E-profiling R&D involvement/ earnings of researchers: a G2E tool for performance management at CSIR–NML

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Abstract

Purpose – Council of Scientific and Industrial Research (CSIR)–National Metallurgical Laboratory (CSIR–NML) has launched a number of initiatives in different perspectives of e-Government. The "Mandays-Involvement" website was implemented by the laboratory in Government-to-Employee (G2E) perspective i.e. facilitating its research and development (R&D) manpower by providing data with respect to their own performance parameters through a single window. The development and implementation of the website had two major objectives : (1) to provide a system to the researchers for tracking and improving their own performance with respect to mandays and external cash flow generation and (2) to equip the management with a tool to enhance the organizational performance and enable optimum employee utilization.

Design/methodology/approach – Software Development Life Cycle approach was followed for the web-based system development and iterative model was used. Open source web development tools i.e. Php, My-Sql and CSS were used for the system development.

Findings – The new system helped in detailed profiling of current and future assignment of the researchers so as to have a check over preference-based allocation of work and providing equal opportunities of work to all.

Research limitations/implications – The percentage average mandays utilization was stabilized after the implementation of the website. The percentage under and over engagements of researchers in R&D projects was controlled and reduced.

Practical implications – The system outputs are utilized for R&D Team formation, Project approvals and Annual Performance Evaluations.

Originality/value – This new information system acts as a decision support system that helps the management to align its organizational policies toward the Future Research Projects and R&D manpower.

Keywords R&D performance, Mandays involvement, G2E, R&D manpower planning, HRIS, Web-based information management system

Paper type Case study

1. Introduction

The aim of e-Government is to provide services to the stakeholders by utilizing the recent Internet communication tools in different perspectives to ensure accountability, easy accessibility and transparency in all processes, namely, *Government to Government (G2G), Government to Business (G2B), Government to Employee (G2E), Government to Customers*

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(G2C) and others (Baležentis and Paražinskaitė, 2012). The Council of Scientific and Industrial Research (CSIR), India is the largest chain of publicly funded research laboratory in India. It has 37 laboratories scattered all over the country that conduct research in various areas, namely, *Metals*, *Leather, Coal, Fuel, Glass and Ceramics, Electronics, Drugs, Chemicals, Food Technology, Aerospace Scientific Instruments*, *etc.* CSIR–National Metallurgical Laboratory (CSIR–NML) is one of the laboratories of CSIR conducting research in the area of Metals, Materials and Metallurgy. All the research work undertaken at CSIR–NML is in projectised mode for proper allocation and monitoring of resources, namely, *Capital and Recurring Funds, Manpower and Equipment*. The researchers at CSIR–NML specialize in their field of work and have the requisite qualifications needed for carrying out their research work. Apart from research, these researchers are also involved in other tasks, namely, *Organizational Committee Memberships, Mentorship, Teaching and Administrative Tasks (Head of Department, Group Leader).* To improve the efficiency of its functioning, CSIR–NML has implemented several information systems to ensure implementation of e-service delivery for its stakeholders, namely, *Customer Query and Feedback System [G2C], E-Recruitment System [G2P]*, *E-Portfolio [G2E]* so as to orient toward (1) Self-*Sustainability through Industrial Earnings* and (2) *Optimal Utilization* of R&D *Manpower*.

The best possible way to enhance self-sustainability of the laboratory through industrial earnings was to (1) increase industrial funding/earnings by increasing industrial research and development (R&D) Projects and (2) increase the development and transfer of the R&D outputs, namely, Know–how, *Technologies and Intellectual Property (Patents, Copyrights)*. The public sector R&D laboratories are funded by the tax payer's money and are expected to produce new technological solutions for the development of Science and Technology in the country (Thornhill, 2006; Erfanian and Neto, 2017). Usually, the large-scale industries consume a large extent of technologies produced by the public sector R&D and provide a large amount of funding for new R&D explorations as well (Scherer, 1982; Cohen *et al.*, 2002). Such funding is utilized for planning new industrial R&D projects that can deliver technological solutions to meet industry needs. On one hand, industrial projects increase external cash in-flow for the laboratory but on the other hand, they also demand high amount of professionalism, on-time deliverables and performance guarantee.

The execution and implementation of industrial projects cannot be achieved without the Optimal Utilization of Resources which includes manpower. The R&D projects in general could be of various types, namely, Collaborative, Sponsored, Consultancy, Grant-in-Aid or Network. All R&D projects are executed by a team of scientific and technical manpower. The researchers need to perform proficiently to complete the planned activities of a project on time. Hence, the allocation of researchers in the R&D projects needs to be done cautiously to avoid under/over assignment of jobs to any individual researcher. A detailed profiling of the prior engagements/assignments of the researchers at large could help in ensuring optimum distribution of work among the R&D manpower. Further, such profiling could also help the management in the allocation of manpower for future R&D projects of the laboratory. In order to achieve the optimum utilization of R&D manpower, it was imperative to analyze the current involvement of the researchers in all the ongoing R&D projects. Additionally, a profiling of the external cash flow (ECF) generated by an individual in the R&D projects was also needed. This was calculated by distributing the total contract value of a project among the team members in proportion to their respective mandays involvement in that project.

Within the laboratory, the term "manday" was used as the unit of R&D involvement of a researcher i.e. booking of the researcher's working time in R&D projects. The term "manday" is gender impartial and one manday is equivalent to eight hours of work. In a year, a researcher can be involved in R&D projects for a maximum of 220 mandays.

A web-based application was conceptualized to fulfill the requirements of profiling the extent of mandays involvement and the ECF generation by a researcher. The development of the web-based information system i.e. "Mandays-Involvement" website was undertaken by a team of in-house experts. This forms the background of this paper. The objective of this paper is to elaborate on the architecture, usage and benefits of the "Mandays-Involvement" website that eventually evolved as *(1) decision support system (DSS) for the management in terms of the R&D and Manpower planning for the laboratory* and *(2) web-based tool in G2E perspective for the researchers that facilitate performance management*. The new website helped in providing equal chance to all researchers for association in the R&D projects without any bias or preference and purely on the basis of their availability and skills. Further, on analyzing the system outputs with the legacy data, it was found that the new system helped in reducing the cases of researchers having no R&D engagements as well as researchers having over bookings. This paper is divided in sections: *Introduction, Conceptual background, Related literature, New system design and development, Current usage and benefits, Limitations, Future scope and conclusion*.

2. Conceptual Background

2.1 Mandays involvement and external cash flow

"Mandays" is a gender independent term used for referring and recording the number of working days an individual researcher is involved in any project. An individual researcher can be engaged in multiple projects at a time. The total mandays involvement of a researcher is the sum of all the mandays booked against him/her in all the ongoing projects at any point in time. A researcher's mandays is actually invested in performing specific activities of the project. An individual is generally not involved in all the activities of a project. Hence, for any specified duration, the total mandays involvement of an individual is calculated as the fraction of mandays that are spent in executing the mapped activities that are ongoing in a given duration. The amount received from a customer against any R&D project, is termed as the contract value of the project. The total contract value of a project is distributed among the team members in proportion to their mandays involvement in the project. The total ECF generated by an individual researcher is proportionate to the mandays involvement of the researcher in all the projects in which he/she is involved.

2.2 The legacy system

The extent of mandays involvement of a researcher in any R&D project was manually provided through the project approval form in legacy system. The form captured information about various entities needed for the execution of any R&D project, namely, *Project (Title, Duration, Objectives, Activities, Deliverables, Manpower, Expenditure and Project Monitoring Chart)* and Customer Profile (See Figure A1). In the manual system, extracting data and profiling the total mandays involvement of a researcher was an extensive job which involved searching a large number of hard files and approval forms. Moreover, it was obvious to have errors in such manual compilation of data in general and probability of errors was even higher in searching data for long duration, namely *five years data for 10 researchers*. Also, the duration of all projects is different and all activities of any project are generally not executed together. Hence, an activity-based mandays calculation was needed rather than a project wise mandays calculation. Further, the data were needed to be fed into worksheets and manually the total used to be calculated (See Figure 1 and Figure 2). The process was repeated for the entire set of researchers to give a complete report of manpower involvement in R&D to the management.

The entire process would take at least a couple of weeks every time a similar report was to be prepared. The frequency of a new project approval was high, and it was nearly impossible to get the mandays involvement report before approving every new assignment of an individual.

