

LeanERP® Mobile Platform Solution for Planning, Visualization and Execution of Business Operations in MSME Units

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Abstract — The paper presents the design and development of a solution framework for a LeanERP® interactive application for use with mobile handheld devices, which enables profile based activity logging, planning and execution of tasks, information sharing, collaboration and decision support aligned with the enterprise operations. The design leverages intelligence with the use of cognitive approaches, classifier systems and a data driven approach for adaptive profiling and configuration of software behavior.

The solution is well suited for MSME units as the architecture is designed on the basis of a SOA for rapid adaptation and deployment for a given cluster and presents an engaging role centric GUI with multiple widgets and tabs for dynamic visualization of information relating to enterprise operations with trails and traceability of process flows, events, activities, analysis and cost estimates.

The solution integrates mechanisms, data structures, algorithms and associated computational models that enable presentation of performance characteristics, predictions and appropriate options for decisions relating to various operations

Keywords — Cognitive Mechanisms, Decision Support, Mobile Solution, MSME, Operations Management, SOA, Software as a Service, Transactions Processing.

I. OVERVIEW OF THE SOLUTION DESIGN

The LeanERP® solution is essentially designed to

- (i) Present and capture information relating to various transactions at the point where it gets generated on a mobile handheld device, in an engaging GUI framework, adapted to the profile of the user.
- (ii) Communicate with the server to store such information in a database with details of the persons who transacted information, the characteristics of the process, transaction or activity, the time the transaction occurred and other transaction related information and
- (iii) At any later point in time, generate the record relating to the transaction by reconstructing it on the fly from the database and rendering it on the handheld mobile device.

The authorized user may invoke and generate the transactional record as an evidential document from the data base, which is rendered on the mobile device screen. The solution does not ordinarily have a document management system.

However, images in the form of visual frames or video clips as are relevant, captured from surveillance cameras at strategic locations can also be associated and stored in the database for reconstruction of events or for the purpose of evidential records in future.

The technology developed relies on;

- (a) Encoding of information logged by the user, use of intelligent cognitive mechanisms that discern the pattern of interactions/ invocations and the parameters associated with such interactions in the form of messages which are communicated to the server end computing environment
- (b) Maturity and sophistication in the design of solution architecture at the server end computing environment that enables the user engage and participate meaningfully in the tasks that he is entrusted with in the enterprise.

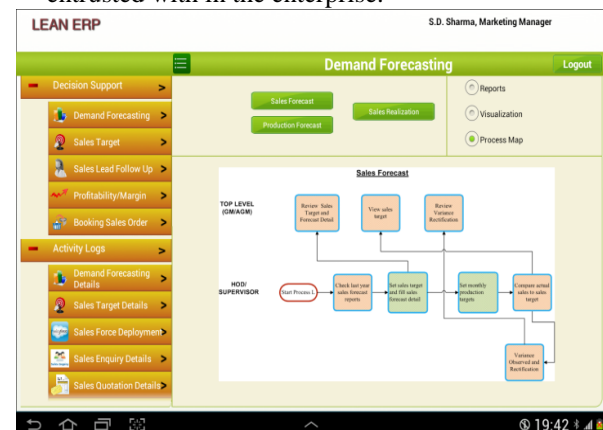


Fig.1. Illustrative GUI of decision support providing an interactive process map for an enterprise operation.

Domain knowledge representation, interactive process maps, information related to key performance characteristics are presented to the user, engaging him and providing him with an insight of enterprise operations to facilitate proactive interventions as illustrated in Fig 1. Automation and decision support are based on functional requirements of enterprise operations with adaptive presentation of links and features to invoke analytical models serving to process information and presenting the results of such analysis to enable the user plan and execute related operations.

The characteristics, requirements and functional attributes of a mature ERP solution are described and documented in sufficient detail. [1], [2] & [3].

While a generic look and feel with organization of links is offered to every enterprise user, some of the widgets are displayed depending on the profile of the user and the operations he is responsible for.

