.30, https://www.wionews.com/south-asia/as-polls-approach-in-sri-lanka-china-begins-cultivating-buddhist-clergy-317068, (Accessed date: 2021.05.03).

To evaluate what China expects from Buddhist monks in Sri Lanka requires the understanding of how Sinhalese Buddhist pulsation functions in Sri Lankan society and it is evident that China has clearly understood the gravity of Buddhist monks as a dynamic factor in the political apparatus of Sri Lanka. The 9th Article in the Sri Lankan constitution enshrines the importance of Buddhism and the role of Sangha (Buddhist Monks) is contingent on the success of any political upheaval in the island. During his tenure, former President Mahinda Rajapaksa maintained a rapport with Buddhist monks which was more palatable and grounded on the common conviction of Sri Lanka's post-independent populist doctrine of Sinhalese Buddhist nationalism. It is a fact beyond a conjuncture that many Sri Lankan Sinhalese Buddhist monks share a sceptical attitude toward modern Indian nations state replete with resentment as they believe India is culpable of planting the seeds of Tamil separatism in Sri Lanka. [30]

These idiosyncratic features prevalent among the traditional belief of Sri Lankan Buddhist monks have been aptly captured by China in its recent Buddhist diplomacy strategy in Colombo. The subsequent actions taken by the Chinese after Mahinda Rajapaksa's political defeat in 2015 shows how cleverly Beijing attempted to approach the Buddhist sangha in Sri Lanka. For instance, in 2015 Chinese ambassador in Sri Lanka arranged a meeting with the chief monk of the Asgiriya chapter of Siamnikaya in Sri Lanka, one the two important Buddhist orders in Sri Lanka. [31] The chief Buddhist monk of Asgiriya chapter was a vocal supporter of former president Rajapaksa. It was in this context that China forged a closer bond with a powerful Buddhist monk in Sri Lanka, which was followed by an invitation to Sri Lankan Buddhist monks to participate in the Fourth World Buddhist Forum in China. The establishment of the China-Sri Lanka Buddhist Association is another platform in Sri Lanka that is a more sanguine hope for China to galvanize its influence among the Sri Lankan Buddhist monks. When the COVID outbreak started in Wuhan in China, a large group of Sri Lankan Buddhist monks under the sponsorship of China-Sri Lanka Buddhist Association conducted a special prayer ceremony in Anuradhapura to invoke the blessings for Chinese people and to express

[30] J.N Dixith, The Assignment Colombo, (Konark Publication: New Delhi), 1997, pp. 78.

[31] Palki Sharma, As pools approach in Sri Lanka, China begins cultivating Buddhist clergy, WION , 2020.07.30, https://www.wionews.com/south-asia/as-polls-approach-in-sri-lanka-china-begins-cultivating-buddhist-clergy-317068, (Accessed date : 2021.05.03).

Sri Lanka's solidarity. [32] The choice of "Abayagiriya" as the venue to conduct the prayer ceremony was a symbolic factor that reminds of China's legacy in the island dates back to Fa Xian's stay in Abayagiriya in the 5th century A.D.

5. Recommendations

China may have clung to appeasing the Sinhalese Buddhist monks in Sri Lanka as an indispensable strategy to counter any possible resistance that may arise from the most influential community in Sri Lanka society for the BRI projects. However, the recent vilifications that emerged within Sri Lankan public opinion, including Buddhist monks regarding China's presence on the island, raise the question of whether Beijing has succeeded in projecting its Buddhist diplomacy as an echoing voice. In particular, Colombo Port City, which is purely a Chinese invested project has been lampooned by Sri Lankan civil society led by Buddhist monks as a blatant breach of Sri Lanka's territorial sovereignty. [33] Thus, it is rather ambiguous to assume that Chine would possibly penetrate the Sri Lankan Buddhist order by projecting its historical Buddhist ties with the island nation. The practicality of Chinese projection of Buddhism in Sri Lanka, despite its growing influence, is a questionable matter by virtue of Sri Lanka's Theravada Buddhist tradition which is closely linked to India. Also, it should be noted that the people-to-people contacts that existed between two countries after independence through the prism of religious tourism is an indomitable factor that China cannot overcome overnight. But the contention that we built in this paper on the intensity of China's Buddhist diplomacy in Sri Lanka has shown the emerging growth of Chinese strategy in its liminal period, which is likely to grow fervently in future. In some ways, Beijing's ardor of carrying out the Buddhist diplomacy in Sri Lanka needs to be understood as a type of influence operation. Gregory V Raymond has analyzed the strength of influence operations executed