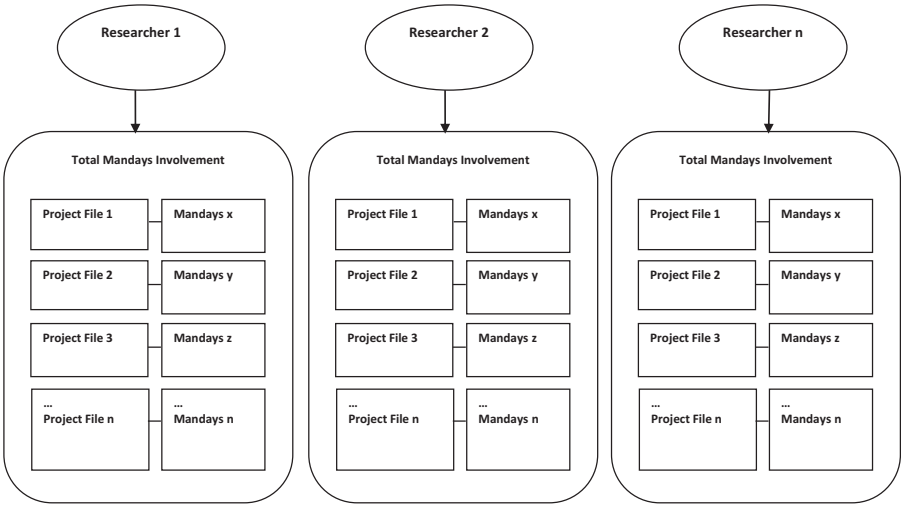

Figure 1.
Project-wise total mandays involvement of researchers

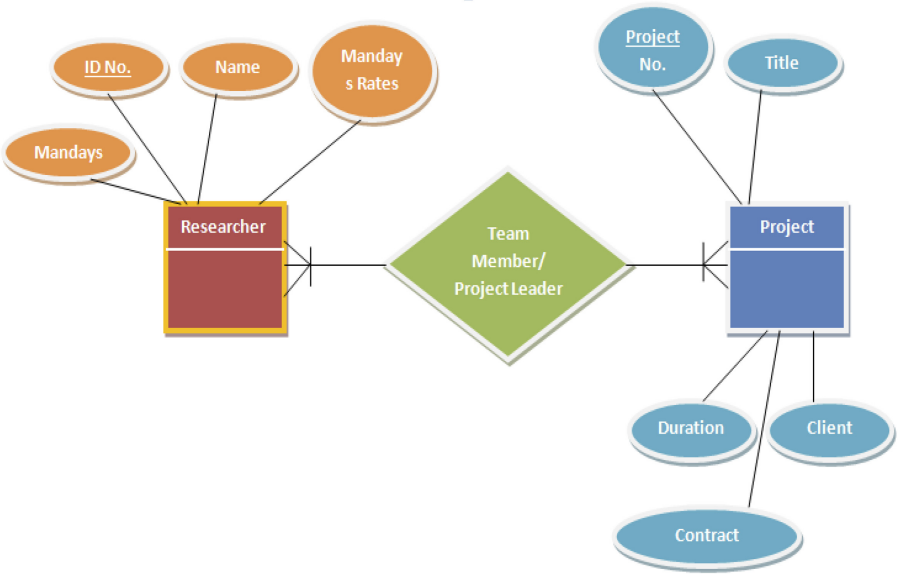

Figure 2.
Entity relationship (ER)- diagram

Hence, the need of an automated system for getting the profile of mandays involvement of researchers was felt by the management and the responsibility was assigned to the in-house website development team. The major challenges in the legacy system are listed in Table 1.

3. Related Literature

3.1 Information management systems and Internet Communication Technologies (ICT) for HRM

A number of past studies have focused the impact of implementing Human Resource Information Systems (HRIS) on the performance of employee and organization (Hussain *et al.*,

		Challenges	Type
1	(1)	Provide quick and real-time data extraction and reporting was nearly impossible or extensively time consuming	Operational challenges
	(2)	Obvious errors in manual handling of hard files of multiple projects	
	(3)	Extremely time intensive: weeks of mandays were wasted to build one report for one researcher	
	(4)	Overlapping of activities of various projects: a need for activity-based mandays involvement calculation	
2	(1)	Maximizing involvement of researchers in R&D projects	Management challenges
	(2)	Maintaining optimum level of utilization of all researchers	
	(3)	Uniform work assignment nearly impossible due to very frequent approvals of new project team: profiling of mandays involvement (MIV) was required in real time on a button click	
3	(1)	Lack of logical data base for rewarding high ECF generation	Performance management
	(2)	Lack of reliable information to consider ECF and MIV as performance parameters	

Table 1. Challenges in the legacy system

2007; Mithas *et al.*, 2011; Kundu and Kadian, 2012, Stone *et al.*, 2015; Bussler and Davis, 2002; Bondarouka *et al.*, 2017, Wibawa *et al.*, 2018). Also, authors of several past studies (Allen, 1986; Winkler *et al.*, 2010; Cette *et al.*, 2017; Edquist and Henrekson, 2017; Pieri *et al.*, 2017) have concentrated on the role of Internet Communication Technologies (ICT) in fulfilling Human Resource Management (HRM) objectives, namely, *performance assessment and manpower recruitment.*

Hussain *et al.* (2007) have studied the impact of HRIS on the human resource (HR) professionals in small-, medium- and large-scale enterprises and found that the HRIS are used extensively by all of them. The authors concluded that in large-scale enterprises, the HRIS is used more for strategic purposes and the small and medium enterprises (SMEs) use them more for the nonstrategic purposes. Although implementing HRIS can be an additional load for maintaining the legal burdens and fair use of the same yet, it can increase efficiencies by organizing the routine woks.

In his influential work, Mithas *et al.* (2011) have found positive impact of information systems on organizational capabilities of the firm, namely, *customer management, process management and performance management capabilities*. According to the authors, implementation of the information systems in these three dimensions in an organization can improve results in various functions of the organizations including HR results, namely, *employee well-being, satisfaction, and development and work system performance.*

Kundu and Kadian (2012) have studied the application of HRIS applications in various perspectives for different Indian industries, namely, manufacturing, service, national and multinational. According to the authors, the "technical and strategic HRM" and "performance and reward management" are considered as most important factors for a useful HRIS. Further, the most popular HRIS features that are utilized by a number of Indian organizations are *"employee record", "pay roll", "technical and strategic HRM", "performance and reward management" and "corporate communication"*.

Stone *et al.* (2015) have studied impacts and limitations of using information technology on the various goals of HRM, namely, *Attracting a talented and diverse workforce, Selecting talented and diverse employees, Increasing the knowledge, skills, and abilities of employees, Managing and enhancing employee performance, Motivating and retaining talented employees with diverse backgrounds*. According to the authors, the e-HRM tools have been both advantageous as well as disadvantageous in terms of achieving HR goals and cannot replace human interpretation of factors while decision-making, namely, less computer literate

persons, lesser privileged personnel and special situations. The authors conclude that the e-HR systems need to be more user friendly and dynamic as well as need to understand the social setups and develop humanitarian reasoning.

Bussler and Davis (2002) have remarked that information technology has brought a revolution in HRM practices and today no functionality in HRM is implemented without the help of software. According to the authors, such software not only enhances overall operational efficiencies for the organization but also simplifies HRM functions, namely, *performance appraisals information systems, online tracking of core competencies, training and development by distance learning, online salary surveys, e-recruitments, online interviews, virtual teams, global teams and others* .

Bondarouka *et al.* (2017) have reviewed e-HRM effectiveness research for a duration of 1970–2010 and remarked that e-HRM supports in improvement and enhancement of overall efficiency of an organization by helping in achieving goals of employees. Moreover, the authors concluded that although e-HRM is meant to facilitate employees in fulfilling organizational objectives yet, hardly any generic factors promote implementation of the e-HRM. Rather a number of people factors are behind the implementation and success of any e-HRM, namely, *innovative and visionary leaders promoting e-HRM, trust, change management, confidence with technology skills and communication about system usefulness.*

Wibawa *et al.* (2018) have worked for the development of a standardized HRIS for Indonesia and designed a system that can handle various aspects of HRM, namley, *employee presence, additional jobs, productivity and performance assessment*. The authors have also defined HRIS as a software program supports in decision-making process or acts as a DSS by providing variety of information about HR in real time from single window. Such information is handy and easy to store, access, modify, classify and analyze. Hence, it can help in quick and impactful decision-making. The authors conclude that any HRIS must provide (1) up-to-date information at a reasonable cost, (2) data security and personal privacy and (3) adequate, comprehensive and sustainable information system of people and jobs. Further, the authors conclude that HRIS can help in encouraging employees to work for high productivity and performance.

The impact of ICT on performance of researchers has been studied by a number of researchers (Allen, 1986; Winkler *et al.*, 2010; Cette *et al.*, 2017; Edquist and Henrekson, 2017; Pieri *et al.*, 2017). Allen (1986) has discussed the role of good technical communication within an R&D organization for enhancing R&D productivity. The author has conducted a literature review of related pieces of research, and concludes that the need of communication and coordination during execution of different R&D projects are different. According to the author, the inputs and outputs of R&D projects can be according to either the functional areas of researchers or the organizational goals. The author emphasizes the role of effective internal technical communication for R&D performance (project). Further, the author stresses upon the influencing ability of information technology on the R&D performance, and advises the need for the formation of a uniform goal-based organizational structure that would smoothen team-wide/organization-wide communication, and contribute to improvement of R&D performance. According to Winkler *et al.* (2010), the use of electronic resources in R&D increases productivity of researchers. According to Cette *et al.* (2013), the investments in R&D and ICT are crucial for a firm's growth in the current era. Moreover, such investments also contribute in improving the efficiency in the firm's productivity. Edquist and Henrekson (2016) have advocated that investment in ICT is extremely important for enhancing long-term performance of a firm. According to the authors, any such investment impacts in increasing the overall productivity of the organization in long run and hence, such investments must have a broad outlook and estimation. Pieri *et al.* (2017) have suggested that the use of ICT in R&D increases efficiencies in productivity.