Notifications appear against the links indicating that actions are required to be performed by the user. The task panel when invoked presents a detailed view of the pending tasks requiring the attention of the user.

II. SIGNIFICANT DESIGN ASPECTS

A. Reconstruction & Visualization of Transactions on the fly

An illustrative list of some of the needs of micro, small and medium enterprises (MSMEs), are traceability of costs, following the sequence of activity trails, discerning the pattern of activity relating to a certain operation, prediction of market opportunities, manpower deployments, gaps in performance and productivity, impediments in production, impact of stockout, estimation of margins, economic value addition at various stages, computation of product costs, interventions required for quick turn around of cash flows, efficacy of distribution channels, decision whether to take up a given order and associated negotiation, articulation of contract provisions adapted to customer/ client profile etc.

The LeanERP Solution framework enables visualization of these aspects in a form that enables comprehension of the underlying relationship between various entities/elements and their inherent dynamics.

Some of the significant capabilities of the solution being implemented as relates to interactive visualization are ;

- (i) Generation of activity status, transaction characteristics, process parameters, forms seeking inputs adaptively
- (ii) Enabling trails and traceability, drilled down features, slicing and dicing of information for various contexts
- (iii) Presenting varying views of underlying information schema from a given perspective desired by the user, for decision support

The entity relationship diagram in the form of a schema which illustrates the complexity of information domain and transactions is shown in fig 2.

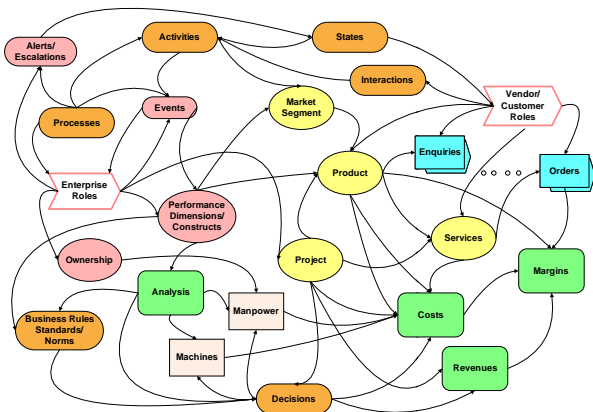


Fig.2. Schema of entities and relationships embedded in the Design of the Enterprise Solution

B. Role Centric Decision Support

An enhanced feature of the solution architecture is the role centric nature of the interactive visualization and associated capabilities for decision support on a mobile platform and the alignment of such features with the roles and responsibilities of the user within the enterprise as shown in fig 3.

A configuration module enables the specification of parameters and the definition of roles and mapping of such roles to process steps and associated features of the enterprise solution.

The dashboards that are presented enable the user get different views and perspectives of operations, activities or outcomes in keeping with his responsibilities.



Fig.3. User Centric visualization of Enterprise Performance with graphics and interactive drill down features

C. Altering Software Structure and Behavior based on parameterized design and configuration parameters

The emphasis in the design of the enterprise solution architecture is based on a Rapid Prototyping approach, where through an Agile – Sprint & Scrum Model, the solution is adapted and rolled out iteratively in keeping with the requirements for user engagement, familiarization, comprehensibility, manageability and progressive build up of individual and institutional capacity.

Software structure and behavioral manifestation of a given functionality is based on a parameterized process design which can be specified or altered to adapt the software behavior to suit the requirements of the enterprise users concerned.

The enterprise need for changes in workflows, definition of roles, allocation of work and such other enterprise behavior would be addressed with features that enable configuration of the application architecture adapted to such change requirements.

D. User Engagement with elegant adaptive GUI and multiple widget Layout segments

A comprehensive layout of GUI is presented to the user in the form of a multi-widget segment layout encompassing (i) interactive links panel, (ii) transaction panel and (iii) intelligent interfaces for invocation of decision support & analytical models with cross functional links, context help on policies, guidelines, process maps and standard operation procedures.

