MSEE

Manufacturing Service Ecosystem

D13.4
Liability, Trust and Reputation Models
M18

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Dissemination:	Public
Contributing to:	WP 1.3
Date:	28/03/2013
Revision:	V1.0

VERSION HISTORY

	DATE	NOTES AND COMMENTS
01	15/12/2012	INITIAL DELIVERABLE DEFINITION
02	24/03/2013	FIRST ITERATION (CHRISTIAN ZANETTI, MOHAMMADREZA HEYDARI, ALESSANDRA CAROSI)
1.0	28/03/2013	SECOND VERSION OF THE DELIVERABLE (CHRISTIAN ZANETTI, MOHAMMADREZA HEYDARI, ALESSANDRA CAROSI)

DELIVERABLE PEER REVIEW SUMMARY

ID	**Comments**	**Addressed (✓)** **Answered (A)**
1	Synthesize sections in chapter 5 and 6	Answered (A)
2	Precise the methodology that VME must follow	Addressed (✓)
3	Clarify Trust issues in the Introduction	Addressed (✓)
4	Add references to other MSEE Deliverables	Answered (A)
5	Shorten and simplify Executive Summary	Answered (A)
6		

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1. Executive Summary

As mentioned in Description of Work (DOW) the main aim of subproject 1 (SP1) is to study the world of frameworks, methodologies and toolsets to provide the methodological and scientific foundations for the application of the service paradigm to European Manufacturing Virtual Factories and Enterprises.

WP13 focus is about laying the foundations for a governance framework, creating the condition to share resources between potentially unknown parties, providing methods to measure and defining performances measurements and service level agreement in order to create trust relationship and meet customer needs and priorities.

The main goal of D13.4 is to develop internal procedures to allow the enterprises achieve trust in order to enter the Ecosystem, join the VME creation within the Ecosystem and align themselves for the interaction with others by having the correct approach toward a system where many actors can be involved. Therefore focus of the current document is to lay the foundations for trust issues, necessary to ensure the effectiveness of servitization and facilitate relationships among ecosystem partners.

Within this document we analyse trust issues and concepts describing trust as an attribute of the governance framework within a virtual manufacturing enterprise environment.

After defining the complex nature of trust and the role of trust in VME (i.e. Virtual Manufacturing Enterprise), we propose a methodology to analyse Trust through Governance processes in order to organise and integrate the knowledge produced by the entire virtual system. According to SP1 main objectives, Trust issues will be described and monitored at different levels according to particular aspects of assets configurations and needing for different requirements: ME or Enterprise level (Manufacturing Enterprise), MSE level (Manufacturing Service Ecosystem) and especially VME level (Virtual Manufacturing Enterprise). In this document we are going to focus on trust at VME level, therefore the relations between VME governance issues and their connection with trust ones have been specified.

A reputation measurement method has been studied too in order to allow the partner monitoring and controlling trustworthiness through the servitization process. Finally we analyse and measure the assessment of trustworthiness. Trust parameters are analysed at two different stages: the entrance and the monitoring phase. A distinction will be made among the characteristics necessary to an Enterprise to enter the Ecosystem and creating a VME, and the ones necessary to measure its performances in progress.

During the VME creation, general enabling conditions will be identified through VME governance processes and monitored through specific parameters in order to build trustful relationships among partners. Indeed governance framework should be able to develop:

- A coherent set of service driven PIs to steer and regulate the value exchange in an enterprise network;
- End to end SLAs dynamic monitoring and controlling procedures;
- Governance, liability, trust and reputation recommendation models using advances IT tools.

Therefore, the proposed trust issues will try to play a strategic role in supporting MSEE Project. Indeed it will provide useful information on the modality trust affects single enterprises and the system. Specifically the methodology will bring information about how the ME will assess its partners during the creation phase of a VME and on how enterprises will act with others in order to create new VMEs.

