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Service performance monitoring and control Toolset

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Abstract

As service sectors in manufacturing companies become more and more important, Performance Indicators (PIs) will need to be taken into further consideration in order to assess the efficiency and effectiveness of service performances. Hence, PIs are designed to help the organizations and decision makers to better understand how well they are performing in relation to their strategic, tactical and operational goals. While keeping in mind that services are contributing more and more to rise an enterprise turnover, measuring and controlling their performances plays an important role in turning company strategic objectives and goals to reality. It is essential for a company to determine the most significant indicators, how they are related to the formulated company goals and how they depend on performed activities. In this respect, the purpose of this paper is to lay out a method for generating and selecting the PIs related to particular service system requirements.

This paper defines an overall PI Toolset which has been developed specifically for Virtual Manufacturing Enterprise (VME) but could also be used for a single enterprise and for a wider set of enterprises in cooperation with additional bodies (e.g. Labs, Industrial associations, universities, etc…). Especially, PI Toolset could be adopted by VMEs in order to improve the management of the service system they want to create through the specification and classification of precised use case objectives. After analyzing the state of the art in literature, a new approach has been developed which provides both a governance methodology and a list of relevant PIs for services. Actually, the proposed PI Toolset may help enterprises in selecting the activity to be monitored, controlled and measured through appropriate PIs. The proposed method essentially consists of a guideline to design, implement and classify effective PIs related to an enterprise's goals and objectives.

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Keywords: Performance Indicators; Service operation monitoring; Service governance support toolset

1. Introduction

In today's competitive business world, participation in collaborative network has become very important for any manufacturing and service enterprises that strive to achieve a differentiated competitive advantage [1, 2 &3], in order to be able to survive in an increasingly competitive context [5]. When competitiveness, responsiveness, interoperability and collaboration are keywords of a successful management in a business area, especially in service industries, enterprises cannot work in an autonomous way anymore [2, 3 & 6]. In particular, collaborative network systems such as supply chains, Extended Enterprises (EE) and Virtual Enterprise

(VE) need to get closer to their partners in supply chain networks or VE environments in order to optimize their relations [1 & 4]; have to interface and integrate their information systems and decision-making processes so to synchronize and harmonize shared activities in order to achieve common goals [1& 6].

Collaboration can be defined as a common way by which all companies in supply chain and VE environments are actively working together toward shared objectives, and it is characterized by sharing tangible and intangible assets such as information, knowledge, risk and profits [6].

A VE environment needs to be supported by indicators to help

enterprises and decision makers in order to evaluate the collaboration benefits in this environment such as: resource utilization; competencies development and quality improvement. Nowadays, numerous methods and tools have been developed to facilitate the generation and selection of the most suitable PIs especially in the service sectors. In order to measure the performance of the service which is provided within the VE environment, a coherent and comprehensive set of service driven PIs should be created for the involved members. Service activities within VE environment need to be monitor changes so to gauge progress. The subsequent performance needs to be monitored to ensure the VE is on the right track or not. As far as the classification of PIs in this context is concerned several kinds of PIs can be found in literature. A first typology of PIs is based on measuring results in terms of performance evaluation in order to achieve specified objectives as defined by the decision makers and managements. For instance, total amount of turnover raised by service within VE environment against overall enterprise revenue. A second kind of PIs is related to progressing performance. Let us consider, for example: total number of service occurrences per month and total cost for gathering service requirements process vs. the enterprise's monthly turnover [11]. With respect to this classification of PIs and also taking into account performance measurement models and decision making frameworks, PI Toolset proposes monitoring framework for service performance assessment which results on a list of PIs that could be listed inside all these categories in order to facilitate service system management. So, it can be stated that, these two types of categorization are interrelated to each other in their way of functioning with respect to cause and effect. For instance, performance measurement will lead to decision making process and decisions will lead to improve future performance. The main purpose of measuring performance of VE environment is the identification of problems in order to improve VE efficiency and effectiveness.