The interfaces and associated links can be visualized in the form of multiple layers. The lower layers correspond to processes and activities performed by a functionary whose areas of responsibility is usually restricted within a given division, but may need to be

kept aware of information or status relating to operations in other divisions on a need to know basis.

The higher layers progressively correspond to senior functionaries and eventually the chief executive who have a broader perspective of various operations and whose purview requires to be addressed in the form of integration of multiple processes and enabling interoperabilities across various functional modules to get a perspective on a given performance dimension and associated decision support features.

The links presented in the GUI enable interactive invocation of data/ visualization required for exercising control over various aspects of production and manufacturing of the products and services on handheld ipads & smart phones

E. Integrating Analytical Models and Business Intelligence

Various analytical models are practiced to facilitate decision making in the context of demand management, inventory management, working capital and fund management, maintenance management, production planning & control, supply chain management, customer relations management, total quality management, performance management, life cycle approach, target costing, activity based costing and the like.

These models and corresponding algorithms are built into the enterprise solution. A schematic view of blocks that come into play during the invocation of software behavior is shown in fig 4.

The optimized and validated algorithms is proposed to be implemented in an embedded form and as programmable hardware for integration at the server end to speed up computation.

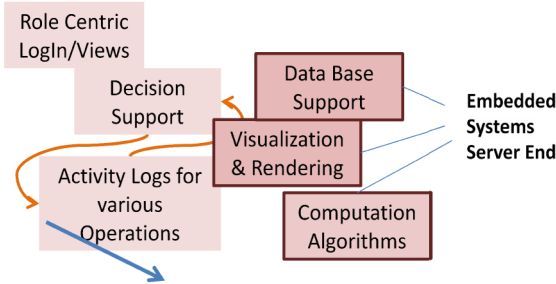


Fig.4. Visualization of Enterprise Performance with Graphics and Interactive Drill down features

F. Activity Logging & Form based transactions

Logging of data related to any manufacturing or non-manufacturing activity can be concurrently happening along side visualization of reports. For example, as data relating to production of items are being entered, the workers and supervisors get to know the past production figures over the week or over a month. This feature serves to provide feedback to the enterprise users and enables them benchmark their performances.

The process automation proceeds as a form based transaction wherein the user views the updates, selects the relevant forms, exercises control options and executes the relevant process steps.

The GUI is enriched with information, forms, status indications, alerts, hints and cluttering is avoided with the use of collapsible and expandable features or tab implementations.

G. Service Oriented Architecture

The solution design is based on a Service Oriented Architecture with capabilities for configuration and user invocation of services which are perceived as useful and adapted to the profile of the operations of the MSME unit.

Progressively, with enhanced enterprise capacity more processes can be instituted with expanded features, and enabling interfaces with other related processes. The design of solution architecture has factored in this requirement. The implementation and deployment architecture is hence usage driven with inbuilt capabilities for dynamic 'on the fly' seamless integration and interoperability across functional modules.

The design of the solution framework leverages extensively messaging, alerts, built in escalations and form based transactions. A schematic overview of the operations relating to various functional domains in an enterprise is shown in fig 5(a) to 5(d).

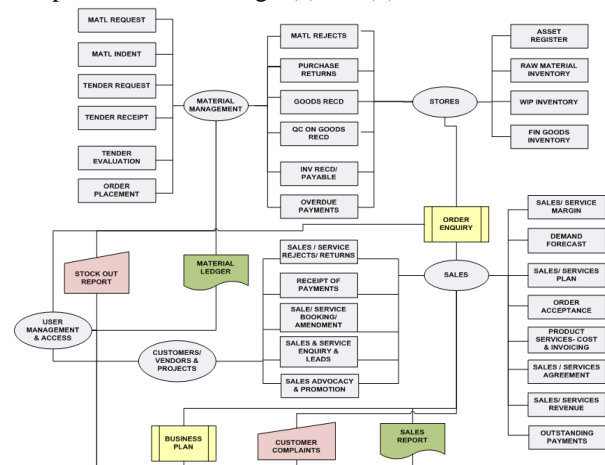


Fig.5. (a) Schematic representation showing operations relating to materials management, stores and sales