[32] Huaxia, Sri Lankans pray for China's victory against novel Corona virus epidemic, Xinhuanet, 2020.02.09, http://www.xinhuanet.com/english/2020-02/09/c_138767660.htm, (Accessed date : 2021.05.03).

[33] N SathiyaMoorthi, Why new Bill makes Colombo Port City a "Chinese Province" in Sri Lanka, Working Paper Series, Observer Research Foundation, 2021.04.21, https://www.orfonline.org/expert-speak/why-new-bill-makes-colombo-port-city-a-chinese-province-in-sri-lanka/, (Accessed Date : 2021.05.03).

during Xi Jinping's era for past few years, which were undertaken by China's United Front Work Department (UFWD) that reported directly to the Central Committee of the Chinese Communist Party. [34] Contrary to the Communist denial of religion, UFWD has taken a paternal interest in promoting Chinese projection of Buddhism in the Eastern Asian Buddhist societies through the common prism of shared world view. Raymond suggests that Buddhist diplomacy became China's shield in Southeast Asian states to counter the furore against BRI. Beijing seems to have understood the cosmological value of Theravada Buddhist doctrine in those states as a colossal figure in the political structure. The significance of religion by creating a shared worldview is benign which constitutes some shared common values that would inevitably lead to independent polities, which is tantamount to what Hedley Bull described as an "International Society". [35]

Overall, the intensified mechanism of projecting Buddhist diplomacy in Sri Lanka buttresses China's influencing position in the island regardless of the strong Indian impacts on Sri Lanka's socio-cultural domain. While China will always cope with an array of setbacks in utilizing Buddhism as a soft power strategy in Sri Lanka to the overarching success of BRI, it has the advantage of newly emerged pro-Chinese Buddhist intelligentsia in the island nation. This paper has traced the steeping increase of Chinese influence over the Buddhist monkhood in Sri Lanka as a pivotal factor that fortifies Beijing's orbit in Sri Lanka and the question that comes to the fore is that how it would vanquish the age-long civilizational tryst with India. In contrast to this strong Indian visibility in every nook and cranny of Sri Lanka's national identity, the acute mechanism China developed in Sri Lanka has emphasized reviving the Chinese elements in Buddhism and its historic significance to Sri Lankan Buddhist identity. This article began by considering the antecedents of Chinese involvements in Sri Lankan history and their contemporary relevance, and also examined how Chine underpins its intrinsic Buddhist tradition which distinguishes it from Indic routs in Sri Lanka through framing the Chinese blend of Buddhism through architecture. Despite the obvious impetus conceived by China in Sri Lanka

[34] GV Raymond, Religion as a tool of influence: Buddhism and China's Belt and Road Initiative in Mainland Southeast Asia, Contemporary South East Asia, Vol.42, No.3, (2020).

[35] Hedley Bull, International Theory: The Case for a Classical Approach, World Politics, Vol.18, No.03, (1966), pp.361-377.

in forming the projection of Buddhism, its fullest objective may be difficult to attain as a soft power strategy. Nevertheless, it would not be an exaggeration to describe Chinese Buddhist diplomacy as a clever mechanism that still stands in its infancy stage and its outcome may be a bulwark for the Chinese presence in Sri Lanka.

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