2. Introduction

Trust means the general act of believing and placing confidence in someone or something. Trust is a key factor in the establishment of long-term relationships between service representatives and their customers as well as different business partners collaborating on the creation of new services. Prior research has documented that both “person-related” (e.g. empathy, politeness and customer/service representative similarity) and “offer-related” (customization, competence, reliability and promptness) service representative characteristics have an impact on trust. However, the relative importance of these characteristics, and in some cases the direction of their relationships with trust, has varied across studies. In D13.3 we mainly focused on the proposition of a Trust model defining Trust as a characteristic of the network configuration. After proceed in the research activities related to WP13, specially on the development of D13.2, related to governance processes and PIs management, the focus of D13.4 has changed and Trust issues have been studying differently, i.e. trust issues have been integrated inside a whole wider picture which refer to Governance assets in order to coherently comply with WP13 objectives. Indeed Governance characteristics in servitization directly and positively influence trust, and trust directly and positively influences commitment. Trustworthiness is tightly linked with reputation and, on the other hand, reputation and reliability are closely connected with the concept of efficiency and quality. A functioning governance framework ensures that the right processes, people and tools are in the place to enable the VMEs to stay on top of changes and ensure effective decision-making. Specifically, governance characteristics in servitization process help the VME build trust in the market by serving as repositories for knowledge about how to govern future cooperation.

In this deliverable we focus on:

- Analysing existing liability, trust and reputation models;
- Proposing a methodology for trust assessment;
- Measuring trustworthiness concepts;
- Identify PIs and SLAs related with trust relationship.

A complete definition of trust is provided in *chapter three* together with the description of reputation and reliability starting from the definition of this complex issue and related elements.

In *chapter four* trust models are analysed. First of all the state of the art of trust and reputation models is considered. Secondly the configuration of relationship is explained. The typology of trust has been investigated dividing this topic into trust inside the enterprise (Internal trust) and trust outside the enterprise (External trust). And finally, levels of trust have been analysed dividing the concept within the enterprise different levels; the MSE level and the VME level.

Chapter five and *chapter six* represent the core of this deliverable. Indeed in those sections the role of trust in VME and trust measurement method is described.

In *chapter five* the role of trust in VME’s has been considered in detail. After an introduction on servitization process and an explanation of governance issues, the methodology to study and assess trust is presented. Within the deliverable the focus will be on VME creation, particularly specified at BSM level. Governance issues can then effectively manage trust relationships among a ME and its MSE partners during the VME creation. Governance framework specifies the rules and procedures which would lead the enterprise to comply its objectives. Governance issues refer to managing concepts and can be applied at different levels. Within this document it is interesting to investigate Governance related at a firm level and at VME level. Indeed a good Governance framework at firm level leads to reach positive reputation in the market and among partners. On the other hand reputation drives to loyalty and therefore, to trust. It can be stated that trust issues are strictly related to how an enterprise is managed, to how its governance if functioning in order to reach its objectives in a correct way. A sane enterprise succeeds on its tasks and reaches its goals with profit on time and with a high quality standard. Apart from governing service system, the governance framework will support the servitization processes, ensure and manage trust requirements linked with MSEE member's assets. Some practical examples of servitization processes have been discussed and described (especially Indesit Use case).

Finally in *chapter six* measurement and assessment concepts have been taken into consideration. The study of performance indicators, SLAs and SLOs has been drawn and MSEE PI Method has been introduced. After describing the methodology we can rely on while measuring trust issues during the VME creation, a list of PIs has been proposed and classified according to some categories which help identify the parameters affecting trust. Indeed, in order to achieve trust and reputation within the system, enterprises have to provide the required information in the correct timing enabling the full usage of PI's and SLA's during the relations with others.

3. Definition of TRUST

3.1. Defining Trust & Liability

Trust is undoubtedly an important feature of our everyday lives. Without the background of trust, it has been suggested, we would suffer from a loss of efficiency and dynamisms (Golembiewski & McConkie, 1975). Perhaps worse, we would find it very difficult to get up in the morning, and would suffer the inevitable collapse of our society.