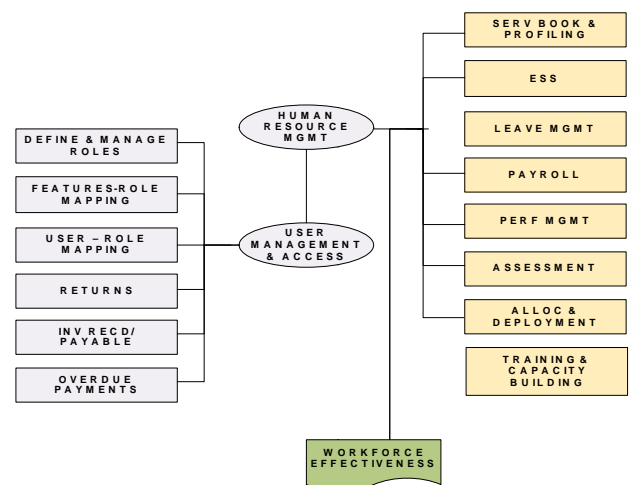


Fig.5. (b) Schematic representation showing operations relating to Human Resource Management and User Management

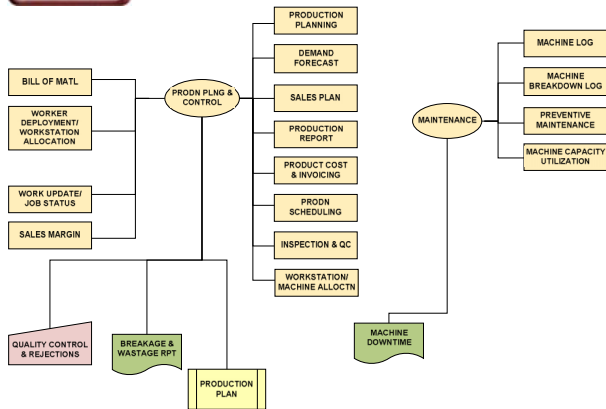


Fig.5. (c) Schematic representation showing operations relating to Production Planning & Control, Maintenance.

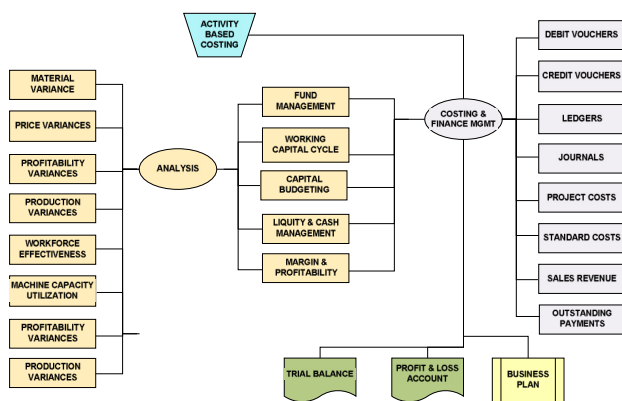


Fig.5. (d) Schematic representation showing operations relating to Costing & Financial Management and Analysis

III. DRIVING BUSINESS VALUE THROUGH DILIGENT ENTERPRISE OPERATIONS

A. Adaptive Profiling and Enhancing Quality of the Solution with a Data Driven Approach

The development of the Solution framework was inspired by the need to engineer a design that enables prudent and diligent human actions and best practices for efficient Operations Management of MSME Units. The framework enables rapid prototyping of the ERP solution adapted to various MSME profiles.

A priori characterization and profiling of MSME units are based on discerning distinguishing factors which determine business value, growth etc for a given MSME cluster. These are validated on the basis of data and user interactions for further refinement specifically adapted for such MSME cluster.

