How to make a Smart Campus - Smart Campus Programme in IIT Delhi

Authors

Prof. M.P. Gupta

Information Systems

DMS, IIT Delhi

Hauz Khas, New Delhi, India - 110016

Email: mpgupta@dms.iitd.ac.in

Dr. Arpan K. Kar

Information Systems

DMS, IIT Delhi

Hauz Khas, New Delhi, India - 110016

Email: arpan_kar@yahoo.co.in

Abstract: This is a technical report on how a plan can be made for developing a smart campus by taking inputs from multiple stake-holders, and then prioritizing the suggestions. The focus of this smart campus initiative was smart services, sustainability, fostering research opportunities and fostering innovative entrepreneurship models. Focus was redefined to improving campus life, water and power sustainability, infrastructure mapping, information management and flow, waste treatment and outsourcing plans. Potential projects were identified and prioritized based on high impact and low complexity (Phase 1), low impact and low complexity (Phase 2), high impact & high complexity (Phase 2) and low impact & high complexity projects (Phase 3). Governance and project implementation blueprint was also developed as part of this technical report.

Smart Campus @IIT Delhi

Report

Indian Institute of Technology Delhi
2015

Smart Campus @IIT Delhi

The idea of "Smart Campus" came out of the recent attention given to 'Smart Cities' world over and also with GoI announcing the development of 100 smart cities which essentially are aimed at deployment of internet based applications, content management platforms and broadband infrastructures in every sphere of public systems (such as healthcare, media, energy and the environment, safety, and public services).

Academic campuses, essentially for people who are expected to be engaged in intellectual progress, knowledge creation and guiding societies for better living, could also embody principles of a smart campus. A typical smart campus would have three pillars: infrastructure, operations and, of course, people. Each of these pillars would be infused with intelligence, but more importantly they would work in an interconnected and integrated fashion to utilise resources efficiently. Such a campus could incorporate the 'Future of Internet' involving Internet of Things and sensor technologies as the main facilitators of smart infrastructure.

Some of the key features of such a smart campus are:
- Smart technology enabled automation
- Integrated services via dashboards
- Energy and water efficiency (Smart distribution systems, smart meters, etc)
- Foster creativity & innovation via collaboration
- Results in best practices

Below depicts a blown up idea of smart campus.
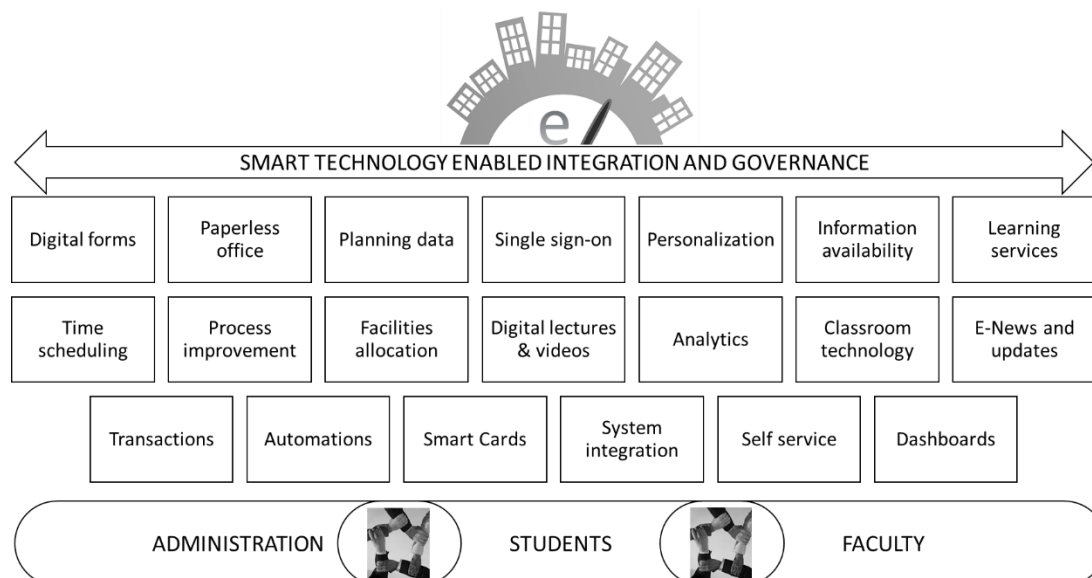
IIT Delhi campus can be easily described by its community consisting of students, teachers and staff and their family; who live together in a campus environment. It is largely a community of individuals who come to stay together with a promise of nurturing an academic/ learning environment and evolve to be responsible citizens, scholars and leaders. It occupies an area of around 320 acres with a resident population of nearly 13000+. This includes 7000+ students and 6000+ members of faculty and staff and their families. The campus is clearly a mini-city with its own multiple residential areas, shopping areas, play areas, hospital, school etc. The fact that a number of citizen oriented services are

administered by a single authority i.e. Institute administration makes it an ideal location to carry out a large number of experiments. Institute administration is responsible for providing and maintaining a large number of typical municipal services including parking, water, sewage & drains, roads, garbage collection and disposal, street lighting, security, maintaining greenery, network infrastructure including wi-fi, limited transportation within the campus and even electric supply in large segments. A techno-savvy, and relatively a very young adult population in the campus also make it an ideal place to experiment with technology.

The success of IITD is gauged by the accomplishment of each individual which makes him/her a proud member of the developing society. The fundamental principle of an academic campus is the overwhelming opportunity one enjoys for intellectual progress and the obligation to conduct activities in ways that help other citizens to do the same.