3.2 E-government (G2E perspective)

Baležentis and Paražinskaitė (2012) have studied the available theoretical and empirical studies on G2E model and suggested new insights for the benchmarking of future G2E model and technologies. According to the authors, the purpose of e-Government (e-Gov.) is improved sharing, flow and access of the information and government services by all stakeholders and the goal of the G2E perspective of e-Gov. is to encapsulate all the activities and communications between government institutions and its employees. The authors suggest that components for the model for implementation of G2E have two aspects, namely, *managerial and technical*. The managerial elements are vision and mission of the public sector institutions. In order to organize public sector research in the framework of G2E first, a thorough research of their mission, purpose and objectives of concrete institution and services is required. According to the authors, these managerial elements can be divided in three levels, namely, *micro (organizational level), meso (interaction between micro and macro levels) and macro (country or sector politics level)*.

Choudrie *et al.* (2004) have assessed the features of a number of e-government portals and found that there exists a need of benchmarking in terms of the information and services such portals offer. Janita and Miranda (2018) have suggested the significant factors for the web portals that are used by the employees of public sector government employees. The authors utilized Delphi method with 31 specialists in quality improvement and found that four aspects must be taken care of while such developments are taking place, namely, *quality of information, technical efficiency and privacy and communication with the employee*. Various G2E implementations across the world are listed in Table 2.

According to Chowdhury (2018), the use of internet and communication technology (ICT) can increase the involvement of stakeholders for the government in developed and developing countries by increasing accountability, transparency and responsiveness in service delivery as well as productive relationships with the stakeholders. Further, the author has defined a web portal as a component of ICT that and a widely used instrument of governance that provides a variety of features, namely, collection, storage, exchange and use of information for various. According to the author the web portals act as the middle element that connects government service providers and the stakeholders. The author also has outlined the difficulties in implementing the ICT and web portals for the developing countries, namely, funding, technical capabilities, political and administrative policies and technical ability of the end users.

3.3 Public sector performance management

The basic aim of performance management is to constantly monitor and develop the processes that an organization follows. The functioning of public sector organization depends highly on the funds received from the government. Besides this, the public sector organizations also generate revenues by conducting research for private sector industries. It is vital for such organizations to sustain the inflow of funds, from all types of sources. This can be ensured by offering a desired level of competence and performance to the stakeholders.

With the increasing level of global competitiveness, and new sets of standards formulated by policymakers, it is necessary that public sector organizations adopt and implement proper productivity measurement techniques so that processes and productivity can be improved and enhanced. Performance management of an organization is important for continuous improvement in productivity. This section primarily focuses on the studies related with the applicability of performance management, as well as the measures of performance management in public sector organizations.

Bolton (2003) has investigated the manner in which the accountability of public sector organizations can be established through performance measurement. According to the

#	G2E implementations	Link and country
1	*E-OFFICE* – Supporting transparent inter and intragovernment processes	https://eoffice.gov.in/ India
2	*EPFO WEB PORTAL & MOBILE APP* – Aims for providing online balance check via "ePassbook" to both employees and pensioners	http://epfindia.gov.in/site_en/India
3	*LEARNING MANAGEMENT SYSTEM (LMS)* – Provides e-learning and training programs for government officials and staff members	https://lms.negd.in/India
4	*BIOMETRIC ATTENDANCE SYSTEM (BAS)* – Aims to track the attendance of all government staff members in the country	https://attendance.gov.in/ India
5	*Secure E-Mail within Government & MOBILE APP* – Provides e-mailing services to all government staff members	https://email.gov.in India
6	*DIGITAL SAKSHARTA ABHIYAAN (DISHA)* – Aims to provide it training to staff members like anganwadi, asha workers and all other nonilliterate staff members	http://www.ndlm.in/India
7	*JEEVAN PRAMAAN* – It enables issuing the online Life certificates to pensioners of Central Government, State Government or any other Government organization	https://jeevanpramaan.gov.in India
8	*SMS-based Vacancy and Recruitment Notifications (MOBILE BASED)* – SMS from various ministries and autonomous organizations	India
9	*The Defense Research Development (DRDO, Ministry of Defense (MOBILE BASED)* – Registration of applications for recruitment	India
10	Health Information *(MOBILE BASED)* – Central Government Health Services provided to their employees	India
11	*Public Safety (MOBILE APP)* – The Delhi Police using Police Control Room (PCR) vans can contact with the victims instantly for medical assistance	India
12	*Salary Notifications (MOBILE APP)* – SMS-based services utilized by the banks to inform the government employees	India
13	GPS-enabled smart phones to monitor the progress of the maintenance work of highway roads *(MOBILE BASED)*	Afghanistan
14	Employees can work from anywhere using phones and other personal or government-issued devices *(MOBILE BASED)*	Amsterdam
15	Mobile Field Inspections of the Environment Protection Department of Hong Kong *(MOBILE BASED)*	Hong Kong
16	A GPS-based mobile system to check its resources and employees *(MOBILE BASED)*	New Zealand
17	The North London Strategic Alliance (NLSA) Street Wardens Pilot Project *(MOBILE BASED)*	United Kingdom
18	The City of Corpus Christi, United States – Asset management system *(MOBILE APP)*	United States of America (USA)

Source(s): 1. https://www.digitalindia.gov.in/, 2. Chanana, L. (2007), Rao (2017)

Table 2. Showcasing G2E implementations worldwide

author, an effective use of tax payer's money in public sector organizations is crucial, and this can only be achieved by establishing the accountability of the users. According to the author, the drivers of performance in the public sector do not include competition; rather they include the extent or degree by which their objectives are fulfilled. The drivers of private and public sectors are also found to have principle differences. The author has also commented on the changing expectations of people from public sector organizations. The revived emphasis is on optimum utilization of public funds, as well as having a performance driven culture in public sector organizations. The author concludes that a balanced set of measures should be employed for performance measurement in the public sector.

Boyle (2006) has doubted as to whether performance management in the public sector is an impossible task. According to the author, the productivity of private sector companies and public sector organizations are considered equally important for the economic development of the nation. The author concludes by suggesting three key measures for performance

management of the public sector organizations, namely, *"developing organization-based measures", "increasing government sponsored studies on efficiencies and productivity of public sector" and "identifying benchmarked organizations for the purpose"*. The author says that it is extremely important to evaluate as to whether the returns given by the public sector are equivalent to the amount of public funds they utilize.

Greiling (2006) examines as to whether the implementation of performance management system improves efficiency in public sector organizations. The author concludes that merely employing measurement systems, do not really enhance the performance. Several related problems of public sector like multidimensionality of efficiency, the constraints of working and the ambiguity of public goals needs to be addressed as well. According to the author, the option of not being evaluated, in comparison with a compulsion for the evaluation of performance, affect in different ways on the efficiency of an individual. The author concludes that intrinsic or inherent motivation helps in increasing performance of an individual, rather than any extrinsic or external source of motivation.

Jyoti *et al.* (2008) have compared the performance of national R&D laboratories of CSIR, India. The authors have developed a simple and effective performance measurement model to evaluate the performance of the CSIR laboratories with respect to their relative efficiencies on the quantity and quality of their outputs. The authors consider annual budget as the input variable in research and development process and a variety of output variables, namely, *paper publications, patents, ECF generated, new product/process/technology, PhDs awarded and awards received*. Jyoti *et al.* (2010) have also identified the critical success factors for the national R&D organizations in India, and have also modeled the structural cause and effect relationship of such factors. According to the authors, 10 internal factors affect the performance of the government R&D organizations in India, namely, *"clear R&D vision and strategic directions", "top management commitment", "resource availability", "R&D project management skills", "organization culture and human resource", "focus continuous monitoring of techno-market environment", "teamwork", "knowledge networks", "customer focus" and "market orientation"*.

Burhan and Jain (2015) have found a connection between the patents filing and licensing of technologies with nongovernment financial resources generated by the laboratories of CSIR, India, during 2002–2015. According to the authors, patents filing, technology licensing and financial resources generated are not correlated rather, a nonconsistent pattern of patents filing and licensing existed amid all CSIR laboratories.

Singh (2017) has reviewed the existing studies on measuring productivity found that the techniques suggested in those studies were complex for implementation. The author has also introduced a simple measurement technique for total factor productivity i.e. "growth accounting" for the Indian scenario.