These types of performance measurement frameworks may have answered the question "what types of monitoring should a VE environment use?" but they do not provide a specific device to a VE for implementing a performance measurement system. In order to accomplish this objective a management process is needed. The prime challenge of performance measurement in VE environment remains to provide the right information at the right place at the right time in order to have efficient and effective execution of VE main goals and objectives as defined by the decision makers.

However, in order to leverage the potential benefits of the agile VE paradigm, there is still a need for flexible and generic infrastructures to support the full life cycle of VE, namely the phases of creation, operation, evolution and dissolution. Achieving such infrastructures is still a major challenge in scientific research [7 & 9].

Although at the conceptual level the advantages of VE are well known [9], but their practical implantation is still far from the expectations, except for the more stable, long-term networks applied to supply chains. Nevertheless, in a scenario of fast changing market conditions, the potential agility of a VE in terms of fast reaction to business opportunities is certainly a very appealing feature. But the early phase of VE planning and creation, as well as several aspects of VE operation are still difficult to manage and need to be properly adapted even by advanced and competitive enterprises. Some of the obstacles include the lack of common reference models and appropriate support tools, namely for [1 & 2]:

- Partners search and selection;

- Monitoring and coordination of task execution according to contracts;

- Performance assessment.

Meanwhile, understanding the full VE formation process, modeling it and developing support tools, are still open challenges in this context [7, 9 & 10].

During the past decades, several methods and tools, such as PRISM, ECOGRAI, Integrated Performance measurement System (IPMS), Dynamic for Performance Measurement System (DPMS), Balanced Score Card (BSC) etc. [12-20], have been developed to facilitate the generation and selection of the most suitable PIs. Some of them are focused on the service performances assessment in order to design, implement and classify a coherent and comprehensive set of service driven performance indicators.

With respect to above mentioned available methods, ECOGRAI represents a method to design and to implement PI systems in any kind of application domains, it is applied with the implication of the decision maker and has the possibility to use modelling tools (GRAI Grid and GRAI nets) to determine the various elements needed for designing PIs [5, 21 & 22]. With comparison to other most well-known Performance Measurement Systems (PMS) such as BSC, the decomposition and the coherence of objectives are clearly studied in ECOGRAI method and it is easy to have a very detailed view of the performance and also control of the performance [21 & 22]. ECOGRAI represents a coherent distribution of PIs in order to cover the various functions and the various decision levels (Strategic; Tactical and Operational).

In order to accomplish the objectives, the Servitization process needs to be modeled for understanding problems during the exchange of information between enterprises and also for synchronizing and harmonizing of practices [7]. The enterprise models aren't good in themselves but serve specific objectives valuable for the company [8, 21 & 22].

A lot of enterprises modeling methods have been developed on a practical basis, without identifying first the user requirements [23 & 24]. Concerning the as-is situation, at the

enterprise modelling level, there are many enterprise architectures, languages and tools available in the market, among them we can mention Computer Integrated Manufacturing Open System Architecture (CIMOSA), Graph with Results and Activities Interrelated (GRAI), Goal-Based Requirements Analysis method (GBRAM) framework [19, 21 & 23], etc. All the mentioned models have their own pros and cones, for example, an Integrated Enterprise Modelling (IEM) model cannot interoperate with a METIS model [23] or in CIMOSA there is no relationships between the objectives are defined therefore no hierarchy of objectives is built [24].

In the development of paper's aims, GRAI method has been chosen as a basis to manage monitoring processes and to define objectives, because it represents a good integration between the focus on results and the consistency with decision process. Indeed, this is the method based on decision modeling, thus focusing everyone's attention on why we need PIs (to make decisions and which decisions), instead of sorting out the best indicators directly [11 & 18]. In order to illustrate the PI Toolset especially proposed for VME, the paper is structured in different sections.

Finally, to be able to perform meaningful analysis, a case study is presented, where the method has been adopted by a company producing domestic appliances.