Smart campus @ IITD has been conceived in line with the national priorities. The purpose is to make use of smart technologies in various aspects of IITD Campus to minimize waste of time and resources and making them more effective.
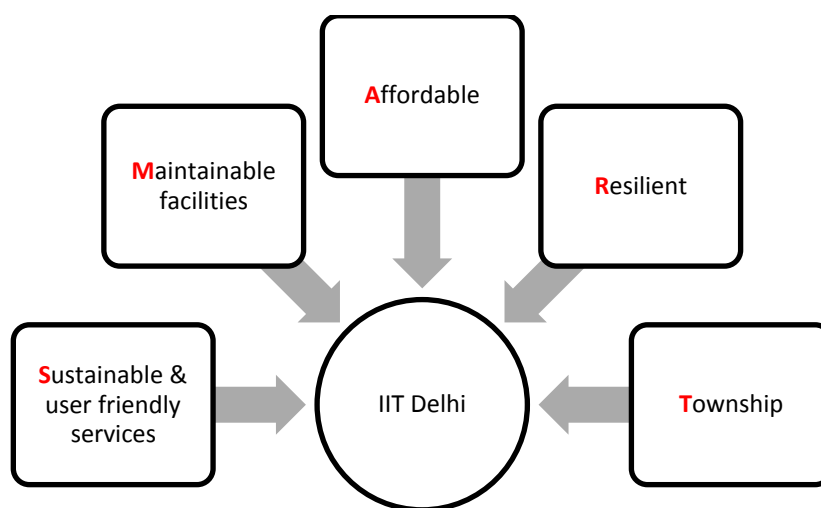
To some extent, campuses can be seen as micro model of "small cities", raising similar issues and concerns of a smaller ecosystem. This is an extraordinary opportunity to establish IIT Delhi as reference model for, not only, improving quality of community living but also support creativity and interdisciplinary collaboration in research. It may emerge as showcase and replicable model across other educational campuses in the country.

A smart IITD campus should also have a forum of idea generation among students community on regular basis that will also promote entrepreneurship culture.

So four (4) broad major objectives may be chosen to guide subsequent effort:
- List of services that a smart campus should provide
- Select those which are sustainable or enhance sustainability
- Involve students to foster entrepreneurship
- Research opportunities

A full blown Smart Campus @ IITD would truly be 'more as a whole' than the 'sum of its parts'.

Idea Generation

First, a meeting of the committee was conducted which brought out some of the key points:

1. **Campus Life**: How to make the campus safe, secure, green, reduce noise and air pollution, ensure maintenance of the campus and its buildings, make it disabled friendly etc. In this activity, active participation of the students would be useful and desirable. It would help if an SOP can be worked out for operation and maintenance of the campus infrastructure and services. Mechanised cleaning needs to be introduced immediately in all open areas to reduce the dust pollution.

2. **Water and Power Audits**: This will help us to identify the potential areas where savings can be made in these scarce resources within the campus.

3. **Preparation of detailed map**: This must be an authentic Institute document. Underground and over-ground map to ensure traceability of locations and services, and mitigate risk of damages of services in any future construction or infrastructure development.

4. **Review / Modify information flow**: Procedures should be modified to reduce the time taken in chasing approvals etc. All communications must finally be in electronic mode to save on paper, manpower, and space and to make information retrieval faster.
   Another issue of concern would be to define (in public domain) all the emergency procedures. Emergency issues could be related to security and thefts, fire, medical emergency, water logging or severe blockages etc.

5. **Waste Treatment & Management**: Sewerage treatment is an absolute priority both to address the issue of waste water management and to make treated water usable for horticulture (and if possible for toilets) available. This would help to maintain green patches in the Institute. Solid waste management needs also to be explored.

6. **Outsourcing where needed**: Engagement of a professional firm to address the issue of toilets and drinking water.

It was agreed to involve entire IIT Delhi fraternity into idea generation on various themes of smart campus @IIT Delhi. A webpage of soliciting feedback was created which available during 17 August to 6 September 2015. A crowd-sourcing model was adopted for idea generation for this initiative. On the following aspects, ideas were solicited:

Table-1 Seeking Suggestions

Smart services	Sustainability	Research opportunities	Business opportunities

▪ Campus Card options
   a) Classroom attendance
   b) Security access
   c) Academic resource access
   d) Any others
▪ Academic Services
   a) Academic ERP System
   b) Moodle LMS
   c) Classroom management
   d) Time-table management
   e) Booking of rooms
   f) Booking of Halls
   g) Booking of Guest House
   h) Others
▪ Internal services
   a) Internet
   b) Telephone
   c) CEP / TEQIP
	▪ Class rooms
	▪ Laboratories
	▪ Buildings & infrastructure
	▪ Roads and civil infrastructure
	▪ Other Physical assets
	▪ Water resources / harvesting
	▪ Electricity conservation
	▪ Sanitation facilities
	▪ Solid waste management
	▪ Campus habitation
		▪ Students projects (BTP/MTP/MBA/M Des)
		▪ Identify best practices/examples of smart campus
		▪ Enhance learning & Productivity
		▪ Scalability
		▪ Replicability
		▪ Documentation
		▪ Funded projects
		▪ Any others
			▪ Foster entrepreneurship
			▪ Event design
			▪ Funding ventures
			▪ Any others

d) IRIS / IRD e) Procurement f) Civil Maintenance g) Electrical Maintenance h) Establishment Section I/II i) Hospital services j) Others ▪ Access to facilities / Kiosk for External services a) Taxi b) Gas c) Electricity d) Banking e) Others ▪ Any others	▪ Green campus initiatives ▪ Mobility and connectivity ▪ Safety and security ▪ Shopping centers ▪ Any Others		

Also it was attempted to identify those would like to volunteer to be part of developing these ideas further into projects and take part or lead the implementation. All suggestions had options like "I would like to lead this further", "Be part of the team to develop this further" and "No".