3.4 Performance evaluation parameters for researchers

The amount of R&D outputs generated by a researcher is a common parameter for performance evaluation, namely, *number of publications, impact factor, h-index, citations, number of patents, technologies transferred, number of R&D projects completed, number of foreign collaborations and others* (Turner and Mairesseb, 2005; Mauleón and Bordons, 2006; Jyoti *et al.*, 2008; Dias 2012; Prathap, 2013). Depending upon the availability of experts, the laboratory undertakes R&D work in varied areas. According to Obembe (2012), not all areas of research yield similar amount and type of outputs like that the fields of research, for example, research areas like chemistry, bio-chemistry, pharmacy and plant science, are found to be more productive than physics, mathematics and electronics in terms of R&D output publications. Hence, not all parameters are applicable for all researchers. It becomes even more intricate in the case of a R&D laboratory to do quantitative performance evaluation for the researchers in a government laboratory. In the case of CSIR–NML, the extent of mandays

involvement was included as a parameter in the annual performance evaluation system of the researchers. The new parameter had high relevance and applicability for all the researchers in general; moreover it could indicate a number of characteristics of researcher in particular, namely, *high mandays involvement (willingness to work, adaptable to various needs of the organization), high mandays as project leader (leadership qualities, ability to manage teams), high mandays as member (willingness to work in large number of projects, possess multiple skill, popular, team player) and others.* In addition to this, another parameter "external cash flow (ECF) generated" was also included in the performance evaluation parameter list. Since the total project value received is considered to be the effort of entire team, the credit to generate the cash flow is shared by all team members. The credit for the generation of ECF is given to the team members as per their quotient of mandays invested for the project work. With the web-based system to generate mandays involvement information an individual, it became easier to extract the ECF generated information through the same web-based system on the click of a button. Hence, along with mandays involvement report, the ECF generated report was added as a required module in the proposed web-based information system.

4. New system design and development

Being a public sector R&D lab. the requirements at CSIR–NML were unique. Firstly, the government encouraged use of open sources and CSIR–NML had an in-house ICT team that could take up the development and implementation work with open source development tools. Secondly, this also saved the investment of public money to buy proprietary software that could be costing in few lakhs per license. Now the web-based system is replicable and available to be utilized by thousands of researchers in minimal costs.

4.1 Changes in the legacy system

It was necessary to modify the legacy project approval form for the new system development, as the information regarding the mapping of manpower and activities was missing in the old form. Hence, the old form was modified to incorporate additional data fields, namely, Team Members Table (identity number of employee), Project Monitoring Chart (name of members against each activity of the project) (See Figures A1 in Appendix 1).

4.2 System architecture and module design

The new system and the modules were conceptualized keeping in view the needs of the organization. Software Development Life Cycle (SDLC) approach was followed for the web-based system development and iterative model was used. The iterative model allows repeating the phases of SDLC (i.e. Requirement Gathering, Analysis and Feasibility Studies, Design, Coding, Testing and Implementation) as per the actual needs of the development. The new system interacted with a number of existing standalone databases, namely, *employee database, project database and cash-flow databases*. The data pertaining to the project (namely, *start date, end date, project number, contract value, activities and the manpower details*) acted as the base for the new system design. The data were managed and available in the organization in the form of a stand-alone project database. One project would always comprise multiple activities and multiple team members work for a project (See Figure 3). Although, the relationship of activities and the manpower with the project is $n \times 1$ yet, the data were saved in a single field in the legacy database. Hence, there was a need to convert these data into $1 \times n$ form.

Further, the information about the responsibility assigned to each team-member was also needed for the new system. The original project approval form did not have any fields to capture these data. The form was modified and new fields were added. Hence, a mechanism to

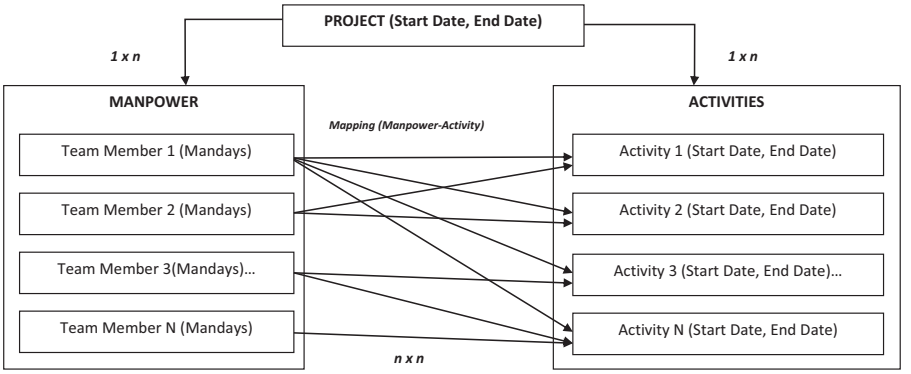

Figure 3.
Typical manpower-activity mapping

store the manpower-activity mapping information was devised in the new system as well (See Figures A1 in Appendix 1).

The architecture of the new system or the MIV website is given in Figure 4. The website is hosted on the apache web server and the User Interface (UI) interacts with the database server for real time data storing (activity, manpower and mapping) and extracting (project, cashflow and employee details). The user inputs (search dates and employee ID no.) are accepted at the client end and the mandays involvement and ECF reports are generated by processing the project-wise mandays allocation and mapped activities of an individual. The reports can also be exported in Ms. Excel format (See Figures A2 and A3 in Appendix 2). The modules of the system are (1) Entry and Search Data (Activity, Manpower and Manpower-Activity Mapping) and (2) Generate and Extract Reports (MIV, ECF Generated). The reports are extractable in Microsoft Excel format. The reporting module of the system was designed as per the requirements of the laboratory (See Figure 5). The access to the modules was

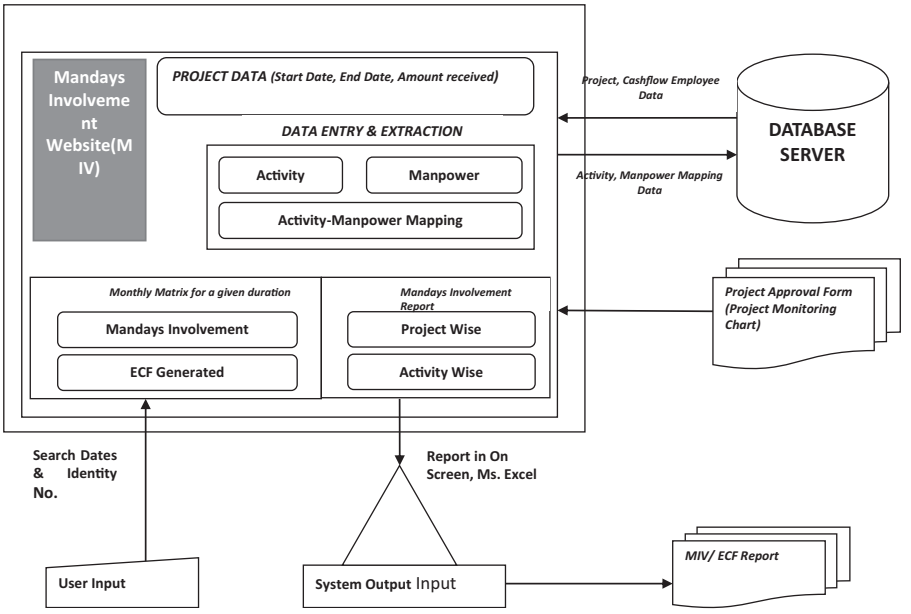

Figure 4.
Architecture of the manpower-involvement (MIV) website

customized as per the role of the user, namely, *Individual User (View and Extract Personal Reports), Administrator (View, Edit and Extract all data and reports), Super Administrator ((1) View, Edit and Extract all data and reports; (2) Approve Users and Assign rights).*

4.3 Development tools and database design

The open source tools, namely, Wamp Server 2.5, PhP and MySql were used for the development of the website. The database design was nonkey dependent. Every business constraint was forced in the code of the website. All the tables were prefixed with the same identifier and a total of four tables storing entities (namely, activities, manpower, activity-manpower mapping and user) were interacting with tables of other databases (namely, project, employee and cashflow) to generate reports.

4.4 Mandays involvement (MIV) and external cash flow generated (ECF) calculations

The calculation of mandays involvement was conceptualized with three entities related to a project, namely, Manpower, Activities, Manpower-Activities Mapping along with other project details like duration (See Table 3). Hence, with respect to a project and an individual, *mandays involvement in a date range can be calculated by*

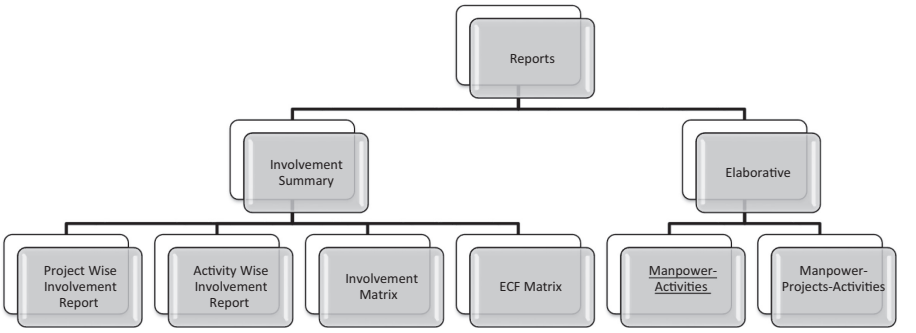

Figure 5.
Type of reports in the manpower-involvement website

1	Total activity months count in a project *(TAMCP)* =	n $\sum$activity$_i$ months $i = 1$ i is each mapped activity for a project
2	Total mandays involvement of a researcher in a month for a project *(TMIVMP)* =	Total mandays involvement in a project for an individual Total activity months count in a project (TAMCP)
3	Total month-wise count for a project in the given date range *(TMCPD)* =	n,12 $\sum$activity months$_{ij}$ $i = 1, j = 1$ i takes from 1 to n number of activities and j takes from 1 to 12
4	Total mandays involvement of a researcher for a project in a month (*TMIVPM*) =	n,12 $\sum TMIVMP_{ij} \times TMCPD_{ij}$ $i = 1, j = 1$
5	Total mandays involvement of a researcher for all projects in a given date range(*TMIV*) =	$\sum TMIVPMP_{ij}$ $i = 1, j = 1$ i takes from 1 to n projects and j takes 1–12 months

Table 3.
Calculation of mandays involvement of a researcher

(1) considering all the ongoing projects in which an individual is involved in a given date range.