2. PI Toolset

As already introduced, PI Toolset has been created in order to support the managing and controlling issues of VMEs. This toolset consists of a Service Governance Methodology, a PI method and a PI List which, adopted together, are able to create a coherent link between governance issues and the selection of specific PIs.

A Performance Indicator is a type of performance measurement which defines a set of values to assess and differs according to business drivers, aims and goals. In order to turn it into a strategic tool a methodology to drive the selection and creation of PIs has been developed. This methodology allows the development of a coherent set of service driven PIs which are able to monitor and regulate the value exchange in enterprise networks. The PI Method has been created in order to generate specific PIs according to Use Case objectives which describe Use Case Governance processes mapped through Service Governance Framework methodology. Hence, both PI Method and Service Governance Framework have been developed in order to create an integrated engineering approach on business management & assessment tools.

2.1. Service Governance Framework

Service Governance Framework methodology has been developed to support service modelling within a virtual manufacturing enterprise environment especially focusing on business goals definition.

Service Governance Framework relies on a structure created merging, on one side, the GRAI method, and, on the other side, Model Driven Service Engineering Architecture (MDSEA) model. In detail GRAI method has been selected for the linkage it creates among governance processes and the definition of precise objectives. MDSEA model has been adopted as a standard reference to classify PIs into different level of decomposition (i.e. decomposition by level of abstraction and decomposition by level of decision).

Each Servitization process could be modelled through the proposed framework first of all defining clear functions and secondly defining the objectives at different decisional levels. Therefore the above mentioned methodology supports organizations on:

- Specifying Servitization objectives at strategic, tactical and operational levels;
- Identifying servitization functions and objectives;
- Identifying decision variables and actions;
- Facilitating the integration between decisional levels & between functions.

Table 1 Reference Governance Framework conceptual schema

		Service Governance Framework							
		IDEATION	CONCEPT	REQUIREMENTS	DESIGN	IMPLEMENT	OPERATION	DELIVERY	DECOMMISSIONS
BSM	STRATREGIC								
	TACTICAL								
	OPERATIONAL								
TIM									
TSM									

BSM (Business Specific Modelling) aims at elaborating high abstraction level model from business users' point of view. TIM (Technology Independent Modelling) gives service system specifications independent of technology for implementation. TSM (Technology Specific Modelling) adds necessary technology specific information related to implementation options. The aim of the framework is to help end users represent and describe the intended service and its system from various points of view, and give structure in order to help the decision making and the controlling activities.

2.2. PI Method

After the Servitization process has been modelled through Service Governance framework (i.e. functions and objectives at decisional levels have been specified), PI Method can be adopted to generate specific PIs.

PI Method has been created, as same as Service Governance

Framework, merging both GRAI approach and MDSEA model. In particular, GRAI approach has been adopted because it represents a good integration between the focus on results and the consistency with strategic, tactical and operational decision process. Indeed, this is the method based on decision modeling, thus focusing everyone's attention on why we need PIs (to make decisions and which decisions), instead of sorting out the best indicators directly [11 & 18]. In addition, also VRM method (Value Reference Model) has been used as a supporting element, so to offer Use cases a wide sample of process categorisation which can be used to select the business processes affecting Use case strategy. Indeed VRM provides a supporting tool to help defining and prioritizing the PIs which are needed to govern business processes because it provides a wide description of standard processes, their inputs and outputs and also metrics and best practices. VRM does not only focus on managing the supply chain processes for a given product, but also incorporates the preceding and successive activities of product development and customer relations in the sense of managing the whole value chain [11].

Finally MDSEA model has been used as a filter, so to define which process is affecting Service Lifecycle Management SLM of a service system at which level within the enterprise environment (BSM, TIM, TSM, with particular focus on BSM: strategic, tactical and operational level).