Analysis & Planning

The suggestions received from the faculty, students and staffs were also quite large in numbers. Total 338 suggestions were received, 208 suggestions from students and 130 from employees including faculty and staff. These suggestions were consolidated into 85 categories based on objective similarity. These suggestion categories were further analysed using the 'Impact-Complexity' Matrix where mapping was done on the basis of Degree of Impact (Low-High) Vs Degree of Complexity (Low-High). As a result, four quadrants were obtained i.e. 1) Low Impact & Low Complexity, 2) Low Impact & High Complexity, 3) High Impact & Low Complexity and 4) High Impact & High Complexity. Each quadrant has few smart campus suggestions based on impact and its complexity which has been shown in Annexure 1. Based on this matrix, the smart campus initiatives have been divided into three phases.
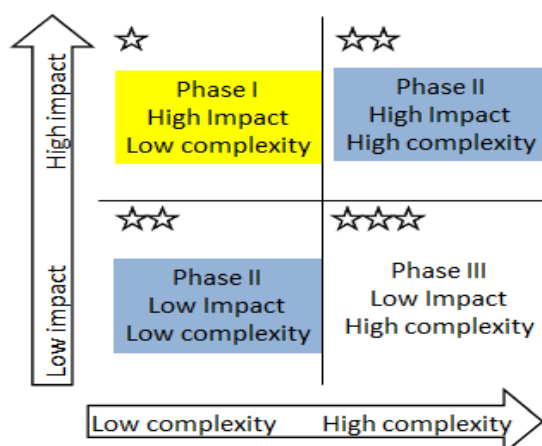

Figure 3: Framework for prioritization

Some additional suggestions came forward during second meeting of the Smart Campus Committee held on 5 October 2015. These are included in various phases suitably:

▪ Free Open Source Software (FOSS) as policy
▪ Claim carbon credits
▪ Harnessing the solar energy (solar PV cells on campus residences)
▪ Improve energy consumption (LED lights and Brushless DC BLDC fans
▪ IT infrastructure (PCs, telephones, wifi, printing and scanning) within 10 feet of everyone
▪ DECT cordless telephony or a soft VoIP client on every smartphone on campus
▪ A paperless environment
▪ GIS information of utility infrastructure (gas pipes, electric wiring, network trenches etc).
▪ Improve our sewerage
▪ A cashless campus
▪ Outsource building and estate maintenance, housekeeping & security.
  Possibility of an entire building for basement parking
▪ Rainwater harvesting and grey water harvesting from residences
▪ Preserve heritage (a Committee on Heritage)

Phase 1: Smart campus initiatives
This phase includes high impact and low complexity suggestion categories to be implemented. Suggestions like Smart cards for all students and employees where card based/biometric attendance system for students is enabled, access to services (library, lab, hospital, printing, etc) is enabled, and Cycle dock (Bicycle sharing system) is enabled through Smart Cards. Further projects like smart security (CCTVs for Video Surveillance, etc), sensor based doors for entry in departments and labs, bus tracking using GPS, smart speed sensors across campus, video conferencing facility in all departments and motion sensing lights and fans could be initiated. In terms of information enabling services kiosks may be implemented. Searchable maps with GPS, digital display panels at key locations and smart navigable notice boards may be implemented. Further bulk SMS for key messaging / alerts may be planned for user groups. Mobile portability for complete IITD website and smart interactive features using Web 2.0 in all website within IITD domain may be planned. For ensuring sustainability, smart management of electricity, smart management of water resources, smart maintenance scheduling and mechanized cleaning and sensor based waste management (degradable vs non-degradable waste) may be planned for.

The lists of all suggestions are provided in Annexure 1 and 2.

Phase 2: Smart campus initiatives
This phase consists of the "low impact and low complexity" as well as the "high impact and high complexity" suggestion categories. In case of low impact and low complexity suggestions like issuance of add-on smart cards for family members and for contract employees may be planned for. For enhancing facilities & infrastructure, projects like smart lecture kits for the management of classroom resources (like duster, whiteboards, pens) may be planned. Transport or travel support for travel outside the campus may be planned for. Separate bicycle path besides roads may be planned to encourage usage of bicycles. Dashboards may enable online booking institute resources (classrooms, halls, guest house, and online book recommendation). SMS Alert facility for all notices/circulars to user groups based on title of content may be planned. Searchable key notifications (pdfs) repository and searchable telephone directory may be planned. To enhance focus on ssustainability, green / non-green garbage collection, green trucking practices inside the campus and noise control mechanisms near road walls may be planned. The lists of all suggestions are provided in Annexure 1 and 2.

On the other hand, high impact & high complexity suggestion categories may include the implementation of suggestions like smart cards enabling a cash free campus and digital wallets as well as an integrated health system enabled through campus card (patient / doctors/ pharma). To improve facilities & infrastructure, smart meter/panels for electricity consumption, intelligent water-free bathrooms/toilets and smart parking facilities may be planned for. Further integration of information

of dept. & central library may be highly beneficial. In terms of e-governance, digitization & integration of past official documents and paperless offices, online System for information retrieving / tracking requests & approvals, dashboard for employee and students for enabling all services may be planned. To enhance sustainability, projects like energy generation from the solid waste management, solar water heaters installed in hostels and residences, shaded footpaths with solar panels on top, regenerative systems across footpaths (generate power when people walk on the footpath) and waste water management to prevent direct/indirect communicable diseases may be planned. These are some of the key suggestions. Further a digital map of underground infrastructure (wirings, pipes) may need to be created so that infrastructure development does not damage existing services.