(2) at least one activity for a project is ongoing and mapped to the individual in the given date range.

(3) calculating month-wise mandays for each project by.

- count of months for the full duration of the mapped activities (overlapping of activities in any given month is counted in multiple).
- dividing total mandays of the project by total count of months.

(4) count of months for the searched duration of the mapped activities (overlapping of activities in any given month is counted in multiple).

(5) multiply month-wise mandays by each month's count to get total month-wise involvement in the searched duration.

Further, *ECF in a date range is the product of amount received in the searched duration and the weighted factor in the searched duration. Weighted factor in a date range is calculated as mandays x rate of the searched manpower in the searched duration divided by sum of mandays x rate of all team members in the searched duration* (See Table 4).

4.5 Implementation

The development of the new system started in the year 2011 and was implemented for testing in the year 2012. Finally, the system with no known bugs was implemented in the year 2013 in two phases and user training was also conducted. Firstly, mandays – data management and reporting was introduced and secondly, the ECF management was launched. The initial response of end users was varied, namely, *fear of changed systems and processes, disclosure of facts and figures, mandays change exercise in older projects*. Today, the MIV website has more than 185 users and the usage is enormous and multipurpose. The system is live on the URL http://bdmserver.nmlindia.org/miv/ and keeps a large number of records, namely, Activities: 8,555 nos., Manpower: 6,635 nos. and Activity-Manpower Mapping: 42,293 nos. The system is dynamic and flexible with respect to the records and reports it generates (See Figure 6).

5.0 Current usage and benefits

Since its launch, the MIV website is considered as an essential tool that acts as a DSS for the management of the laboratory for various purposes, namely, *Manpower planning, R&D planning, Performance evaluation and Optimum utilization of the scientific manpower*. Currently, the mandays and ECF data are in use by all levels in the laboratory, namely, organizational, divisional and individual. The data are used for regular monitoring and policy decisions by the management and the divisions are utilizing data for ensuring feasibility in implementing the recommended changes. For example, if the new mandate is to participate in a government-funded project of national importance the divisions would ascertain the

1	*Weighted factor (in a given date range for a project) (WF)* =	$\sum_{i=1}^{n} TMIV_i \times Mandays\ Rate_i$
2	*ECF generated for all projects* =	$\sum_{i=1}^{\text{i takes 1 to n team members}} CashFlow_i \times WFi$ *i takes from 1 to n projects*

Table 4. Calculation of external cash flow generated by a researcher

Figure 6.
Manpower involvement (MIV) website home page

inclination and availability of the researchers by inquiring the pattern of involvement of the researchers in the division through this system. The responsibility then may be given to the researchers who are keen in participating in the government program of national importance. Further, the divisional contributions in organizational earnings can also be tracked through the new website. The mandays and ECF generated reports are popular among the individual researchers as it is a single window access to all information related to their participation in R&D projects and their ECF generation.

5.1 Comparative analysis of the organizational performance

The mandays involvement website has enabled convenient and quick profiling of R&D involvement of researchers. Years of data can be compared and studied to gain new insights about the achievements, strengths and lacunas of the laboratory. The number of researchers who have a nonzero involvement in R&D projects are 2011(130), 2012(141), 2013(137), 2014(142), 2015(140), 2016(144) and 2017(147), 2018(140). For instance, an analysis of mandays – involvement data of eight years (2011–2018) (See Figures 7–9) brings various insights about the development of R&D involvement of researchers over the years. The laboratory has a policy to preferably engage the researchers in R&D for a maximum 70–80% of their total mandays while encouraging the researchers to invest their 20–30% of mandays for self developmental activities, namely, *attending conferences and up-keeping their knowledgebase, obtaining academic memberships and fellowships* and *learning new skill sets by trainings*. Further, along with R&D, the researchers are also engaged in a number of other jobs that supports and are unavoidable for any R&D work like *procurement (namely,*

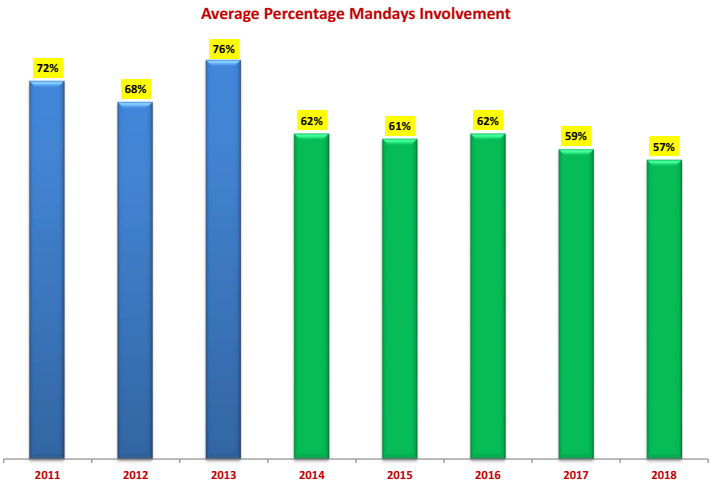

Figure 7.
Average percentage mandays-involvement of researchers (2011–2018)

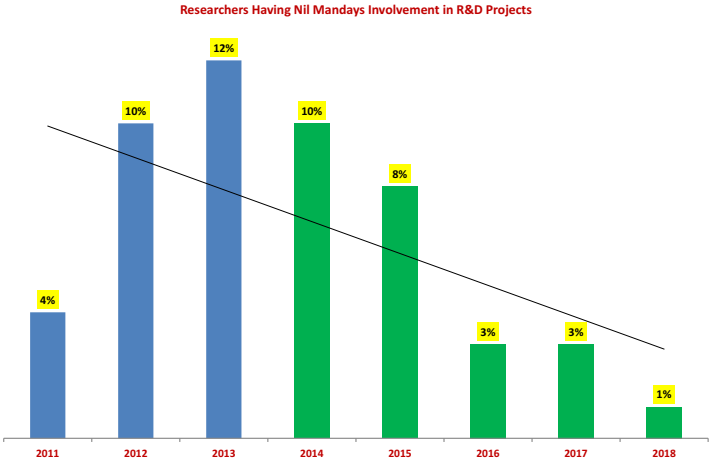

Figure 8.
Reducing percentage of never-utilized researchers (2011–2018)

equipments, raw materials and fabrications), committee memberships/chairmanships (namely, recruitment, purchase, assessment and promotion, annual performance appraisal, renovation and welfare), mentorship (namely, skill development of society, training to industry people, PhD scholars and postgraduation) and others (namely, headship, tendering, reporting to stakeholders, audit processes and certification). Hence, *Total Mandays Involvement of a Researcher = Direct Booking in R&D Projects + Additional Administrative or Support Jobs that are inevitable for conducting R&D.*

The scenario of R&D involvement of manpower in the laboratory can be divided into three periods, namely, pre-MIV website (2011 & earlier), transition (2012–13) and post-MIV website (2014 onward). Prior to the implementation of MIV website the allocation of manpower was done randomly or preferentially. During the initial implementation of MIV system, and legacy mandays-involvement data analysis pointed toward an extremely overloaded workforce i.e. 2011(72%) (See Figure 7). Hence, the next two years were invested in regular monitoring and

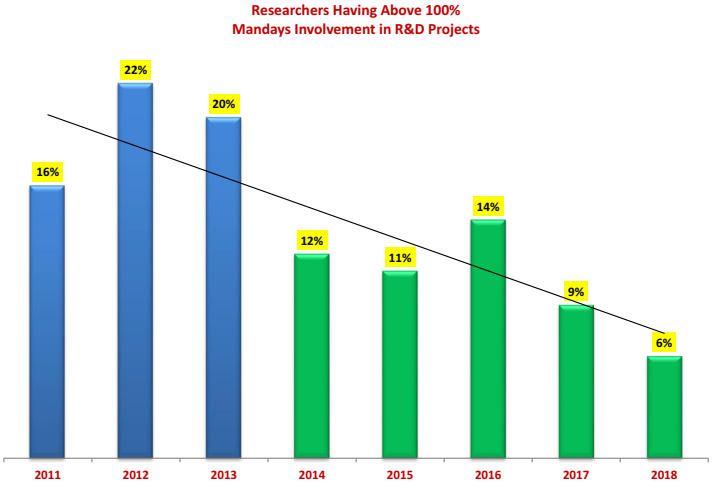

Figure 9.
Reducing percentage of overutilized researchers (2011–2018)

correction of the extreme patterns of mandays allocation in the R&D projects. An exercise for reducing and optimizing the mandays distribution in each and every R&D project was initiated and continued for almost two years. After the year 2013, with the help of MIV website and new organizational policies in place, the mandays allocation patterns were eventually normalized. As a result, over the years, the average percentage mandays involvement in R&D projects has stabilized to be 60%. This percentage of involvement leaves scope for the researchers to be engaged in other non-R&D jobs as well as undertaking some self-developmental activities. Further, the average involvement of researchers is also proportional to the number of projects being executed in the laboratory (See Figure 10). The average mandays involvement decreases with the decrease in number of projects, namely,

Figure 10.
Total number of projects executed during 2011–2018

years 2017 and 2018. The laboratory has also succeeded in reducing the count of researchers having no involvement in R&D as well as researchers overinvolved in the R&D work (See Figures 8 and 9). In this connected Figure 10 clearly indicates that the overall involvement of researchers in R&D has increased gradually over the years (see Figure 11).