It is generally accepted by various fields theorists like: psychologists, sociologists and managements that trust is an important element in the conduct of human affairs. Trust has important role and is essential for stable the social relationship among individuals, groups or organizations level or on a combination of them.

In the field of relationships the issue of trust has been conceptualized as a feature of the relationship quality.
Different writers have given different definitions of trust.
Trust has been studied as an essential element to cooperation, credibility, a determinant for communication between parties (Andreson and Weitz, 1990; Mohr and Nevin, 1990).
But the literature lacks a holistic point of view that can help understand which techniques or technologies are best in various contexts and circumstances. Trust is to be considered as an evolving, contextual and composite issue: the belief one actor (the trustor) has towards another actor (the trustee) he will perform certain actions with certain expected results, when not complete information about those actions is available.
Elofson (2001) asserts "Trust is the outcome of observations leading to the belief that the actions of another may be relied upon, without explicit guarantee, to achieve a goal in a risky situation."
The definition for trust provided by Gambetta (1988) is often quoted and widely accepted in the literature:
"Trust (or, symetrically, distrust) is a particular level of the subjective probability with which an agent assesses that another agent or group of agents will perform a particular action, both before he can monitor such action (or independently of his capacity ever to be able to monitor it) and in a context in which it affects his own action."
Trust is a subjective quantity calculated based on the two agents concerned in a present or future dyadic encounter. Dasgupta (2000) gave a similar definition for trust: the expectation of one person about the actions of others that affects the first person's choice, when an action must be taken before the actions of others are known.

Castelfranchi and Falcone make a clear distinction between Trust as an evaluative belief in which a truster agent believes that the trustee is trustful; and Trust as a mental attitude, in which a truster agent relies on a trustee for a given behaviour.
So we can assume Trust needs both belief and behavioural intention components to exist.
A service has been defined as, "any act or performance that one party can offer to another that is essentially intangible, and does not result in the ownership of anything…" (Kotler, 1997, p. 467). Unlike physical products, service products cannot be seen, tasted, felt, heard, or smelled before they are bought (Parasuraman *et al*., 1985). Because of services inherent intangibility, consumers are often faced with not knowing what to expect of a service until they have consumed it, and hence perceive service as risky (Murray and Schlacter, 1990). Research has

demonstrated that the need for trust arises in any situation characterized by a high degree of risk, uncertainty, and/or a lack of knowledge or information on the part of the interaction participants (Mayer *et al*., 1995).

Refer to the MSEE DOW document, where the definition of service system is provided, IBM and University of Cambridge (2007) defined service system as "a service system can be defined as a dynamic configuration of resources (people, technology, organisations and shared information) that creates and delivers value between the provider and the customer through collaboration. A service is therefore value co-creation."[1]
Thus, customers have an inherent need to trust in their service provider to deliver the desired service outcome.

In industrial service relationships, Anderson and Narus (1990) have defined trust as the belief that another company will perform actions that will result in positive outcomes for the firm while not taking actions that would result in negative outcomes.
Moorman et al. (1993) offered similar definitions and describe a state between two parties involved in a relationship. One of the parties is perceived by the other as possessing or controlling assets that the other party values while remaining convinced that the possessor of these assets will continue sharing them in a mutually beneficial way.
This conviction drives to integrative behaviour that reinforces the relationship and helps sustaining it, sometimes prolonging the duration of the relationship (Morgan and Hunt, 1994).
In this way, trust is regarded as a valuable component of any successful relationship (Morgan and Hunt, 1994) by functioning as a lever for reducing the risk associated with partnering, the development of long-term relationships and increasing the commitment in the relationship (Anderson and Weitz, 1992). Trust, therefore, can be seen as a mental mechanism that helps reduce complexity and uncertainty in order to foster the development or the maintenance of relationships even under risky conditions (Luhmann, 1988).