GIS based portal of IIT Delhi campus (shown below)) developed by Civil Engineering department, is already available with us (http://gisserver.civil.iitd.ac.in/walktoiitdelhi/). This can be used to add layer of applications from the list shown in Annexure 1 & 2.
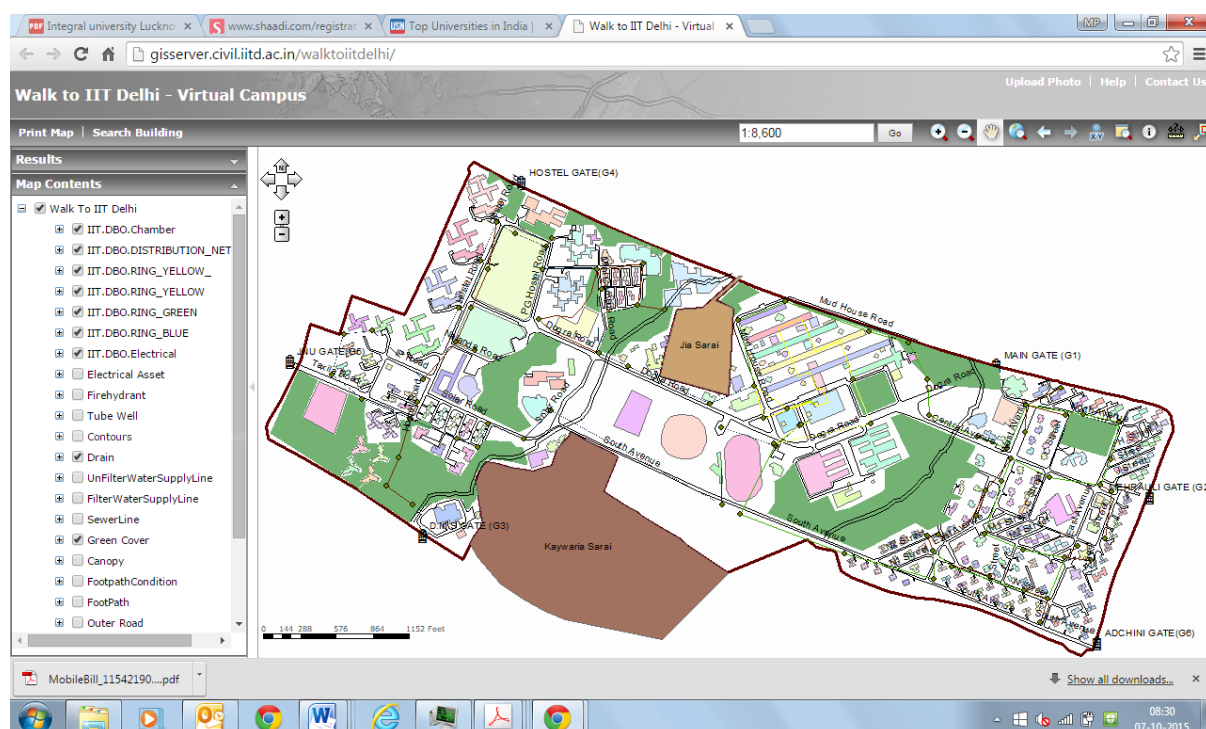
Phase 3: Smart campus initiatives
This phase have the low impact & high complexity suggestions. In this phase, projects like smart card for mess management and meal billing could be started. Further to enhance facilities and infrastructure, projects like online management of inventory items may be started under maintenance facility. ICT enabled facilities could be implemented for physically challenged. Technologies like speech technology enabled kiosks may be implemented for the blind. Further to enhance the sustainability of changes, a bio-gas plant could be developed to generate energy. Initiatives could be planned to monitor carbon footprint of the campus (Reference: University of Chicago, Waggle project). Further rrainwater harvesting for all buildings on campus ay be planned for to enhance usage of key water resources. The lists of all suggestions are provided in Annexure 1 and 2.

Details of the projects which may be undertaken in each of these Phases (Phase 1, Phase 2 and Phase 3) are elaborated out in the Annexures 1-3.

Among the exhaustive list of activities, many of them are independent to each other (e.g.Cycle Dock, Smart Digital displays, Sensor doors etc.). Rest others need to be integrated with IITD computing

infrastructure (e.g. network of sensors, CCTVs, Back office integration, Analytics & service access via 'Dashboard').
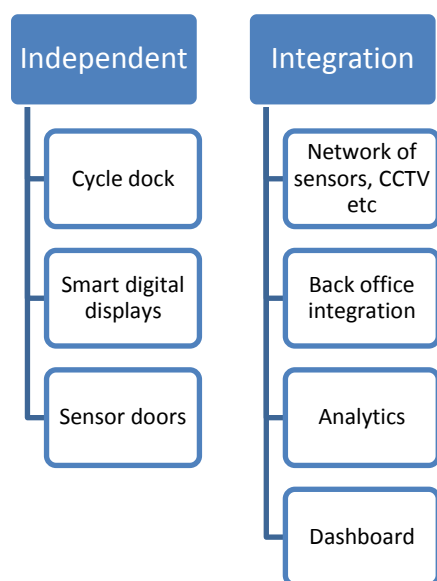
Smart Campus Architecture @ IITD

