

ICT Based Performance Measurement and Benchmarking Methodology

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Abstract - Performance benchmarking and performance measurement are the fundamental principles of performance enhancement in the business sector. For businesses to enhance their performance in the modern competitive world, it is fundamental to know how to measure the performance level in business that also incorporates telling how they will performance after a change has been made. In case a business improvement has been made, the performance processes have to be evaluated. Performance measurements are also fundamental in the process of doing comparisons of performance levels between corporations. The best practices within the industry are evaluated by the businesses with desirable levels of the kind of performance measures being conducted. In that regard, it is fundamental if similar businesses applied the same collection of performance metrics. In this paper, the NETIAS performance measurement framework will be applied to accomplish the mission of evaluating performances in business by producing generic collection of performance metrics, which businesses can utilize to compare and measure their organizational activities.

Keyword - Network of European Institutes for Advanced Study (NetIAS); Performance Benchmarking; Performance Measurement; ICT Management.

1. Introduction

The main rationale of this research paper is to test and evaluate the NETIAS performance measurement framework in the modern business world and to formulate generic performance benchmarking and performance measurement utilized in the business network. This business network will permit businesses to visualize performance measurement information from other businesses in the world to visualize their position of in the competitive business world. Over the past few decades, significant transformations have happened in a manner manufacturing enterprises operate. Based on the application of advance technologies, businesses can shift from operating as function-based to operating as process-based [1]. Although manufacturing frameworks have transformed significantly, the manner in which performance is evaluate has to transformed that drastically. In that case, there is requirement for novel performance measurement frameworks, which consider these transformations to be implemented in the manufacturing segment.

This research evaluates the ancient performance measurement framework and the reason behind their invalidity in the modern-day manufacturing ecosystem. Based on this form, modernized performance measurement framework for the state-of-the-earth manufacturing process has been evaluated as well [2]. Apart from that, this paper has provided a critical evaluation of two essential performance measurement frameworks: ETFAM and SINTEF. Some fundamental guidelines and issues for structuring performance measurement frameworks are evaluated as well. Lastly, the paper provides an assessment of the fundamental guidelines for the novel performance measurement framework. The major definitions to be considered in this research include:

- Performance measurement: This is a definition of something, which can be assessed; for instance, networks utilized in a single day.
- Performance indicator: This is the definition of something, which is evaluated from performance measurement, such, percentage networks in a single day for every worker.
- Performance measurement information: This represents the results and values for performance indicators and measures; for instance, the reworks number in a single day equals thirty-six or the percentage reworks in single day in every worker is approximately 2% [3].
- Performance measurement framework: This represents an overall collection of performance indicators and measures derived in a more consistent manner in reference to the guidelines or rules defined in the performance measurement framework.

This paper is organized as follows: Section II provides a critical analysis of the performance measurement frameworks; while Section III evaluates the SINTEF system. In Section IV, an analysis of the protocols for performance measurement frameworks is done. Finally, Section V concludes the paper and provides future direction of the research.

2. Critical Analysis Of Performance Measurement Frameworks

Ancient Performance Measurement Frameworks

The ancient performance measurement frameworks are typically utilized in management and cost accounting sectors. These approaches were structured in the late 19s and 20s centuries to accomplish the requirements of advancing manufacturing segments. The business concepts were completely standardized in early 1990s and since then have been termed as a basis of the business performance measurement frameworks [4]. Over past few decades, significant transformation have taken place in production and technology approaches, which have made ancient performance measurement frameworks (management accounting centred) no longer fundamental. These ancient methods are at more irrelevant and false positive harmful. There are five fundamental issues with the ancient management accounting approaches for performance measurement, which include:

Relevance Issues

Management accounting documents are not connected to the manufacturing method, are not fundamental for the control of distribution and production operations and are considered misleading or irrelevant to pricing decisions [5].