PI Method provides a methodology to design and implement relevant PIs generated on the basis of the requirements identified within the Governance framework. Once the Service objectives have been defined, the identification of affected business processes has been facilitated thanks to the support of VRM process classification. Finally PI List can be surfed in order to select proper PIs which are strictly linked with the already identified use case processes and objectives.
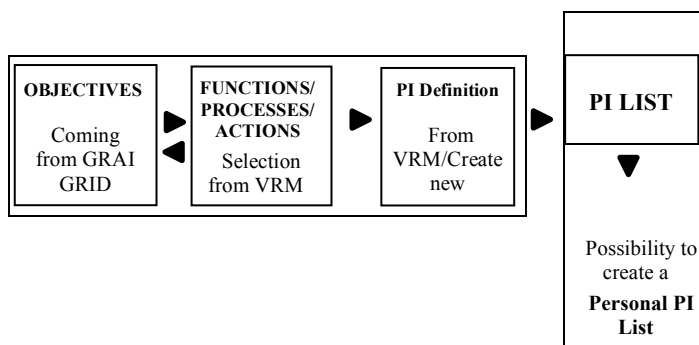

Fig. 1. PI Toolset: detail on PI Method and PI List

As described in Fig. 1 PI method can be adopted by following the synthetized list of actions:

1. Define the objectives at decisional levels through Service Governance Framework adopting the GRAI Grid approach;
2. Define clear functions, specify the actions and define the affected business processes supported by VRM;

3. At this stage a first definition of PIs can be done surfing the PI List;
4. A personalized PI List can be created.
5. Finally selected PIs can be exploited to monitor service activities.

2.3. PI List

According to PI Toolset, PI List structure has been created coherently with Service Governance Framework and PI Method in order to facilitate the selection and the linkage of PIs to objectives and decision variables.

Therefore also PI List has been created merging on one side the MDSEA, and on the other side, VRM processes categorization.

PIs have been listed in three levels, as following the decomposition of BSM level (i.e. strategic, tactical and operational) and following VRM process categorization. While PIs referred to TIM and TSM levels specify the parameters which can be used as supporting means in reference to technology implementation. Table 2 represents a sample of the above mentioned PI list, mentioning just one example for each BSM category.

2.4. Results

In order to optimize the methodology and tools, a first approach on real pilot has been addressed. This action has been conducted in order to test the method validity on the manufacturing world and to simplify the practical approach structuring on industrial partners. The Toolset has been therefore developed and refined through industrial case studies creating a real Servitization process. All the Scientific results have been obtained through testing the activities together with "Case A" industrial pilot.

The results are still needed to be validated but this contribution can be considered as a first step towards the development of PI Toolset scientific methodology.

The following List of Actions synthesizes, in a pragmatic sequence, all the passages use case has been asked to afford when adopting the above mentioned PI Toolset:

1. Identify use case Virtual Manufacturing Enterprise;
2. Design use case service processes and map all the phases through the service modelling tool;
3. Identify the objectives of use case Servitization process (scientific/theoretical approach for Service Governance Framework methodology);
4. Adopt PI Method to select PIs (scientific/theoretical approach for PI Method and PI list);
5. Identify PIs related to Servitization Objectives surfing PI List;
6. Personalize and validate the List of PIs;
7. Exploit Use case personal PI List.

Table 3 represents the results obtained with the

cooperation with "Case A" regarding the definition of their Service Governance Framework. Several elements have been identified in the horizontal axis (where CC is stand for Code-Category and NC is stand for Name- Category) and have to be considered like the "functions" which have been specified through GRAI approach. These functions have been identified following the service life cycle phases and use case objectives have been defined at each stage. Table 4 represents the results

related to the definition of "Case A" Personalised PI List. Service Objectives have been linked with VRM Process categorization so to facilitate the selection of business processes involved. Then PI List has been analysed so to define which are the proper PIs linked with Use case objectives, processes and decision variables. Finally a personalised PI List has been created and it is ready to be used.