All those services where integration with IITD computing infrastructure is necessary will result in a new technical architecture. There will be a layer of 'Smart solutions' ov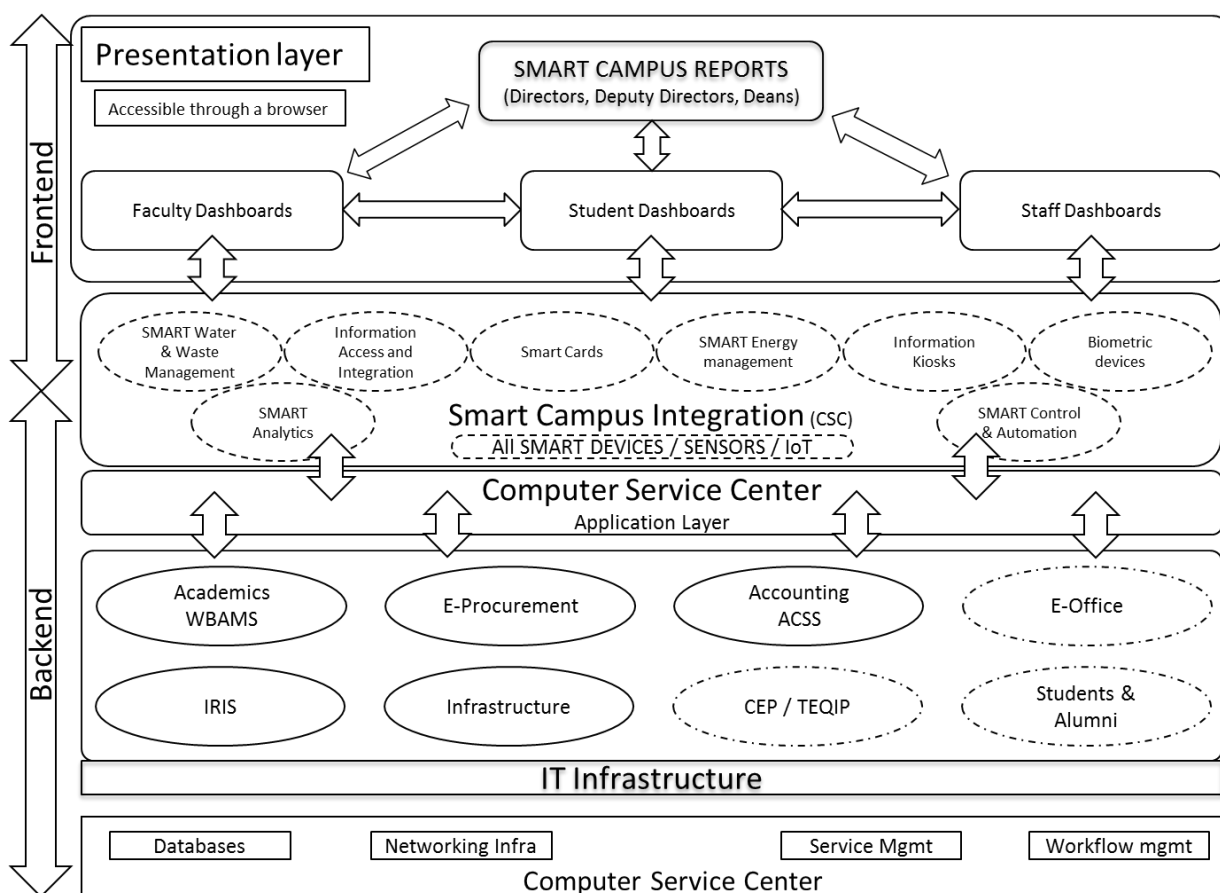er the existing set up. To realise the above, laying a campus wide infrastructure of sensors of various types, will be necessary. It would be prudent to leverage emerging technology in solar power, low-power processors, sensors, smart cameras, smart meters and cloud computing to build powerful and reliable sensor nodes and smart trees across the campus. It would be possible to deploy of various smart applications (viz. monitoring water flow, electricity consumption and pollution etc.) and also provide wi-fi hot spots for IITD community around key locations in the campus.

Once smart infrastructure put in place, will open up opportunities variety of research and innovation across the campus. Faculty and students at all levels; UG, PG and PhD would be encouraged to come up with ideas that can be tested as pilot projects using these sensors. They could target any domain from security & surveillance to transportation to waste management. In fact such an infrastructure could trigger innovation and solutions for future smart cities.

For users (students & employees), a mobile interface for all service should be conceived. This will eventually drive complete integration of the back office systems (Academic, Accounts, Establishment etc.). In view of this, role of 'Computer Services Centre (CSC)' with enhanced responsibility will become extremely crucial and may appropriately be designated as 'Smart Computing Services Centre (SCSC)'.

The following architecture could be adopted to enable the plans of achieving a smart campus and subsequent governance of the SMART initiatives. Such an architecture and governance may enable seamless information interchange and enable the holistic governance of the projects.

Presentation layer

Accessible through a browser

Frontend

SMART CAMPUS REPORTS
(Directors, Deputy Directors, Deans)

Faculty Dashboards Student Dashboards Staff Dashboards

SMART Water & Waste Management

Information Access and Integration

Smart Cards

SMART Energy management

Information Kiosks

Biometric devices

SMART Analytics

Smart Campus Integration (CSC)

All SMART DEVICES / SENSORS / IoT

SMART Control & Automation

Computer Service Center
Application Layer

Backend

Academics WBAMS

E-Procurement

Accounting ACSS

E-Office

IRIS

Infrastructure

CEP / TEQIP

Students & Alumni

IT Infrastructure

Databases   Networking Infra   Service Mgmt   Workflow mgmt

Computer Service Center

Emergence of Smart Campus will result in several benefits. It will provide complete control over resource utilization; ask for reforms and integration among various academic and administrative operations, bring discipline in delivery of services, create a positive culture of collaborative research & innovation. Overall, it will lead us acquire immense capability in 'smart campus' deployment while IIT Delhi gains the status of first smart campus in the country and a 'reference' model for replication elsewhere.