The solution is designed for shorter lead time & lesser scale of investments in the customization and deployment of the systems that support decision making for efficient operations in a given MSME cluster.

Ingenuous service oriented solution architecture with configurability options and embedded hardware systems design at server end for improved computational speeds – help realize software capabilities adapted to the MSME cluster and serves to help them improve the efficiency with which they carry out various operations.

B. Empowerment of Users and Early Adoption

Adoption of the Solution is facilitated as the enterprise users are empowered by the capabilities of the enterprise software that enables them iteratively view results to discern impact of various activities carried out. The enterprise functionaries perceive the following capabilities of the solution as useful;

- (i) ability to view the results of a simulation such as the estimated margins on account of a transaction,
- (ii) prioritize for pursuit of potential marketing leads and enquiries for conversion of such leads to sales orders
- (iii) be informed of actual material consumption and deviances against standard material quantities for a given product,
- (iv) do smart procurements viewing the price trends, past history of procurements and variations *vis a vis* standard costs of procurement,
- (v) be apprised of production plans, machine or workstation scheduling, capacity utilization of machines, breakages or rejects beyond permissible limits,
- (vi) estimate the optimal value of inventory holding for a given product.
- (vii) reduce fund flow cycle, view cash flows and follow up on sundry debtors,
- (viii) monitor costs applying activity based costing methods
- (ix) apprise and review performances, enforce productivity norms and ensure optimal allocation of work

C. Performance Characteristics

A range of algorithms, models and tools are integrated to enable perform analytics and facilitate decision making. Such analytical models are intended to be rendered as embedded hardware implementations for parameterized solutions with associated mechanisms for their interfacing at the server end to help speed up the application.

A conceptual illustration of the analytical schema and schematic view of some of the design components that contributes to improved performances are shown in *fig 6* and *fig 7*.

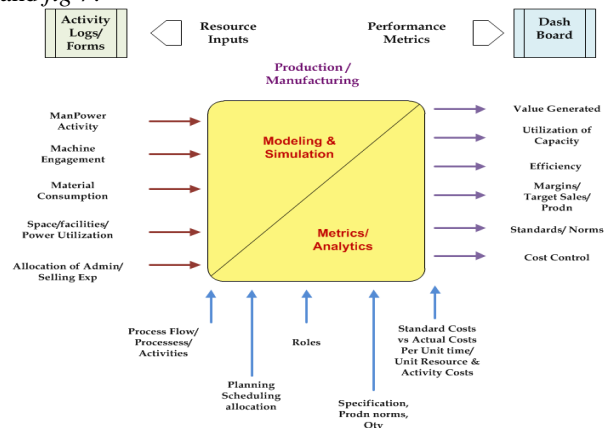


Fig.6. Conceptual illustration of modeling, simulation and analysis for ascertaining performance measures even as various operations are undertaken

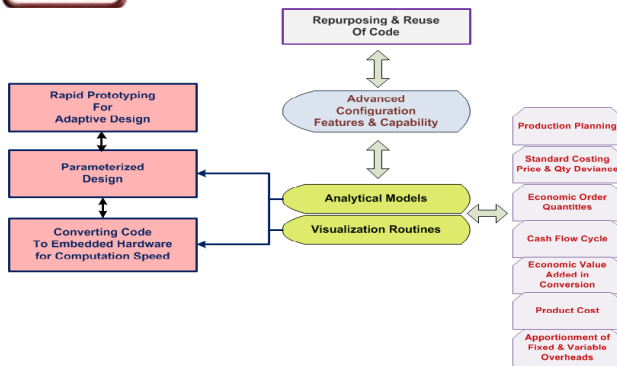


Fig.7. Illustrative view of performance enhancing aspects incorporated and embedded in the design of the solution.

The useful characteristics of the LeanERP Solution described lend itself to progressive build up in institutional capacities in keeping with the absorption capacity and familiarity of the users. Building institutional capacities for transformational change is a prerequisite for effective implementation as described in [4]. The solution design approach that was adopted has taken into account this aspect to ensure the successful implementation of LeanERP solutions for MSME units. The solution is scalable and modularity in the design ensures reliability, fail safe performances and even if problems are encountered, the design enables error trapping, isolation, fault diagnosis on the basis of exception throws built in.