Cost Distortion

Ancient cost accounting is connected with the elements of cost. The pattern of the elements of costs has transformed significantly over the past few decades, and this detailed evaluation is less fundamental [6]. Moreover, the variation between indirect or direct costs (and fixed and variable costs) is not considered rigid as it was before).

Inflexibility

The ancient management accounting documents do not vary from a single plant to another within the business and do not transform over time, as organizational activities need change. In that case, cost accounting documents are typically received late and valuable. As such, this is typically considered with disdain through operation manager because they do not aid them with their tasks meant to blame operational managers whenever variances are considered negation [7].

Hindrance to Progress in Global Manufacturing

Ancient approaches of evaluating the paybacks on capital projects might impede the advent of global business, and might stimulate managers to do unnecessary or wasteful obligation to make figures look incredibly. Moreover, concentrating on labour and machine efficiency rates encourages the manufacturing of significant batch amounts and cost accounting necessitates most of the detailed information, which can be expensive to obtain.

Subjection to the Necessities of Fiscal Accounting

Normally, cost accounting is confirmed as the subsidiary ledger of fiscal accounts. To be valuable, the management accounting frameworks have to be based on various assumptions and methods compared to the fiscal accounts [8]. These approaches apply to such problems as inventory valuations, accounting periods and overhead absorption.

The assumptions, which the management accounting approaches are centred on, are considered invalid since they are considered localized in the scope. The assumptions have been listed below collectively with the major reasons why they are termed invalid:

- The overall costs of the framework the same as the sum of the costs of every operation. This form of assumption is considered invalid for the overhead allocation.
- The overall cost of every business operation is considered proportional to labour that is direct for the business operation. Some business operation are automatic and this have no more direct labour.
- The overall cost for the framework, eliminating material costs, is more proportional to the summation of direct labour expenses. Direct labour costs create small proportional of the overall costs for majority of the business systems.
- The standardized cost process that uses the calculated labour ratio and overhead might be reversed to evaluate the implication of the actions on the overall costs of the framework. In case the calculated labour ratio and overhead is invalid, therefore the converse should be termed as invalid.
- In business operations, the influence of optimizing localized decisions, as evaluated by their implication of the expenses of the business operations, is to conduct the optimization of the overall framework. Optimizing a number localized decision might have non-optimum effect in other business departments.
- The key to attaining the globalized optimum is reaching localized optima. A number of localized optima might be in conflict with other localized optima. Because of these issues of management accounting approaches, performance measurement frameworks based on these methodologies are termed as invalid for manufacturing organizations in the modern age.

Modernized Performance Measurement Frameworks

Other than the issues evident in ancient performance measurement frameworks, there are other fundamental reasons as to why there is the necessity to implement novel performance measurement frameworks in manufacturing organizations. These incorporate: clients are asking for higher standards of product quality, flexibility or performance, and the management approaches utilized in a production plant, which are transforming fundamentally [9]. As businesses introduce state-of-the-earth manufacturing approaches, they require novel approaches of performance measurement frameworks to control their production plants. Ancient performance measurement frameworks are invalid for the evaluation of state-of-the-earth manufacturing practices since they do not supply the organization with the essential data to compete in the competitive niches. As ancient performance, measurement

frameworks are centred on management accounting and fundamentally connected to expenses. However, in the modern manufacturing ecosystem, the cost-based measures are not based on decision-making in organization. Organizations now necessitate performance measures, which are centred on the other competitive aspects such as quality and time to enhance the process of decision-making [10].