Reputation
The most general form of transferrable trust is reputation. Trust is able to develop favourable reputations which then generate social and economic benefits. Reputation can be measure through several valued attributes (content evaluation) or through an unexplained estimation (esteem level). They can be divided into quantitative or qualitative ones. MUI (2002) indicates two types of reputation:

- Primary reputation: direct and observed type of reputation;
- Secondary reputation: collective, propagated and stereotype reputation.

In order to be trusted, individuals, as well as economic agents, strive to establish a favourable reputation (Good, 1988). Indeed, the reputation of a little known party can supplement and influence the first impression it makes on other parties. Although reputation does not necessarily imply direct interaction, it can nevertheless be used as data on which to base one's judgment of trustworthiness (i.e. predictability and dependability). In addition:
"Not only will the perceivers of a reputation usually have access to information which the reputation holder does not control, but also the manner in which [this] information is interpreted is not straightforward" (Good, 1988).

Reliability

Hart and Saunders (1997) maintain that reliability is an important dimension of trust. Referring to reliability as the consistency between what a party says and what it does, implying that the party is dependable and follows through on its promises. Reliability helps develop cooperation, which is an antecedent of trust (Anderson and Narus, 1990). Carnevale et al. (1982) earlier stated that trust involved 'a concomitant expectation that the other in a dyad will reciprocate' and had declared this expectation essential for 'the goal of achieving mutual cooperation' (Carnevale, Pruitt et al., 1982). Reliability has been previously included in IT-related models of trust (Hart and Saunders, 1997). As a result, it is reasonable to expect that the influence of perceptions of reliability on trust will hold in e-commerce, leading to the following hypothesis:

- Perceptions of predictability are positively related to trust;
- Perceptions of technical competence are positively related to trust;
- Perceptions of fiduciary responsibility are positively related to trust;
- Perceptions of reliability are positively related to trust.

3.2. The complexity of the definition of trust

Geography of trust

The recent literature on trust shows a number of different approaches which trust can be dealt with. Trust is a multidimensional construct and this is the reason why it is not easy to define it. It is related to behaviours, handling of sensitive information, capacities, competencies, resources, financial, skills, etc.

There are various perspectives trust can be looked at like organizational, social, financial/economical, technological, and behavioural/managerial. Or also emotional, operational, relational, personal and institutional.

The contribution of different disciplines

Many contributions that can help us defining trust come from different disciplines like, economics, game theory, and sociology.

In psychology trust is related to the issue of beliefs (Marsh, 1994): "Trust is a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behaviour of another" (Rousseau, Sitkin, Burt, and Camerer, 1998:395).

Researchers take for granted that trust exists and they ask what leads to trust. Cognitive processes and affective reaction are seen to be such general antecedents. Other antecedents in dyadic trust can be the attitudes of the trustor (disposition, prior experiences, values, motivation) and the trustee (ability, benevolence, integrity).

While the psychological approach gives us a basic understanding of human behaviour with regard to trust, it often neglects the context of specific situations.

In economics perspective, the notion of trust makes sense only if it is seen as a rational choice: actors behave in a rational way to maximize their gains. Two of the most influential theories are transaction cost economics and game theory.

In economics and game theory, trust is considered the instrument for a transition from static rationality of non-cooperative behaviours to dynamics of cooperation (Berg, Dickhaut and McCabe, 1995). In transaction cost economics, two basic assumptions characterize actors:

Human beings have a bounded rationality and they tend to behave in an opportunistic manner (self-interest seeking with guile). Moreover, the costs for any one transaction are the sum of production and transaction costs. Transaction costs arise ex-ante (information gathering, negotiation, and contract) and ex-post (supervision, conflict solution and re-negotiation). Under these conditions, institutions should be organized taking bounded rationality into account and safeguarding against opportunism (Williamson, 1985). Trust plays no role while mistrust does.