Further, Figure 12 reflects that the researchers are investing their mandays in same proportion i.e. around 40% in both Industry-Sponsored Projects (Sponsored and Collaborative) and Government/Network Projects, and around 20% of their mandays in In-House Exploratory Projects. On the contrary, the total count of government projects (17%) is nearly four times lesser than the sponsored projects (65%) (See Figure 13). This indicates that although the extent of government-aided projects is lesser yet, the mandays commitments in government projects are at par with the total mandays commitments in sponsored projects. Hence, this indicates that the researchers are not only keen to earn from the sponsored projects but also participating in the national importance projects remains a priority for them as well. Further, the data also indicate that the laboratory has been successful in optimizing the manpower utilization of its researchers' around 60% and could orient toward sponsored research as well (65% of sponsored projects undertaken during 2010–2018).

5.2 Key benefits for the stakeholders

The mandays involvement website was primarily conceptualized as a tool to assess the status of mandays involvement of a researcher in R&D projects, but the data and outputs became useful in meeting additional objectives of the management as well. Primarily, the mandays involvement report facilitates Manpower Planning for the laboratory. The extent of mandays involvement during a particular time period gives two folds information about a researcher. Firstly, the extent of mandays that are already booked during a given time period and secondly, the mandays available for booking in future projects. The mandays availability information can be utilized in planning team members for all future projects of the laboratory. For example, availability of a researcher having a required specialization can be checked before formulating a typical R&D proposal and its deliverables. In this way, timelines for activities and deliverables of future R&D projects can be planned practically and any delays in fulfilling the promises to the clients can be avoided. Hence, a regular reviewing of the mandays availability information for all the researchers provide crucial information on the

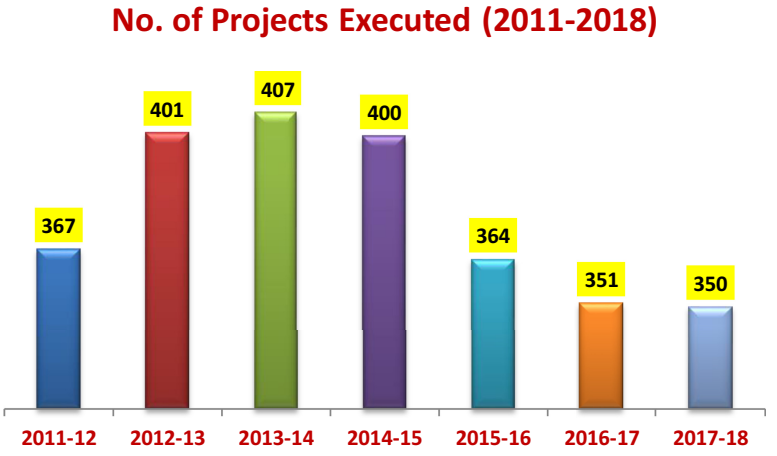

Figure 11.
Increasing overall percentage of researchers involved in R&D

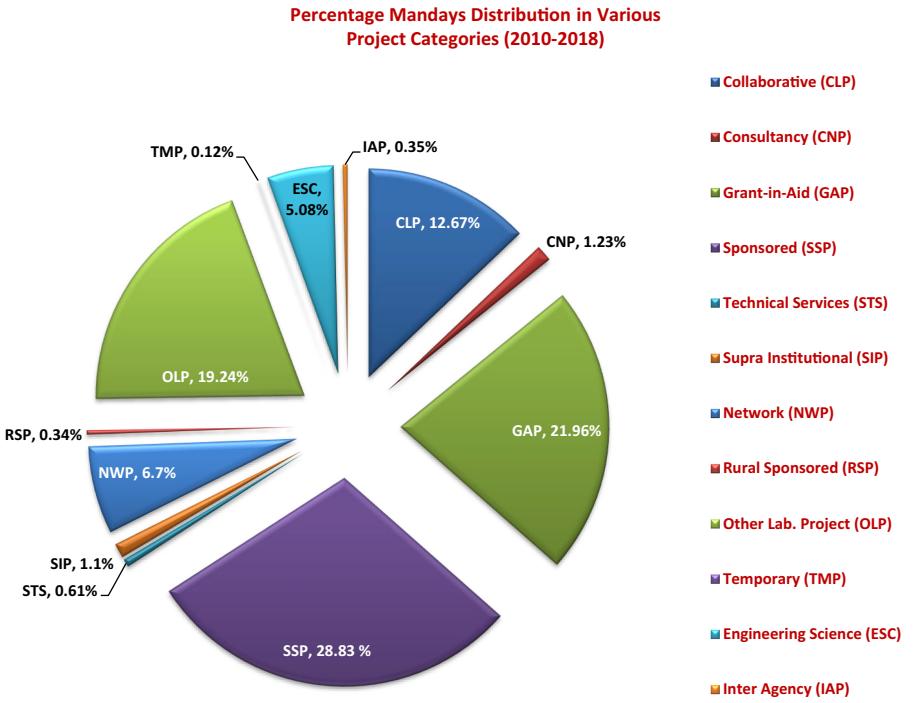

Figure 12.
Percentage mandays distribution in various project categories (2010–2018)

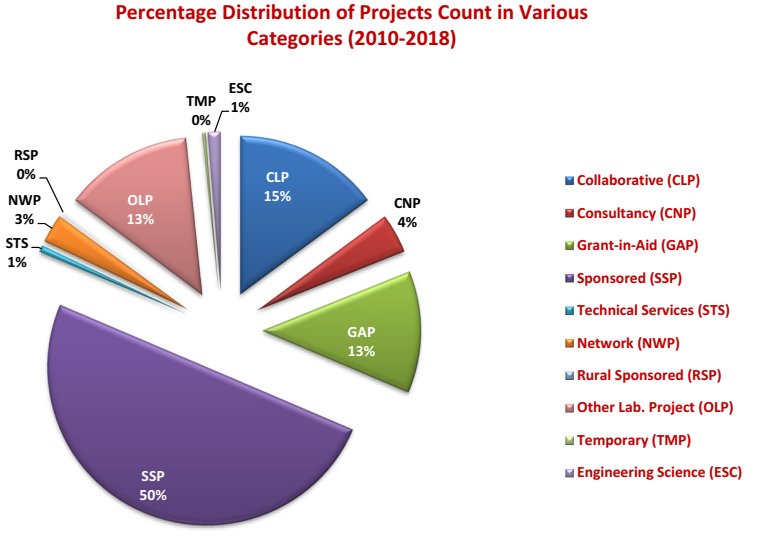

Figure 13.
Percentage distribution of project count in various categories (2010–2018)

need to recruit with respect to maintaining an optimum strength of researchers in a particular specialization or area of research.

It is true in all cases, that resources are always lesser than required, so all resources must be optimally used for maximizing the gains. Especially with respect to the human resources, achieving optimum utilization can be even more complex at times (Kumari *et al.*, 2015). When the individuals are different their expertise and choices are also different. While the core area of a laboratory is supposed to have the largest sets of researchers and the projects, the actual situation may be entirely different. The most profitable R&D areas for a laboratory can be more than one and it is possible to have only a handful of experts working in those areas. In such cases, a large section of R&D manpower may not be able to contribute significantly toward the earning and growth of the laboratory. Hence, a feeling of dissatisfaction may arise among the researchers. Here the management has to play a crucial role and find solutions to engage the manpower in providing new opportunities for them or training them on new tools and techniques. It is extremely important to achieve a balanced distribution of work among all the manpower of the organization for creating a healthy working environment. It is equally important for the organization to optimally utilize their researchers and avoid any under/over utilization of any researcher, so that a sense of equal participation and equal opportunity exists amongst the employees (Post *et al.*, 2009; James, 2011). A regular assessment of the mandays involvement data can help in presenting a true picture of the involvement of all researchers. Corrective actions can be initiated for optimum utilization of the R&D manpower as well as for facilitating individual researchers to act and improve upon their own R&D involvement.