Novel performance measurement frameworks for intercontinental manufacturing companies need to have the following features:

- Are directly linked to manufacturing approaches
- These are primarily utilize non-fiscal approaches
- They vary between different geographical locations
- They transform over time as business change is inevitable
- Are easy and simple to utilize
- They give fast responses to managers and operators
- They are purposed to foster enhancements instead of monitoring the performance in business

Modernized performance measures are not developed, what is novel here is the significance incorporated in them. These have been in existence for some time now, but over the past few decades, the intercontinental manufacturers started to replace their expenses in reference to performance measurement frameworks with the ones, which actually drive the process of business production. Since the performance measure can command the actions, it is fundamental that they are appropriate for the procedures they are evaluating. When adopting the modernized performance measurement frameworks, the present frameworks have to be abandoned. In case the novel measures have been implemented in addition to the present ones, then they might not have their intended impacts and usefulness. They will completely be ignored since the people are fundamentally familiar with the old measures, or both the collection of measures will be utilized and the organizations will not achieve the focus and coherence, which the novel measures are purposed to offer [11]. The advent of novel performance measurement frameworks have to correlate to the advent of novel manufacturing approaches. For instance, before business procedures can be restructured, there have to be a vivid strategy, i.e. manufacturing approach, for the businesses and critical performance measures have to be in place to evaluate the implication of the re-engineering procedures. The approach and the novel performance measures are considered prerequisites to organization Procedure Re-Structuring. A brief explanation of two modernized performance measurement framework (ETFAM and SINTEF systems) will now succeed.

3. SINTEF System

One sample of a novel performance measurement framework is the SINTEF framework that was formulated

in Norway by SINTEF with Norwegian Federation of Engineering Corporation. SINTEF is a query, which is utilized to evaluate how enterprises are performing in various areas of manufacturing. It is grouped into three fundamental parts. The first segment is utilized to obtain a general analysis of enterprise and it replied by a single person. The second segment is utilized to comprehend how companies operate and might be replied by twenty various persons. Lastly, the third segment is concerned with concentrating with focusing on twenty certain fields within the business, which might require advancements, such as design, marketing, product development, technological planning, control assembly, production planning, personnel management, advancement processes and financial management [12]. SINTEF framework considers performance measurement alongside three dimensions. These include:

- Efficiency: customer needs satisfaction
- Effectiveness: optimal and economic utilize of corporation resource, and
- Capability to transformation: strategic awareness to deal with transformations

The responses to every query are qualitative (i.e. on 1-7 scale, whereby one is poor and seven is quality). Corporations are entreated to respond to every question for their conditions today, and for their projected status in two consecutive from now. They are requested to determine how significant every question is to the corporation's rivalry on three-letter scale: Whereby N = No significance, M = Medium significant and G = Great significant. The SINTEF framework is time-consuming and large to fill-out. In this research, more than 60-page and approximately 15-20 questions for every page. Every question also necessitates three fundamental ratings (condition today, future conditions, and relative significance). In that regard, in overall, approximately three thousand evaluations have to be structured to fill out a single complete questionnaire. The SINTEF framework is a generic questionnaire and, in that regard, the performance evaluations are not acknowledged. The SINTEF queries are not directly connected to the customer requirements and strategies of the business.

Moreover, the hierarchical connections between the performance measures are not noticed. SINTEF questionnaire is considered qualitative, in reference to the views of persons not the real measurement, and, thus the responses can be biased. SINTEF questionnaires are significantly thorough and allow enterprises think about the parts of manufacturing they might not have thorough significance before [13]. Anything that corporations assess, it will necessitate approval, mostly performance segments, which are of 'G' i.e. great significance. Asking businesses to evaluate their present conditions and their future conditions is a firm point of the SINTEF questionnaire. In case businesses purpose to evaluate their future condition to be effective compared to the present condition in a certain way, then they should realize that they have to introduce an enhancement project in that field. Since the various enterprises utilize a single questionnaire, SINTEF

is more suitable for creating comparisons between businesses.

ETFAM Framework (The European Task Force for Advanced Manufacturing)

A second sample of the modernized performance measurement framework is ETFAM performance measurement system. The main purpose of this system is to initiate an approach, which senior officials can utilize to

evaluate the implication of the strategic choices initiated by businesses. The system gives a method of translating business plans of businesses (i.e. fundamental success elements) into a collection of performance measures. The measures of performance will be connected to the methodology of the enterprise and would be considered process-centred. The ETFAM system utilizes the business framework, as indicated in Fig 1, to illustrate the manufacturing business.