D. Human Computer Interface

The human computing interface is presented with enriched characterization of problem space to engage the user with cues like information dashboards, event trigger indications, alerts, system states, exceptions, active warning systems, status displays, navigation aids, user tips, cross-references etc. The solution works with messaging & notifications to initiate transactions and for the progression of the transactions

The solution leverages robust session management to ingeniously retain activity trails, attribute values, history of transactions to facilitate recall, retrace on process steps, iterative analysis prior to decision making and makes extensive use of buffers & data structures for storage of parameters and intermediate results

E. Value Propositions offered by LeanERP Solution

The decision support that is required for MSME units concerns answers to questions which seek an answer to the distinguishing aspects that drives Business Value for the enterprise. These can relate to

- (i) Improvements that are required in the product design features and the nature of services rendered which are discerned from the pattern of feedback, issues and interaction/follow up with customers
- (ii) The impact of doing or not doing an activity in terms of its impact on the business results, which can be ascertained with activity based costing analysis
- (iii) Comprehending the available sales strategy options, scenario analysis or trials for estimation to

ascertain the impact on account of a planned intervention

- (iv) Analysis to estimate augmentation of revenues, cost cutting, realization of returns for an enhanced rigor in operations relating to sales efforts, quality improvements,
- (v) Sensitivity analysis for determining the optimal product mix, portfolio of service support for customers
- (vi) Analysis of customer preferences & discern approaches to market differentiation,
- (vii) Determination of price and considerations for negotiation and deciding on the terms of a given sale,
- (viii) Awareness of new and unknown dimensions which are discerned on the basis of interactions within and outside the enterprise and associated data capture.

The process characterization of manufacturing and related business operations integrates Activity Based Costing Methods. The parameterized design & reconfigurable and reusable libraries enable adaptation of the solution for varying contexts. Re-configurable flexibility is also presented for role profiling and defining the process flows customized to the needs of the enterprise.

IV. COGNITIVE INTELLIGENCE

A. Classifier Systems for discerning User Profiles and Configuring Solutions

The Software solution incorporates a rule engine which encapsulates the business rules that require to be complied with in the processing of transactions. The parameters and input values for these rules can be adapted in line with the delegation of powers to users, setting time limits, qualifying pre-conditions and contingent events.

The configuration modules also provide options for business solution variants, process re-engineering options, data entry screens to specify desired values for parameters, define pre-requisite conditions, consequent events, flows, behavior and associated business rules. A schematic overview of the layered implementation and modular approach followed for solution design incorporating these features is shown in fig 8.

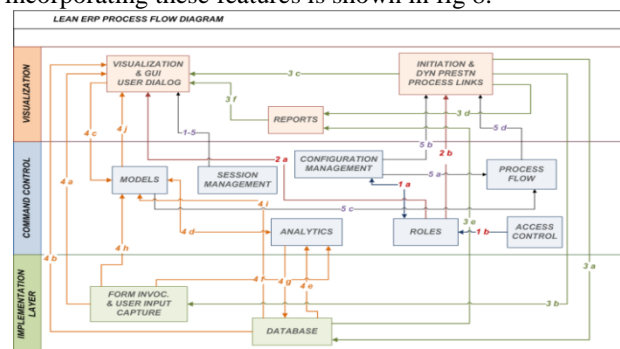


Fig.8. Schematic view of interconnecting modules and components providing capabilities for high level of configurability options.

A need was also felt that the software would require to interface and provide for cognitive intelligence acting upon data profiles, interaction patterns and user feedback to evolve, improving its usability and performance.