Trust is an important element within organizations and in business transactions, as it facilitates risk taking (Luhmann, 1988). Trust has been found to be a remarkably efficient lubricant to economic exchange that reduces complex realities far more quickly and economically than prediction, authority, or bargaining (Powell, 1990). Also, the costs of acquiring new customers is significantly higher than retaining existing customers, which explains that relationships based on trust constitute a strong competitive advantage.

Trust is also seen as a cultural phenomenon and so studied by sociologists. In sociology trust is related to reputation and previous interactions among individuals. According to Parsons (1962), we can only put our trust in people who share the same goals and values.

"From a sociological perspective, trust is defined as a set of expectations shared by all those involved in an exchange" (Zucker, 1986).

A comprehensive early study within a framework of functional-structural system theory was published by Luhmann (1968) and Parsons (1962). While Parsons stresses the structural component in his normative system theory, Luhmann is more concerned with function. He describes it as: "Trust in the broadest sense of confidence in one's own expectations is an elementary fact of social life. Man has admittedly in many situations a choice whether or not to put his trust forward in a certain way. Without any trust, however, he could not leave his bed in the morning".[2]

Finally in computer science researchers usually relate trust to security, reputation, and privacy.

As we have seen, Trust has been studied extensively in a number of disciplines. For instance, personality psychology focuses on trust as an individual characteristic, while social psychology focuses on the dynamics of trust between individuals. Economics and marketing look at the trust in the context of commercial exchange and transaction. Despite the multidimensional character of trust, the different conception all share common elements.

Research Keywords related to trust

As it has been analysed until now, trust is a complex issue to explore. In order understand better this topic so to be able to propose our trust model, we investigated meaningful concepts related to trust.

Several keywords have been extracted as reference elements to make it out clearly.

These elements can be considered as pillars in the study of a trust model. Here below the most significant ones are provided:

- Reputation;

[2] Luhmann, N., Vertrauen, Lucius & Lucius, Stuttgart, 1968.

- Reliability;
- Trustworthiness;
- Accessibility;
- Security;
- Privacy;
- Credibility;
- Empathy;
- Social skills;
- Expertise;
- Complexity (to define and measure);
- Uncertain phenomenon;
- Relationship durability;
- Acquiescence;
- Participation- cooperation.

Trust produces cooperation and support. Thought trust it is possible to gain ambient more open, more tolerant, less competitive. In this way you can have much more creative settings for collaboration and co- innovation.

Participation generates innovation (Collaborative consumption, Peer to Peer Movement, Openness) therefore new social capital can be brought by a community of trust.

4. Studying Trust Model

In this section the focus will be on the analysis of trust models. First of all the state of the art of trust and reputation models is considered. Secondly the configuration of relationship is analysed and explained: actors involved are described, the typology of configuration and the level of trust is studied. The typology of trust has been investigated dividing this topic into trust inside the enterprise (Internal trust) and trust outside the enterprise (External trust). Finally, levels of trust have been analysed dividing the concept within the enterprise level, the MSE level and the VME level. The information gathered from the analysis of the state of the art about Trust models has been processed in order to generate the definition of trust typologies (internal, external, hierarchical, non hierarchical). In the same way the definition of trust typologies has been adopted as a starting point to create and describe the model referred to levels of trust in which VME level is of vital importance for MSEE Project and which we are going to focus in within next chapter.

4.1. State of the art of Trust & Reputation Models

Trust models allow identifying and isolating untrustworthy agents, evaluating an interaction's utility and deciding whether and which partner interact with. Following a good trust model should be:

- Accurate, should provide good previsions;
- Adaptive evolve according to behaviour of others;
- Quickly converging quickly compute accurate values;
- Multi-dimensional Consider different agent characteristics;
- Efficient Compute in reasonable time and cost.