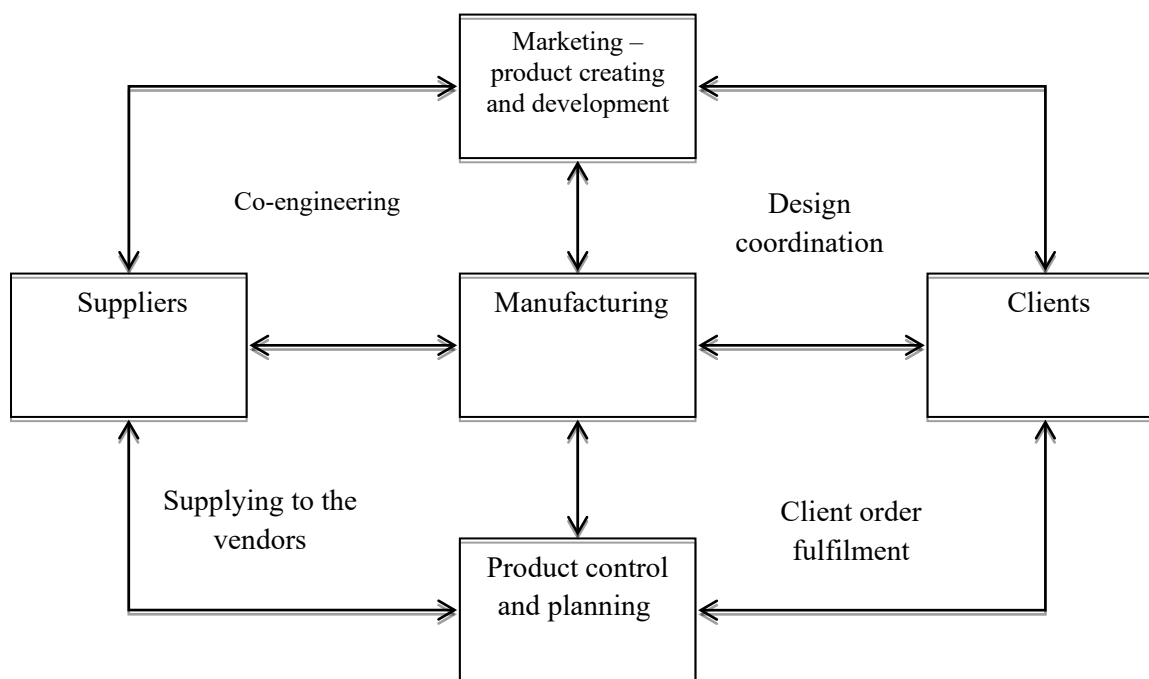


Fig 1. Business framework for manufacturing businesses

Every of the five fundamental macro-business procedures (manufacturing, co-engineering, design co-ordination, vendor supply, and client order fulfilment) in the figure above has been centred into five fundamental performance measures (ecosystem, flexibility, quality, cost and time). This is fulfilled to Assemble-to-order, make-to-stock, engineer-to-order, and make-to-order. Mapping five fundamental macro-business procedures to five macro performance measures give a collection of 25 strategic indicators of performance for every manufacturing typology. The ETFAM approach considers the efficient success factors of businesses and encompasses it into the ETFAM model. As a result, this assures strategic performance indicators essential to the business. These performance indicators can therefore be grouped into many lower level performance indicators. The categorical analysis of every performance indicator will be varied for each business hence producing unique collection of customized performance indicators for each enterprise. The ETFAM performance evaluation system is complete in that, whenever the business identified its efficient success factors (in reference to the organizational strategy), it should not be challenging to develop consistent collection of performance indicators for that specific business, which is directly connected to CSFs.