Control over Resources

Reference Model

Smart Capabilty

Smart Campus @ IITD

Collaboration

Research opportunities

Culture of Innovation
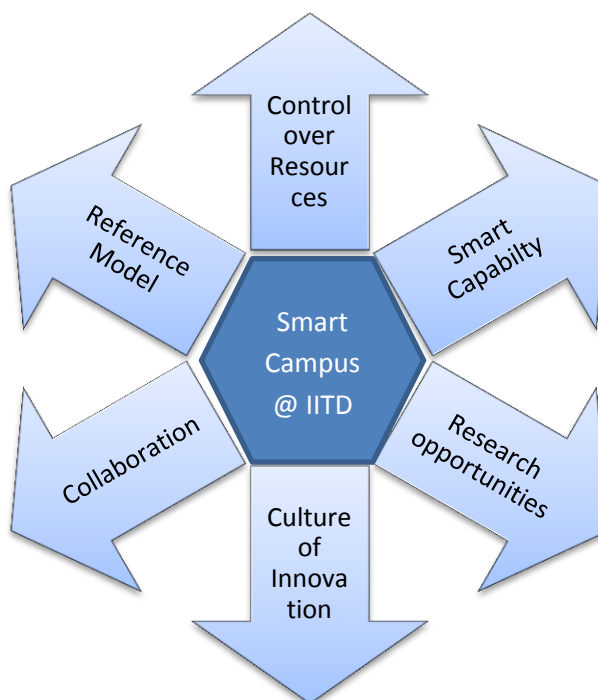
Implementation Strategy

The following implementation strategy was adopted for the Smart Campus Initiative.

- **Phasing of the Projects**: This has already been completed and all the suggestions have been categorized into three phases based on its impact and implementation complexity.

- **Identifying Champions for Projects**: Some of the potential champions have been identified. Employees and students are identified who volunteered to lead these activities in the campus are elaborated in Annexure 2.

- **Forming teams for Projects**: For each activity, a team could be formed who are the expert in those areas or who wants to be a part of that activity. Potential inputs are provided in Annexure 2 from people who could provide support.

- **Project Implementation**: Each team will need to do brain storming sessions over the implementation of the particular projects. Further planning would be required for actual implementation, in terms of process reengineering, vendor prequalification, technology selection, implementation strategy formulation and change management plans.

- **Budgeting:** Budget estimation also needs to be done by the implementing team. Further a cost-benefit analysis may be conducted before selecting any project..

- **Seeking collaboration:** Some collaboration might be required to accomplish the activity with private firms and solution providers.

- **Project planning**: Project pipeline, phases and deadlines could be set to achieve the target. Progress monitoring would need to be done by the project implementation team.

- **Deployment:** Deployment would need to address not only the implementation of the projects, but also work-flow changes required, governance of projects and change management.

- **Monitoring:** Post deployment monitoring could be required for maintenance and impact assessment. 'Benchmarking' will help regular monitoring and maintenance.

Looking Beyond

The Smart Campus initiative would become a reference model for many organizations with residential campuses in general and academic campuses in particular. This initiative would pave the path for further research opportunities across domains like electronic governance, administration, internet of things, smart technologies and process re-engineering, to name a few. This would also foster collaboration through Public Private Partnership models for the deployment of solutions, which could also empower entrepreneurship initiatives surrounding these smart technology enabled ecosystems. In the days to come, successful implementation of the smart campus initiative would also improve the IITD ecosystem in general, which may help in attracting foreign students and faculty members, and thus affect the global rankings of IITD. Further, this could also enable formulation of sponsored research projects and international collaboration with reputed organizations and government bodies like European Union, DEITY (Good Governance scheme) and Waggle (University of Chicago), where there is a strong mandate to explore knowledge creation for such "SMART Initiatives".

Report prepared by Prof. MP Gupta and Dr. Arpan Kumar Kar, DMS, IIT Delhi

ANNEXURE 1. Impact Vs Complexity Matrix

1. (A). This table contains the high impact suggestions, mapped with both low and high complexity of implementation.

High Impact & Low complexity (PHASE 1)	High Impact & High Complexity (PHASE 2)
1. Smart cards for all students and employees 1.1 Card based/Biometric attendance system for students. 1.2 Access to services (library, lab, hospital, printing, etc.). 1.3 Cycle dock (Bicycle sharing system) **2. Facilities & infrastructure** 2.1 Video conferencing facility in all departments 2.2 Motion sensing lights and fans 2.3 Smart security (CCTVs for Video Surveillance, etc) 2.4 Sensor based doors for entry in Departments & Labs. 2.5 Bus tracking using GPS 2.6 Smart speed sensors across campus 2.7 Free Open Source Software (FOSS) as policy 2.8 IT infrastructure (PCs, telephones, wifi, printing and scanning) within 10 feet of everyone **3. Access to information services / kiosks** 3.1 Searchable maps with GPS 3.2 Availability of information kiosks in key locations 3.3 Digital display panels at key locations 3.4 Smart navigable notice boards 3.5 Bulk SMS for common messaging / alerts 3.6 Mobile portability for complete IITD website 3.7 'mygov' type community engaging portal 3.8 Smart interactive features using Web 2.0 in all website 3.9 DECT cordless telephony or a soft VoIP client on every smartphone on campus **4. Sustainability** 4.1 Smart management of electricity 4.2 Smart management of water 4.3 Smart maintenance and mechanized cleaning 4.4 Sensor based waste management (degradable vs non-degradable waste)	**5. Smart Cards** 5.1 Cash free campus and digital wallets 5.2 Integrated health system enabled through campus card (patient / doctors/ pharma) **6. Facilities & Infrastructure** 6.1 Smart meter/panels for electricity consumption 6.2 Intelligent water-free bathrooms/toilets. 6.3 Smart parking facilities. **7. Access to information services / kiosks** 7.1 Integration of information of dept. & central library 7.2 Digitization & integration of past official documents and paperless offices 7.3 Online System for information retrieving / tracking requests & approvals (move towards paperless office) 7.4 Dashboard for Employee and students 7.5 Digital map/ GIS for over & underground infrastructure **8. Sustainability** 8.1 Energy generation from the solid waste management 8.2 Improve energy consumption (LED lights and Brushless DC BLDC fans 8.3 Solar water heaters installed in hostels and residences 8.4 Shaded footpaths with solar panels on top 8.5 Regenerative systems across footpaths (generate power). 8.6 Waste water management to prevent direct/indirect communicable diseases