Several trust models have been proposed by researchers for different contexts, each one with its own characteristics and proposing its technical solution. We propose here a brief overview of some of the most relevant ones.

Online reputation models

We refer to eBay (eBay, 2002), Amazon Auctions (Amazon, 2002) and OnSale Exchange as interesting examples of online marketplaces that use reputation and trust mechanisms.
eBay is one of the largest online marketplace in the word; most items are sold by auctions following the reputation mechanism based on ratings that users perform after the completion of a transaction.
Buyers and sellers evaluate each other after transactions and the evaluation is not mandatory and will never be removed. eBay considers reputation as a global property and uses a single value that is not dependent on the context. The user can have three possibilities of value: positive, negative or neutral. Each eBay member has a "reputation" (feedback score) that is the summation of the numerical evaluations, i.e. the sum of the last six months rating that gives the reputation value (Sabatar et al, 2005).
The eBay model is specifically oriented to scenarios with the following characteristics: human oriented a lot of users and few chances of repeating interaction with the same partner.
In a similar way Amazon Auctions and OnSale Exchange use a mean to assign a reputation value. The value is not dependent on the context and the source for the reputation value is due

to witness information. It directly comes from information's given from others agents that have previously interacted with the target user. These models do not provide a specific way to deal with false user's information. The only way to increase the reliability of a user is a great number of opinions that mitigate false information.

SPORAS and HISTOS

In 1999, Zacharia et al. proposed a trust evaluation model for loosely connected online communities based on a reputation mechanism and called SPORAS. In this system the trusting agent bases its opinion of the reputation of its interaction partner on the feedback the latter gives on the trustworthiness of their latest transaction. In this model only the recent rating between two users is considered. Only the most recent ratings are scored for agents who have repeated interactions. A new user will have the minimum reputation that is gradually builton the agents interactions with others. Trusted agents with very high reputation values experience much smaller changes in reputation rating after an update than agents with low reputation. SPORAS incorporates a measure of the reliability of the reputation of the users based on standard deviation of reputation values. This model presents the same general characteristics of online reputation models mechanisms and works even with few ratings but is more suitable to changes in the user's behaviour and the reliability measure improves the usability of the reputation value.

The centralized approach is one of the main problems of this model because it makes it not suitable for open communities. Among other problems of the model we can find the assumption that all the users are considered untrustworthy at the beginning (even if it affects system performances) and the fact that occasional short-chargers could be undetected when they select less trusted users to cheat on.

While SPORAS provides a global reputation value to each agent in the online community, HISTOS takes into consideration information about its peers when available.

HISTOS is a decentralized model and has been designed to complement SPORAS by assuming abundance of ratings thanks to including witness information as a second source of reputation. It takes into consideration information about its peers when available. As agents in the system rely more on recommendations given by users they trust, HISTOS builds social network from the ratings it has previously obtained, represented as a directed graph with nodes representing the agents and the weighted edges representing the most recent reputation rating given by any agent to another. Thus transitive trust relationships are applied in case of directed paths between two agents. Anyway this model presents correlated and biased evidence problems.

REGRET

The REGRET model is a modular trust and reputation system oriented to complex small/middle size e-commerce environments where social relations among individuals play an important role. The system takes into account three types of information sources: direct experiences, information from third party agents and social structures (i.e. system, neighbourhood and witness reputation).

The Witness reputation is the reputation calculated from the information coming from witnesses.

Neighbourhood reputation (social credibility) is calculated using the information extracted from the social relations between partners. And system reputation consists in a reputation value based on roles and general properties. Therefore REGRET includes the measurement of the social credibility of the agent and the information credibility in the computation of witness reputation.

Another element in the REGRET system is the ontological structure that combines values linked to simple aspects in order to calculate values linked to complex attributes. Each individual can present a different ontological structure to combine trust and reputation values and then a different way to measure the importance of these values once combined. Therefore it investigates the notion of individual preference.