The ETFAM system gives low-level certain performance indicator via decomposition of high-level performance indicators. The hierarchical connection, between the indicators of performance, is explained by decomposition. This is a procedure oriented, generic system and, thus, it is applicable to many enterprises of different sizes. The system gives customized collection of performance indicators for every business, which utilizes the system. This makes it challenging to make contrasts between businesses, mostly with performance indicators of lower levels. The high-level performance indicators for majority of businesses will appear the same, but will be structured under various performance indicators that are of a lower level. In that regard, contrasts at a high level are considered valid; however, cautions has to be considered when comparing performance indicators, which are referenced at a lower level. Other than the two-performance measurement frameworks (ETFAM and SINTEF) illustrated above, there are other frameworks of performance available for application by SMEs today. A number of these performance measurement frameworks include EFQM framework, ECOGRAI framework and the Balanced Scorecard Approach.

4. Protocols For Performance Measurement Frameworks

Many literature sources have analysed the performance measurement frameworks and how they should be developed in business. Businesses are now committing resources and time to structure novel performance measurement frameworks to assure credibility and motivation to enhance business performance. This assures that the processes of business have been evaluated, which include ensuring the conflicts and linkages being managed and visible and not encrypted underneath hence permitting change in the business. Despite the competitive priorities business pursue, the successful measurement frameworks will share five fundamental features:

- Mutually consistent and supportive with organizational operation objectives, success programs, factors and goals
- Convey data through simple and a few collection of measures
- Focusing on measures, which clients can visualize
- Permit the organizational members of the business to comprehend how activities and decisions affect the complete business, and
- Support business education and continuous enhancements.

Whereas modernized performance measurement frameworks should be features defined, a number of other aspects require being current under novel performance measurement frameworks. It is argued that performance measurement frameworks have to meet four essential necessities:

- A system, which permits top down decomposition to fundamental levels of the significant details, which permits the customer and strategic necessities to be translated to a collection of efficient performance measures and the ones that identify business procedures.
- An organizational process focus
- Performance measures, which are process-centred and quantitative. These are connected to a collection of high-level macro measures related to a collection of high-level macro measures and the ones, which are connected to the strategy of the business or the client requirement views.

Performance measures have to provide feedback to the required gaps between the various manufacturing units and the best-in-class performance over a significant duration of time, which are meant to boost business learning. Another approach of filtering a significant collection of performance measures is through the application of the analytical hierarchy process, which is meant to identify fundamental performance measures. Fundamental performance measures are the measures of performance, which are connected to more than CSFs or client requirements. This is attained by utilizing the performance measurement tables and a collection of quality function

deployment systems, which is identifying different business connections.

All the relevant literature sources provide fundamental protocols for initiating performance measurement frameworks, but neglect a single problem that is fundamental in business. In modern-day manufacturing ecosystem, businesses are collaborating and the extended enterprises are dissolving and forming strategic alliances and partnerships, which are a commonplace [14]. In that case, standardized collection of performance indicators and measures are applicable to various businesses and considered advantageous. The standardized collection of performance indicators and measures would be fundamental for comparison between businesses. This form of comparison is identified as performance benchmarking.

With a standardized collection of performance indicators and measures, it is contradicting to have performance indicators and measures, which are customized to customer requirements and strategies of a certain business. In that case, both the performance indicators and measures should be considered. High-level performance indicators and measures have to be efficient for both the contrast purposes and to support customer requirements and strategies, whereas lower level performance indicators and measures might not be suitable for contrast purposes, but might support the client requirements and business strategies.

Various Perspectives of Performance Measures

Different individuals have different views on performance measures presented to them in different ways. For instance, some fiscal individuals prefer performance measurement information based on monetary costs and units, which includes the overhead costs whereas other fiscal individuals prefer performance measurement information based on percentages and ratios. This incorporates the overhead expenses as the operational expense percentage, and personnel individuals might consider performance measurement information based on individuals (workers) such as the overhead in direct workers. Most people might have various views on what measures are and how they can express the different measures, but this is normally what we cannot evaluate things effectively. These individuals are searching for individualized performance indicators that are localized in scope and might be in conflict with each other. The performance framework has to evaluate the core collection of the performance measures and a number of performance indicators.