1(B). The table below is highlighting the low impact category of suggestions with low and high complexity of implementations.

Low Impact & Low complexity (PHASE 2)	Low Impact & High Complexity (PHASE 3)
9. Smart Cards 9.1 Add-on smart cards for family members 9.2 Smart cards for contract employees. **10. Facilities & Infrastructure** 10.1 Smart lecture kits for the management of classroom resources 10.2 Transport / Travel support 10.3 Bicycle path besides roads **11. Access to information services / kiosks** 11.1 Online booking institute resources (classrooms, halls, guest house, and online book recommendation). 11.2 SMS Alert facility for notice/circulars (Title) to user groups 11.3 Searchable key notifications (pdfs) repository and telephone directory **12. Sustainability** 12.1 Green / Non-green garbage collection 12.2 Green trucking practices inside the campus 12.3 Noise control mechanisms near road walls	**13. Smart Cards** 13.1 Smart card for mess management and meal billing could be started **14. Facilities and Infrastructure** 14.1 Online management of inventory items may be started under maintenance facility. 14.2 ICT enabled facilities implemented for physically challenged 14.3 Speech technology enabled kiosks **15. Access to information services / kiosks** 15.1 Detailed map of all underground infrastructure (wiring, piping). **16. Sustainability** 16.1 Bio-gas plant could be developed to generate energy 16.2 Claim carbon credits for the campus (U Chicago Waggle project) 16.3 Rainwater harvesting for all buildings on campus. 16.4 Harnessing the solar energy (solar PV cells on campus residences)

2A). Phase 1 Suggestions (High Impact and Low Complexity)

Grouping	Suggestions	Impact	Complexity	Request count
	Campus card options			**46**
Card related	Smart card ID for all students and employees.	High	Low	28
	Lab access through campus cards only	High	Low	7
	Smart printers in campus, access using campus cards	High	Low	2
	Biometric/card based attendance system for students	High	Low	1
Transport	Payment for transportation facility	High	Low	8
	Facilities & Infrastructure			**76**
Hostel related	Wi-Fi facility in hostels and residential areas	High	Low	16
	Motion sensing lights, fans, ACs	High	Low	1
Maintenance	Smart maintenance scheduling system for buildings/labs/office/houses.	High	Low	15
Security	Smart security across the campus (e.g. Sensor based CCTVs).	High	Low	1
	Sensor based safety solutions (labs & across the campus)	High	Low	1
Energy	Solar cell enabled lighting using LEDs in Classrooms	High	Low	7
	Use of LED lights in entire campus.	High	Low	5
	Smart electronic switches for classes and departments.	High	Low	2
Water	Smart meters for water consumption across campus	High	Low	2
Transportation	Small buses in shuttle mode with higher frequency with GPS tracking	High	Low	7
	Electric Autos/Rickshaws with pooling facilities	High	Low	4
	Small Bus/Shuttle services to nearest metro station.	High	Low	6
	Speed sensors for vehicles	High	Low	2
Smart facility	Facility for video conference calls/classes in each department	High	Low	6
	Entry to all departments/labs using sensor based sliding doors	High	Low	1
	Access to Information Services / Kiosk for external services			**32**
	Searchable maps enabled for GPS / Navigation inside campus	High	Low	2
	Electronic signs (Digital signage) for marking entire campus.	High	Low	6
Services	Single point payment facility for utility (gas, electricity etc.)	High	Low	5
	SMS (bulk) to all campus residents for disaster management	High	Low	1
	Online cab booking system for outside campus travel	Low	Low	2
	Online food ordering from vendors from kiosk / website	High	Low	1
E-Governance	Online booking facility for hall and classrooms.	High	Low	3
	Online booking of guest house.	Low	Low	3
	Online leave application and tracking.	High	Low	2
	Online book recommendation from library for the faculty	Low	Low	2
	Availability of lectures resources via the kerberos id	High	Low	2

	e- Notice facilities over intranet.	High	Low	3
	Sustainability			**3**
	Waste management (degradable vs non-degradable waste)	High	Low	1
	Mechanised cleaning for all open areas to reduce the dust pollution.	High	Low	1
Water	Smart monitoring of Gas leakage in residences / flats	High	Low	1
	Other Suggestions Received (Misc)			**8**
	24 * 7 power supply across the institute	High	Low	4
Energy	Planting trees as much as possible in a holistic manner.	High	Low	3
Environment	Cycle dock (Bicycle sharing system)	High	Low	1
	Total			**165**

2B). Phase 2 Suggestions (Low Impact and Low Complexity; High Impact and High Complexity)