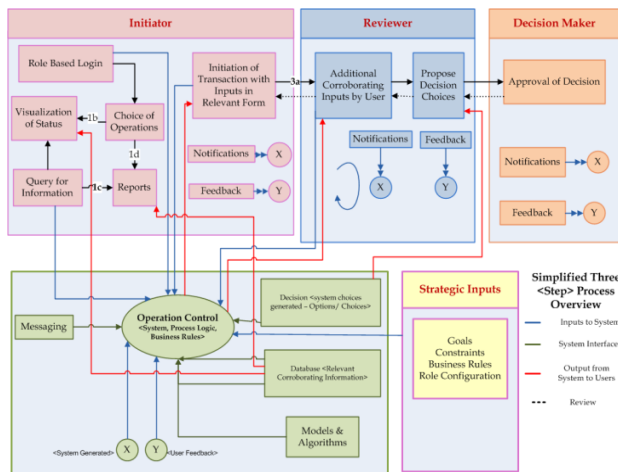
The parameterized design of Solution & Data Driven Approach is also suited to leverage such intelligence. This has been accomplished with the integration of a Classifier System that employs a set of classifiers/rules.

The Rules fire and activate or invoke the desired component and functionality on the basis of the pattern of user interactions. The system dynamics related to this approach is a variant of the one that is described in [5], [6] and [7].

The active set of rules at any point in time, is the validated set of rules that has evolved on the basis of rule selections, apportionment of credit and reinforcement learning on the basis of user activity and perceived utility of such rule set dynamics ascertained through analytics.

The initial process design & process specifications for automation of transactions with a given/ default set of apriori assumptions, are hence progressively and dynamically adapted with classifier systems that discern and fine tune the process parameters on the basis of user interactions and data patterns.

A simplified process approach is also followed with any process transaction involving not more than 3 or 4 steps. The process gets initiated, flows through 1 or at best 2 reviewers before it is presented to the approver and the decision maker as shown in *fig 9*.



V. CONCLUSION

The LeanERP® solution that has been designed and developed for use on a mobile platform, leverages a mature service oriented architecture, with embedded capabilities interfacing intelligent cognitive features for profile based adaptation and customization on the basis of user interactions. It integrates form based transactions for process automation, enables activity logging, interactive execution or invocation of decision support and drilled down visualization of transactions facilitated by engaging role centric user interfaces.

VI. ACKNOWLEDGMENT

The work associated with the design and development of the LeanERP solution is a result of consolidation and application of the knowledge and experiential learning gained in the development and implementation of an enterprise ERP solution at CSIR. LeanERP® solution design described in this paper is being funded under the NMITLI programme of CSIR in alignment with the renewed focus on initiatives that can give an impetus to strengthen and build capacities in MSMEs and enhance their capability for self-reliance while meeting the challenges for global competitiveness.

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AUTHOR'S PROFILE



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born on 09 Mar 1962 Graduated in Mechanical Engg. from PSG College of Technology Madras University, did his Post Graduation in Management from IIM Bangalore and later obtained his M.Tech in Production Technology and a Ph.D for his work in Mutual Man-Machine Learning from IIT, Kharagpur.

He joined the Indian Administrative Services in 1987 and held various positions as District Development Officer, District Magistrate, Deputy Secretary in Health and Family Welfare and later as Director Technical Education in the Govt. of Sikkim. During his tenure in Govt. of India he served as Director IT in the Department of Administrative Reforms. On completion of his tenure, he served as the Vice Chancellor of Sikkim Manipal University, Gangtok. He is presently serving as Joint Secretary in the Govt. of India and is the Administrative Head of the Council of Scientific & Industrial Research and the Department of Scientific and Industrial Research, GoI. Dr. Jayakumar is currently championing the CSIR Transformation and ICT Interventions Project under which an "ERP Bespoke application" has been developed and implemented across the 37 National Laboratories of CSIR. The project has bagged the CSI-Nihilent Special Recognition Award under Research Category in 2010.

He has authored a book on "Dynamics of Organisational Behavior and Executing Change" which has been published by CSIR in 2011. He has a number of publications to his credit.