The connections between the performance indicators and measures in performance measuring model need examination and documentation. Most of the performance indicators and measures might have direct influence on others. For instance, diminishing the time for a certain procedure might be attained by spending more funds and, thus, enhancing the process cost. Trade-offs have to be structured to sustain performance indicators at efficient dimensions according to customer requirements and strategies of the business. In that case, where transitions are made, the performance indicators and measures have to be

evaluated to evaluate the implication of this transformation. The transformations might have enhanced a single performance indicator and diminished performance in another performance indicator. In that regard, what is significant to the business should be seen.

Essential Data on Performance Measures

There are some details, which have to be encrypted about the performance measures and these have to be considered essential. These items of data have been presented in Table 1 below.

Table 1. Data on performance measures to be stored

Data	Details	Samples
Name	The aspect to be calculated or measured	Distributed lead duration
Details	Detailed definition of what performance indicators and measures have to be measured. This does not have to be left for user interpretation undertaking measurement.	Distributed lead duration equals the time taken to distribute the orders at the outgoing stocks unit delivery is done for the client
Units	The dimensions alongside which performance indicators or measures are evaluated	Km, percentage, months and days
Acronyms	Codes (at least 2 letters long)	Distributed lead duration = DLD
Equation	Formula to evaluate the performance indicators	$DLD = \text{storage} + \text{packing duration}$
Targets	The correct performance level is a mission to follow	DLD takes about five days
Position	It is at this level that performance measurement is done	DLD represents the process level performance indicators that belong to the order attainment process.
Location	The location of the business is fundamental to produce data for the performance indicators and measures	DLD can be retrieved from the department of shipping
Obligation	The place of the individual who has to undertake a particular measurement tasks	DLD is evaluated by shipping experts

There are some details, which have to be encrypted with performance measurement information (the results of the performance indicators and measures). These details have been listed in Table 2 below.

Table 2. Data on performance measurement information to be stored

Data	Details	Sample analysis
Findings	For quantitative performance indicators and measures and for performance evaluation this is considered as a rating (good to poor).	$DLD = 2 \text{ weeks}$
Explanation	In case unusual events happen, which might affect the findings of the performance indicators and measures, note have to be taken and preserved with the performance indicators and measures.	Trucks broke down and added to the average 2 weeks duration
Duration	This is timeframe, which performance indicators and measures are for. This is 'time' or 'date of commencement.'	Mean DLD per annum

All the details above would create complete results for the performance indicators and measures. The performance measurement framework that encourages the analysis of the details, concerning the performance indicators, results and measures, is NETIAS performance measurement framework.

NETIAS Performance Measurement Framework

In reference on the other performance measurement frameworks and the protocols structures in this research

paper, a novel performance measurement framework has been structured. This novel performance measurement framework is known as NETIAS. The project (NETIAS) is indicate by Fig 2 below and signifies the future perspective of the manufacturing business since it includes the end of life of the products.