Further, the mandays-involvement and ECF-generated data are parameters for the performance evaluation of the researchers. There are a number of parameters for the performance evaluation of a researcher, namely, *patents, copyrights, publications, technologies and citations* (Turner and Mairesseb, 2005; Mauleón and Bordons, 2006; Jyoti *et al.*, 2008; Dias, 2012; Prathap, 2013) It may not be necessary that a researcher having higher mandays involvement may have a better performance in terms of generation of R&D outputs. Though, this may increase the probability for the same as it helps in encouraging a researcher to be involved in a large number of research projects. For a laboratory that has a focus on industrial earnings, it may consider the ECF generated as a parameter for performance evaluation to encourage a researcher to focus on earnings from industries.

The outputs of the website are beneficial for an individual researcher in improving his performance as well. The new system provides detailed information of the type of projects a researcher is involved in. It also provides the statistics with respect to the mandays and ECF. The main output of the system is the mandays involvement report of a researcher for a specified duration in various categories of projects, namely, *Industry Sponsored, Grant-in-Aid, Collaborative, Network and Consultancy Projects*. There can be many perspectives to analyze these data. For an individual researcher, one's mandays involvement data could be a tool for self-assessment of one's capabilities and performance. If the extent of one's contribution is not sufficient in comparison to the standards of the organization (60%–80% of 220 man-days in CSIR–NML) then necessary steps could be adopted for improving the situation. Hence, this system acts as an awareness tool for the improvement in performance of an individual. Further, a researcher can also review the type of projects he or she is involved in. Another significant output of the new system is the report of ECF generated during a given duration (by a researcher). ECF generated from the government agencies and external industry sponsors can also be tracked through the system. If the ECF is less than the target set by the organization, necessary steps can be taken immediately to improve the situation. These may be monitoring the payments to be realized from the clients, involvement in a large number of industry sponsored projects or grant-in-aid projects having a high contract value.

The data and reports generated by the website are immensely useful from the organizational perspective as well as an individual perspective. Firstly, the system helps in

ensuring an even distribution of work to the researchers by analyzing and acting upon the mandays involvement reports at regular intervals. Further, new organizational policies can be drafted for mandatorily engaging most of the researchers for a minimum number of mandays in the R&D projects, namely, *all junior researchers must take in-house exploratory projects, one senior researcher to act as a mentor in every in-house project, 25% of total mandays in any project to be booked in the name of entry level and junior scientist, pattern of team formation (keep all levels of researchers in any project team) and others*. The management can implement such mechanisms to enhance the average participation in R&D projects. Secondly, the type of projects along with the pattern of manpower involvement can also be analyzed, for future R&D planning. The system also plays a major role in the performance assessment of the researches.

5.2.1 Key takeaways for governmental research institutions. R&D for the benefit of industry as well as society is the primary responsibility of any government laboratory. But the onus of conducting R&D is on the researchers always. Hence it is the duty of the institutions to facilitate its researchers and fulfill their overall needs, namely, resources (equipments, literature and funding), equal opportunities of growth and rewards for achievements. Hence, other government R&D institutions can also plan for implementing G2E initiatives or HR applications that can help in optimum resource and work allocation and bring sense of equality amongst researchers. Moreover, such applications can also help in better R&D planning and achieving improved performance of researchers. Mobile applications and social networking can be integrated into the HR applications encouraging the researchers to be connected and aware and alert toward their existing and future assignments as well.

5.2.2 Lessons learned and key takeaways to other G2E scenarios. The purpose of any G2E implementation is to facilitate and empower the employees in a functional area. Unless the proposed system is user friendly and simplifying the process that was earlier manual, the new system may not be smoothly implementable. Further, it is notable that besides having a detailed plan of user needs and having adapted the most suitable model for new system development (iterative/waterfall/spiral), the scenario during implementation may change and a need for recoding or troubleshooting may arise. In case of a proprietary system adaptation, the contract given to the vendor must focus on maximizing the support for the new system, in the same cost. In case of the in-house development, the staged implementation would be advantageous to learn and avoid troubles in the later phase. Finally, it is necessary to involve the end users right from the beginning of the development and testing, so that the gaps may be addressed from an early stage.

6. Limitations, future scope and conclusion

The MIV website was implemented in CSIR–NML with the aim of development of R&D manpower and efficient long term R&D planning. Although researchers have the prime responsibility to execute R&D projects, yet, any organization cannot run without the help of other support divisions, namely, *Administration, Finance and Accounts, Stores and purchase, Research Planning and Business Development, Internet Communications and Technologies, Knowledge Resource and others.* CSIR–NML also has a number of manpower who are involved in the aforementioned R&D support divisions. Further, the scientific staff also contributes to a number of support activities, namely, *Committee Memberships, Mentoring, Exhibitions and other administrative jobs (namely, Head of Division and Group Leader).* The MIV website only captures information about the booking of manpower in R&D projects and has no mechanism to capture the involvement of manpower in other non-R&D or R&D-support jobs. This is a lacuna in the system as it does not take into account the non-R&D activities. Hence, a comprehensive picture of the actual involvement and availability of R&D

and non-R&D manpower of the laboratory does not exist. Future development can be taken up to overcome this issue. Future studies can be taken up by academicians and practitioners on various other aspects, namely, *relationships between mandays involvement and ECF generated, impact of mandays involvement on productivity of researchers, impact of pattern of researcher's involvement with their performance, impact of MIV website as a DSS Tool.*

The researchers are the spine of any R&D laboratory and the dependence of the organization, on its researchers is extremely high. Unless, the organization is able to engage its R&D manpower optimally it cannot fulfill its commitments towards the external clients. Every individual researcher is likely to pursue their own preferences in terms of the kind of outputs they generate (namely, *Patents, Publications or Copyrights*) and the kind of R&D they do (namely, *Basic Research, Technology Development or Industrial Research*). It may become tricky to make them all work together towards achieving a specific organizational goal (Kumari *et al.*, 2015). Hence, some measures for enhancing the involvement in R&D must be implemented by the management for the researchers at large. They should also be facilitated with tools to monitor their progress. The MIV website provides a solution to both organizational and individual perspectives. It assists the management in (1) understanding the current engagement and performance of its R&D manpower in terms of the external earnings i.e. ECF generated per researcher, (2) helps to predict the future needs of the laboratory in terms of skills and specializations of researchers for future projects and (3) provides data for performance evaluation of the researchers. From the individual perspective, the website provides an opportunity to the researchers for continuous review and improvement with respect to optimal R&D involvement and earnings. The MIV website has also been able to meet the organizational objective to provide the electronic delivery of services to the researchers in G2E perspective i.e. providing data and information along with setting transparency and accountability.

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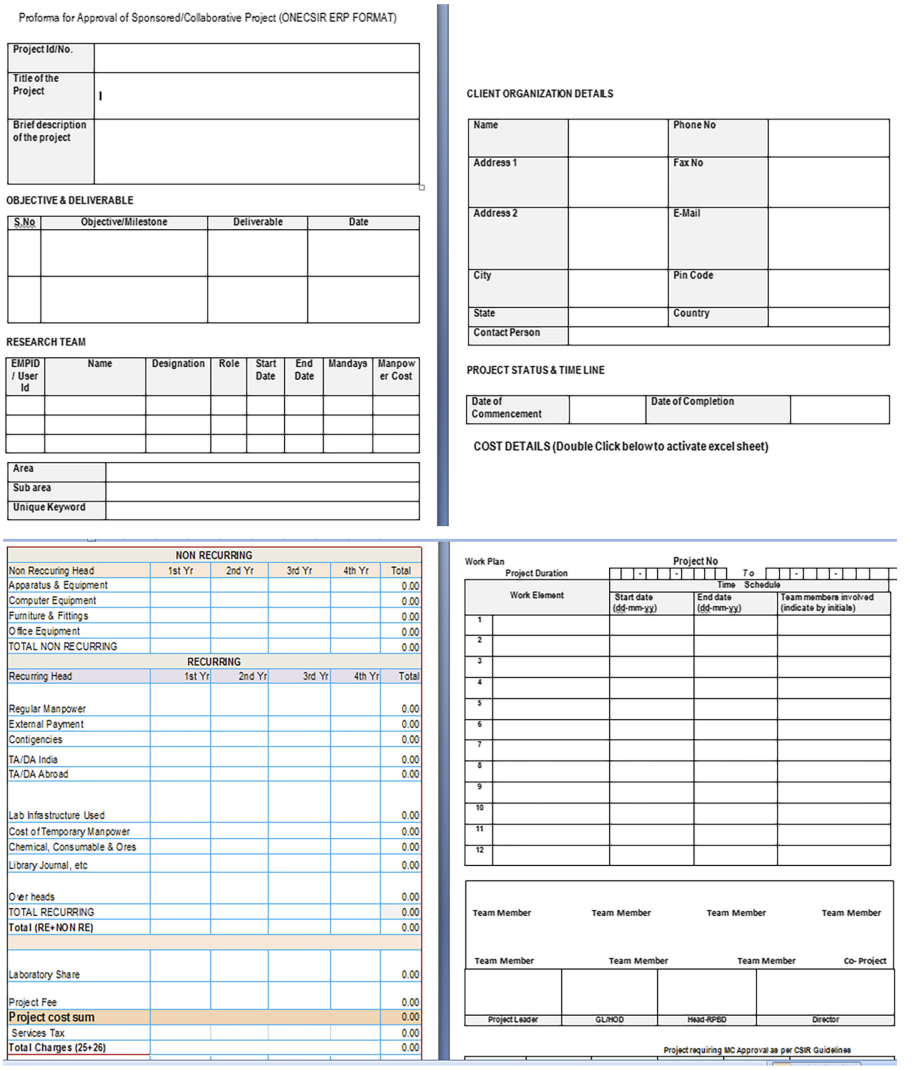
(The Appendix follows overleaf)