Table 2 PI List Sample

MDSEA	CC 1	NC 1	CC 2	NC 2	CC 3	NC 3	Field	Dimensions	PI Metrics
Strategic	G	Govern	GV	Govern, Value Chain	GV01	Set Strategy & Vision	Assets, Strategy & Vision	Asset	New market development investment
Tactical	P	Plan	PC	Plan, Customer relation	PC04	Create, Plan Customer relations	Cycle Time, Create Plan Customer relations	Velocity	Order processing time
Operational	E	Execute	M	Market Analyse	M01	Market Analyse	Cost, Market Analyse	Cost	Time to market

Table 3 Case A: Service Governance Framework sample

	EI	F1	F2	F3	F4	F5	F6	II
	External Information	Customer decision	Customer ideation	Service -Product design	Service -Product Implementation	Service -Product planning	Service -Product delivery	Internal Information
STRATEGIC H= 2 Years P= 6 Month	Existing Services in competitive companies	Customer expectation in terms of services	Business plan for service proposition	Selection of design methodologies and partners	Selection of targeted goods and technologies	Annual service planning	Partner relationship organization	Business Strategy and Master planning
TACTICAL H = 1 Year P= 1 Month	Existing HW & SW Implementation technologies	Feedback on customer satisfaction	Assessment of existing services	Definition of PSS functions and design specifications	Action plan to modify production process	Planning of the specific service actions	General planning of service delivery	In- house Available technologies
OPERATIO-NAL H = 1 Month P = 1 Week	Advertising	Customers orders; Customers claims	Brainstorming meeting;	Detailed design planning	Implementation of modifications	Service scheduling; Feedback measurement	Short term delivery planning	Status of service production and service system

Table 4 Case A: Personalised PI List sample.

	F1	F2	F3	F4	F5	F6
MDSEA	Customer relationship	Service ideation	Product-Service System design	Product-Service system development	Product-Service system planning	Product-Service system delivery
STRATEGIC H= 2 Years P= 6 Month	ROI for each product-service (like the minimum ROI range); Net margin expected	Capability to implement cross-selling (through a CRM system)	Total cost of product-service system design	Global implementation costs	Amount of product-service sales for the next two years	Cost of delivery channels
TACTICAL H = 1 year P= 1 Month	Service Exploitation	Amount of sales per month	Time to design the PSS	Time to market	Turnover	Number of new customers/contracts
OPERATIO-NAL H = 1 month P = 1 week	Time to start up the service, Customer satisfaction rate	Increase of of the new ideas	Delay/advance in design	Checking of timing and costing (deviation in%) of master plan	% of WMs with Carefree Washing Service produced in time	Product-service frequency

2.5. Further steps

Other scientific activities have been studied to be integrated within PI Toolset in further steps which could generate

additional positive results on use case Servitization managing and controlling processes. The following additional improvements are not included in the toolset at the moment; anyhow they can be presented as scientific requirements, i.e. further steps which can be taken into account for a future

integration:

- PI calculation activity;
- Visualization of performances;
- Internal audit;
- Trend analysis;
- Feedback on performances.

Implementing all these additional features to PI Toolset will provide useful information on the whole Service system allowing VE partners to exploit better their Servitization activities entailing strategic and functional tools to be used in service management.

In this way the PI Toolset could have the potential to become a learning tool for the organization which adopts it providing an improved vision on performance and capabilities and helping increasing service maturity level of the organization.

3. Conclusion

This paper defines a PI Toolset for the Virtual manufacturing enterprises that may help enterprises in selecting the activity to be monitored, controlled and measured through appropriate PIs. With respect to above mentioned definitions, PI Toolset provides a structured approach which results in:

- Providing a reference framework for monitoring and controlling VMEs;
- Supporting and managing strategic assessment;
- Sorting out significant PIs, in order to take coherent decisions;
- Optimizing the selection and use of PIs;
- Defining a personalised list of PIs;
- Avoiding the proliferation of Performance Indicators.

In conclusion PI Toolset is able to support managing and controlling activities of service systems in the identification of proper performance assessment in order to optimize the evaluation of performances and optimize the selection of activities to be monitored so to prevent errors causing and redundancy or duplication of work among main actors of service ecosystems.

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