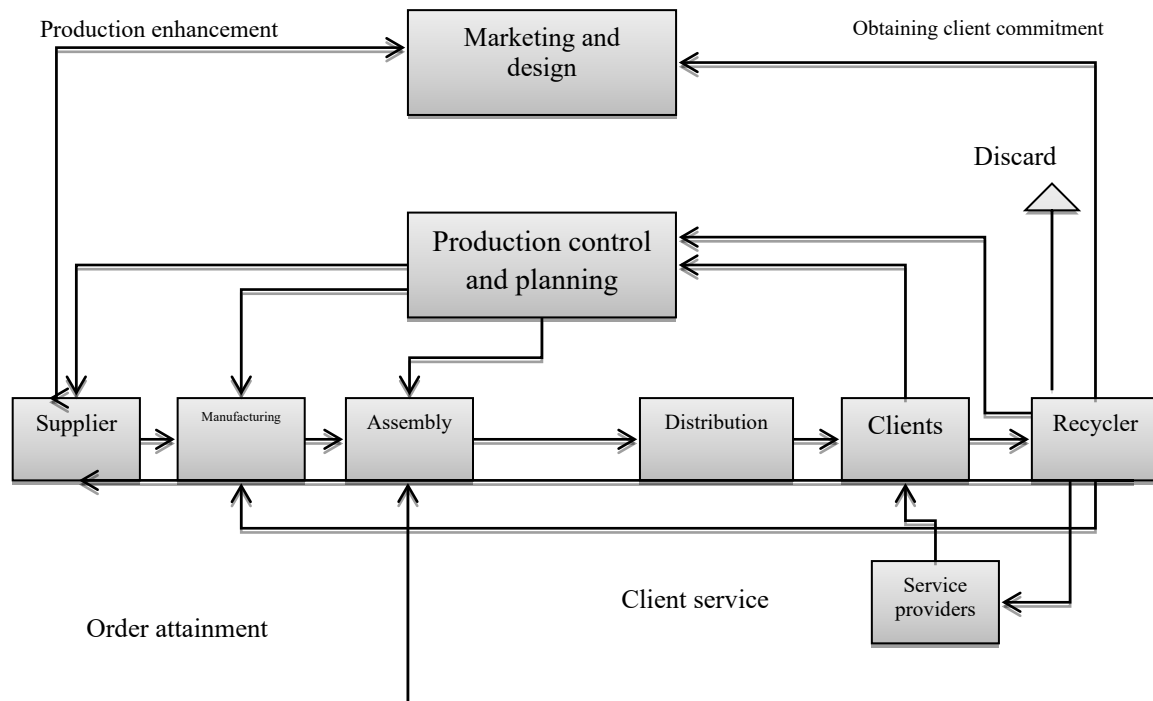


Fig 2: Extended NETIAS business framework

Based on this enterprise framework, NETIAS is considered a three-level of hierarchy for displaying performance indicators. These include functional level, processing level and business level. The measures of performance utilized in evaluating these indicators are evaluated over businesses under the following headings: accounts, product enhancement, marketing and sales, planning and production, purchasing, customer service, and personnel. Presently, there are many performance measures utilized in evaluating the performance indicators for NETIAS framework for evaluating business performance. All the business level has to be suitable for each manufacturing business. Actually, all the process level indicators of performance have to be suitable for the various manufacturing businesses.

Lastly, many functional level indicators of performance are overall indicators. They therefore provide a general assumption of the fiscal and size position of the business. The NETIAS framework incorporates the enterprise level

indicators of performance. Some of the enterprise level indicators of performance include return on investments, profit margin, sales per worker, operating expenses, and the inventory turnover [15]. The process level performance indicators are applied to evaluate the performance of the procedures, which are explained in the NETIAS system. The performance measurement framework has considered two fundamental processes: secondary processes and business processes.

Business procedures are the value-added procedures incorporated in the production and creation of sales and products, which are transferred to the buyer. NETIAS has considered four fundamental business processes and are illustrated below:

- Client service: the various activities included in providing the various after-sale services, which incorporate product take backs.

- Obtaining client commitment: the various activities included from the market evaluation and sales
- Order fulfilment: the receipt of the orders until the clients have paid and received the products
- Product enhancement: the various activities included in analysing, formulating, engineering and presenting products to manufacturing.

The secondary procedures include the non-value added procedures of the business. NETIAS includes two segments of the secondary procedures and these are illustrated as:

- Support procedures: are the procedures supporting the enterprise and evolution procedures and every other, whereas providing the infrastructure and resources essential to perform the various processes, like human resource management and financial management.