Grouping	Suggestions	Impact	Complexity	Request count
	Campus card options			**26**
Card related	Cash free campus. Payments through smart card enables digital wallets	High	High	19
	Smart cards for contract employees	Low	Low	1
Health related	Integrated health system enable through campus card (patient / doctors / labs / pharmaceuticals).	High	High	6
	Facilities & Infrastructure			**53**
Hostel related	Air-conditioned hostels, to accommodate residential density	High	High	7
	Smart meter/panels for electricity consumption.	High	High	6
Water	Intelligent water-free bathrooms/toilets	High	High	6
	Waste water management to prevent direct/indirect communicable diseases	High	High	1
Transportation	Bicycle-path and footpaths for pedestrian.	Low	Low	2
	Bicycle-path and footpaths for pedestrian.	Low	Low	2
Smart facility	Smart lecture kits for the management of classroom resources such as markers, dusters etc.	Low	Low	5
	IITD can have a centralized server for DC++	Low	Low	1
Notice/Circular	SMS Alert facility for notice/circulars (Title) to user groups	Low	Low	3
Parking	Smart Parking in IIT Campus (layout/no/status display).	High	High	20
	Access to Information Services / Kiosk for external services			**32**
Services	Online cab booking system for outside campus travel	Low	Low	2
E-Governance	Digitization & integration of past official documents and paperless offices.	High	High	1
	Online booking of guest house.	Low	Low	3
	Online book recommendation from library for the faculty	Low	Low	2
	Online System for information retrieving / tracking requests & approvals	High	High	1
	Online searchable telephone directory of entire campus.	Low	Low	3
	Searchable scanned circulars for distribution and records	Low	Low	2
	Library dashboard linking of Department Library with Central Library.	High	High	4
Dashboard	Employee dashboards for complete information & service requests	High	High	2
	Student dashboard for complete information & service requests	High	High	12
	Sustainability			**11**
Energy	Derive energy from the solid waste management.	High	High	2
	Solar water heaters or solar PV for hostels and residential area	High	High	1
	Shaded footpaths with solar panels on top.	High	High	1
	Regenerative systems across footpaths (generate power)	High	High	1

Environment Cleaning	Green / Non-green garbage collection / trucking practices (use sensors wherever possible)	Low	Low	3
Water	Treated grey water for horticulture and bathrooms.	High	High	1
	24*7 water supply with intelligent monitoring to minimize waste	High	High	1
Noise Control	Noise control mechanisms near road walls	Low	Low	1
	Other Suggestions Received (Misc)			**18**
Campus	Establishment of a shopping mall.	High	High	2
	Facility of lockers for all students in the academic area.	Low	Low	3
	Sitting facilities along Main Roads, Nalanda ground, etc	Low	Low	1
Buildings	Provide insulating doors/windows in hostels, offices and residences.	Low	Low	1
Notice	Mail drops at specific time periods	Low	Low	1
Service	Creche for children of employees	High	High	1
Hostel	Provide automatic washing machine to each floor in hostels	Low	Low	4
Energy	24 * 7 power supply across the institute	High	Low	4
Library	Family members may be allowed to access library but issue of books only on employee/student card.	Low	Low	1
	Total			**140**

2c). Phase 3 Suggestions (Low Impact and High Complexity)

Grouping	Suggestions	Impact	Complexity	Request count
	Campus card options			**6**
Mess related	Smart Card for mess management and meal billing	Low	High	6
	Facilities & Infrastructure			**17**
Maintenance	Online Management of inventory items.	Low	High	3
	All possible ICT enabled facilities for Physically Challenged (Eg Speech technology enabled kiosks)	Low	High	3
Notice/Circular	Digital Notice boards with touchscreens in all depts, hostels & across the campus (main locations).	Low	High	11
	Access to Information Services / Kiosk for external services			**12**
Campus layout	Smart visual communication system for easier navigation.	Low	High	11
	Detailed map of all underground infrastructure (wiring, piping)	Low	High	1
	Sustainability			**5**
Energy	Implement Bio Gas plant.	Low	High	2
Environment	Monitor carbon footprint of the campus (U Chicago Waggle project).	Low	High	2
	Rainwater harvesting for all buildings on campus.	Low	High	1
	Other Suggestions Received (Misc)			**6**
Classroom	Improve the poor visibility of some classrooms.	Low	High	3
Transport	Build a proper road that connects to Jia Sarai gate.	Low	High	3
	Total			**46**

Miscellaneous Suggestions

These are the miscellaneous suggestions which are out of scope of smart campus but useful.

PHASE 1 (High Impact & Low complexity)	PHASE 2 (High Impact &High Complexity)
1. Campus Shuttle Integrated metro transit services **2. Energy supply** 24 * 7 power supply across the institute. **3. Green Environment** Planting trees as much as possible in holistic manner.	**4. Campus requirement** Establishment of a shopping mall **5. Services for employees/ married students** Well managed crèche for children of employees.
PHASE 2 (Low Impact & Low complexity)	PHASE 3 (Low Impact & High Complexity)
6. Campus facility Facility of lockers for all students in the academic area. Sitting facilities along JC Bose road, Nalanda ground, etc. **7. Buildings related** Provide insulating doors/windows in hostels, offices and residences. **8. Notice** Mail drops at specific time periods. **9. Washing facilities in the hostels** Provide automatic washing machine to each floor in all hostels **10. Library** Family members may be allowed to access library but issue of books only on employee/student card for the library management.	**11. Classroom condition** Improve the classrooms with modern facilities **12. Misc** Outsource building and estate maintenance, housekeeping & security. Possibility of an entire building for basement parking Rainwater harvesting and grey water harvesting from residences Improve our sewerage Preserve heritage (a Committee on Heritage) **Special effort** Delhi Metro extending upto the Rajiv Gandhi Education City (Sonepat & Jhajjar)