Appendix 1



Proforma for Approval of Sponsored/Collaborative Project (ONECSIR ERP FORMAT)

Project Id/No.	
Title of the Project	
Brief description of the project	

OBJECTIVE & DELIVERABLE

S.No	Objective/Milestone	Deliverable	Date

RESEARCH TEAM

EMPID / User Id	Name	Designation	Role	Start Date	End Date	Mandays	Manpower Cost

Area	
Sub area	
Unique Keyword	

CLIENT ORGANIZATION DETAILS

Name		Phone No	
Address 1		Fax No	
Address 2		E-Mail	
City		Pin Code	
State		Country	
Contact Person			

PROJECT STATUS & TIME LINE

Date of Commencement		Date of Completion	

COST DETAILS (Double Click below to activate excel sheet)

NON RECURRING					
Non Reccuring Head	1st Yr	2nd Yr	3rd Yr	4th Yr	Total
Apparatus & Equipment					0.00
Computer Equipment					0.00
Furniture & Fittings					0.00
Office Equipment					0.00
TOTAL NON RECURRING					0.00
RECURRING					
Recurring Head	1st Yr	2nd Yr	3rd Yr	4th Yr	Total
Regular Manpower					0.00
External Payment					0.00
Contigencies					0.00
TA/DA India					0.00
TA/DA Abroad					0.00
Lab Infrastructure Used					0.00
Cost of Temporary Manpower					0.00
Chemical, Consumable & Ores					0.00
Library Journal, etc					0.00
Over heads					0.00
TOTAL RECURRING					0.00
Total (RE+NON RE)					0.00
Laboratory Share					0.00
Project Fee					0.00
Project cost sum					0.00
Services Tax					0.00
Total Charges (25+26)					0.00

Work Plan — Project No

Project Duration — To — Time Schedule

	Work Element	Start date (dd-mm-yy)	End date (dd-mm-yy)	Team members involved (indicate by initials)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

Team Member | Team Member | Team Member | Team Member

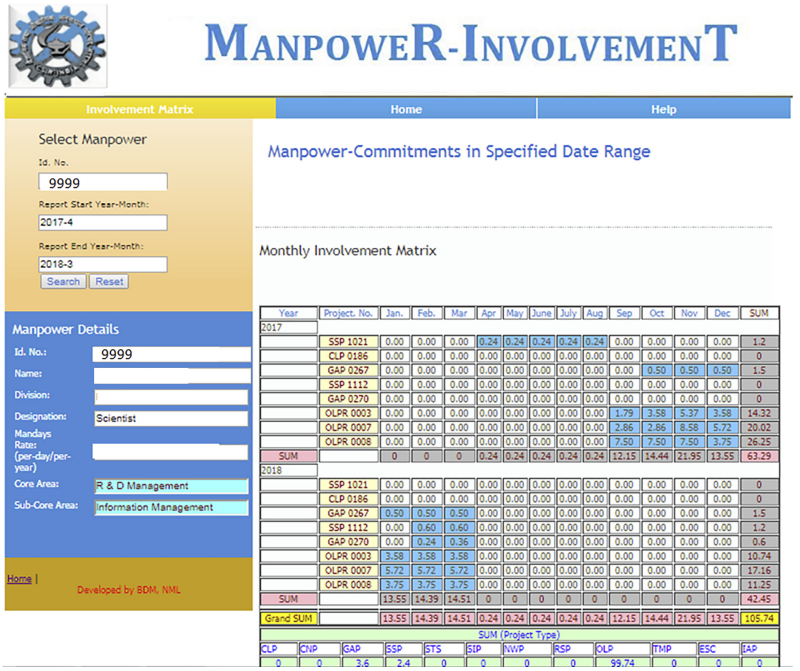
Team Member | Team Member | Team Member | Co- Project

Project Leader | GL/HOD | Head-RPBD | Director

Project requiring MC Approval as per CSIR Guidelines

Figure A1.
Revised project approval form

Appendix 2
Reports



MANPOWER-INVOLVEMENT

Involvement Matrix | Home | Help

Select Manpower

Id. No.: 9999

Report Start Year-Month: 2017-4

Report End Year-Month: 2018-3

Search | Reset

Manpower Details

Id. No.: 9999
Name:
Division:
Designation: Scientist
Mandays Rate: (per-day/per-year)
Core Area: R & D Management
Sub-Core Area: Information Management

Home | Developed by BDM, NML

Manpower-Commitments in Specified Date Range

Monthly Involvement Matrix

Year	Project. No.	Jan.	Feb.	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	SUM
2017														
	SSP 1021	0.00	0.00	0.00	0.24	0.24	0.24	0.24	0.24	0.00	0.00	0.00	0.00	1.2
	CLP 0186	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
	GAP 0267	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.50	1.5
	SSP 1112	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
	GAP 0270	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
	OLPR 0003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.79	3.58	5.37	3.58	14.32
	OLPR 0007	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86	2.86	8.58	5.72	20.02
	OLPR 0008	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.50	7.50	7.50	3.75	26.25
SUM		0	0	0	0.24	0.24	0.24	0.24	0.24	12.15	14.44	21.95	13.55	63.29
2018														
	SSP 1021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
	CLP 0186	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
	GAP 0267	0.50	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.5
	SSP 1112	0.00	0.60	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.2
	GAP 0270	0.00	0.24	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.6
	OLPR 0003	3.58	3.58	3.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.74
	OLPR 0007	5.72	5.72	5.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.16
	OLPR 0008	3.75	3.75	3.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.25
SUM		13.55	14.39	14.51	0	0	0	0	0	0	0	0	0	42.45
Grand SUM		13.55	14.39	14.51	0.24	0.24	0.24	0.24	0.24	12.15	14.44	21.95	13.55	105.74

SUM (Project Type)

CLP	CNP	GAP	SSP	STS	SIP	NWP	RSP	OLP	TMP	ESC	EAP
0	0	3.6	2.4	0	0	0	0	99.74	0	0	0

Figure A2.
Report-month-wise mandays involvement matrix

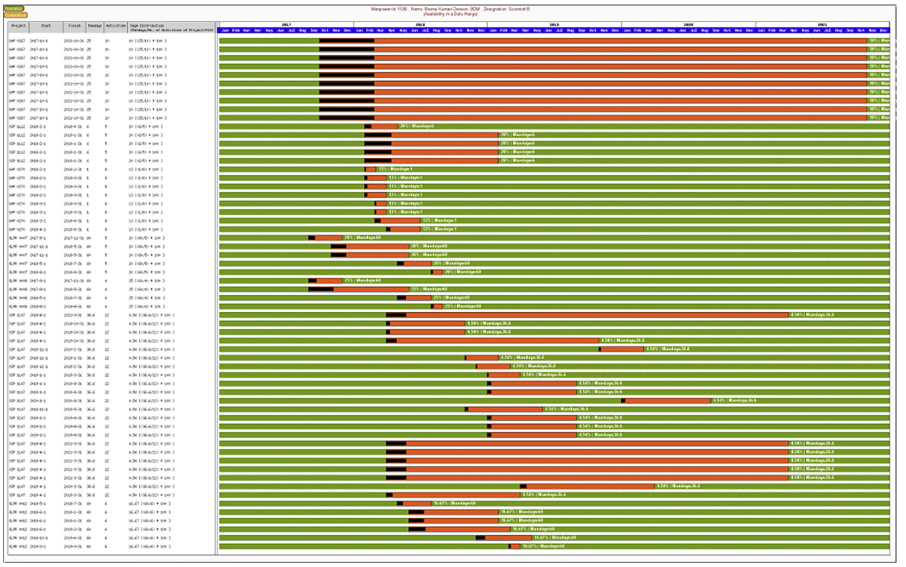


Figure A3.
Report-mandays availability (green)/ engagement (Rd) Gantt-chart for the searched duration

About the authors

Dr Beena Kumari is a Sr Scientist in CSIR–NML. She has an experience of above 13 years in the areas of software and website developments and R&D project management. She has led and participated in a number of software application/websites development projects, with the aim of e-Government implementation in her organization. Her research areas focus is on R&D Manpower Development, Public Sector R&D Organizations and e-Government. Beena Kumari is the corresponding author and can be contacted at: beena@nmlindia.org

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