- Evolution procedures: gives ways for businesses to attain long-term strategic aims via planning and managing the transformation of the environment and enterprise, such as strategic planning and human resource management. Every of the six critical procedures have some performance indicators allocated to them.

Samples of the process level performance indicators include: product development (product enhancement efficacy), product enhancement costs, order fulfilment, general complaint resolution timeframe, obtaining client commitment, preventing the cost of maintenance and enhancing the evolution efforts. These procedural levels indicators of performance have been structured from functional level indicators of performance, which are utilized to evaluate the performance of the sub-processes defined by NETIAS. Every of the six procedures include a collection of the functions connected to them. The NETIAS operations and the procedures have been listed in Fig 4 below.

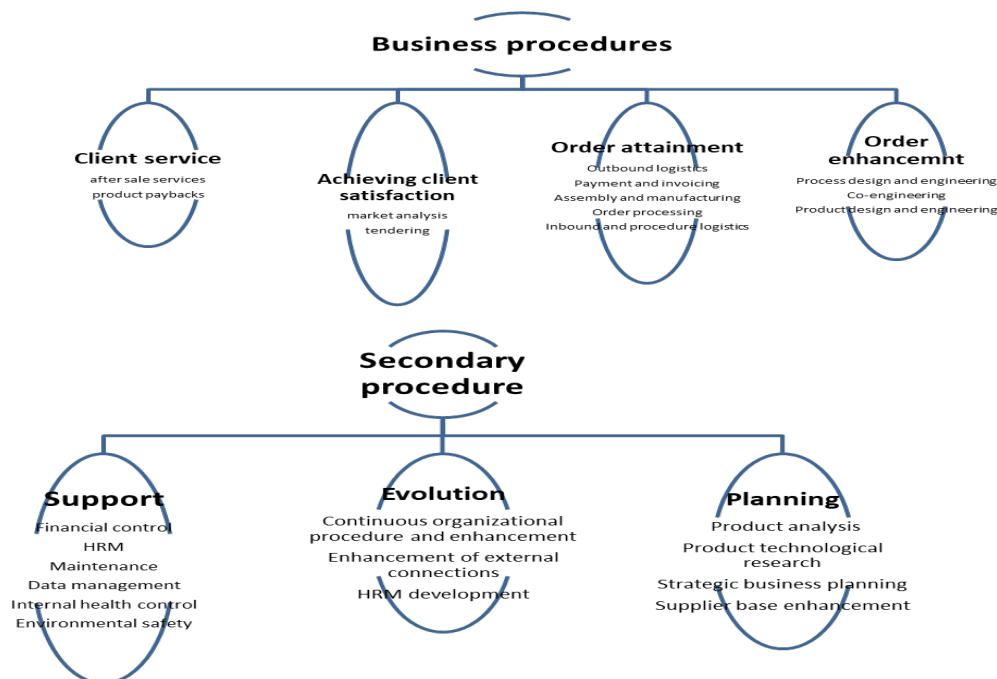


Fig 3: NETIAS business framework

5. Conclusion And Future Directions

This research paper argues that ancient performance measurement frameworks, in reference to the management accounting approaches, fail to accomplish the requirements of the intercontinental manufacturing businesses. It is evident that are five major issues with management accounting approach, which consider them are invalid for application in the performance measurement framework. These include cost distortion, lack of relevance, hindrance to progress, inflexibility in the intercontinental manufacturing business, which possibly provide businesses

with data they require to make proper business decisions in the modern-day manufacturing ecosystem. Future novel performance measurement frameworks have to be based on the following elements: direct connection to manufacturing approaches, primarily apply non-fiscal measures, transform over time, as change is essential, and issue prompt responses to workers. The various performance indicators and measures are quantitative (in reference to objective actual data, not typically subjective) and that the performance indicators are calculated using the defined

performance measures. The future indicators have to be quantitative to enhance the process of doing comparisons.

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