In each trusting situation the outcome is defined by variables, expected values and real values. This model is able to calculate uncertainty but does not use this information in a useful way. This issue has been partially resolved in FIRE model that puts less importance to the social aspects of witness statements. Neither FIRE nor REGRET considers the possibility one agent could be not willing to provide testimonies in order to protect his private information.

Finally, refer to the above mentioned trust models it should be emphasized at this point that the mentioned models have their own advantages and disadvantages. Like eBay model is specifically oriented to scenarios with the human oriented characteristics or in SPORAS and HISTOS model because of centralizing the approaches community opening is not suitable.

4.2. Trust Model based on the configuration of the relationship

This Section proposes to analyse a model based on the configurations of the Enterprises giving shape to VMEs inside the Ecosystem (a model for configuration and propriety attribution of the VME).

We can refer to a VME in terms of a network of relationships. A relationship is a process of interaction which is supported by mutual trust and established by commitment. Relations are complex systems of many interrelated dimensions that have emerged together over time in an environment as a result of the experience and outcomes of the on-going interactions taking place (Hakansson, 1982; Ritter et al., 2004).

A relationship is made by specific knots and connections while trust is defined as a quality which is expressed inside this relationship. Building and developing relationships is a process that demands time and managerial resources. Business relationships consist in exchange interdependent relationships between firms doing business with one another. Successful business networking creates a win-win situation among business partners through valuable trust, commitment and improved performance. Therefore entering a network and building the right connection have a strategic importance. It is also fundamental to monitor continuously and evaluate individual partners' performances inside the network.

Morgan et al. (1994) affirm trust is one of the most salient factors for cooperation networks to achieve their business objectives.

Organizations have often to create relationships with other stranger organizations in order to take advantages on opportunities the market suddenly offers. Therefore, the more one organization is confident about getting involved in a collaborative network, the more its trustworthiness level increases and the more it get used in estimating the level of trustworthiness of other organizations.

In the global economy, trust relationships are becoming more and more important in order to reduce the risk surrounding most of the businesses.
First we will define the field of action of this relationship (who or what is this relationship applying to) and then we will define its specific qualities (how, in which scale). In order to define the trust model we will need to specify the knots and the connections that give shape to the configuration of the network. Talking about network, we focus on relationships configurations that are actually based on governance arrangements.
We can define VMEs as multi-actor environments, in which each actor is an autonomous element characterized by certain interests and goals. So, in order to create a stable and functional VME, a particular balance of trust relationships among its members needs to be established.
Actor's roles are dynamic in adaptive service systems. The Ecosystem should design configurations that are capable of adapting to changes induces by actors inside or outside the system.
Trust plays a great role in how social interactions are modelled. It is a prerequisite for collaboration, delegation and the creation of a network (see Luhmann, 1979, 1988). Trust characterizes relationships and can be used as a mechanism to coordinate those relationships. A trust model based on the configuration of the relationships can offer a new way to forecast the trustworthiness of other VME members. Establishing ex ante trust relationships with partners is essential to the success of any VME.

Actors involved: trustor and trustee

A trust relationship as an action that builds a trust relation between an actor and another. Actors refer to the organization parties involved in a specific trust relationship. The trustor refers to the first organization that needs to assess the trustworthiness of another party. The second one, that needs to be trusted, and thus will need the trustworthiness of the first organization to be assessed, is called trustee. However, this is already a social relationship where the behaviour of both parties may influence the relationship (if I lend my friend money, which he or she does not repay, then I am not likely to do it again). Building trust can thus be an investment in social capital, which can facilitate later cooperation. Trust between teams and between organizations is also considered. These situations involve many interactions over time where a trust theory that is both socially oriented and processual may be preferred. The object of trust can also be a technology artifact or some form of abstract system, such as a market.

Essentially, the trustor-trustee relationship is characterised by dependency, under conditions of uncertainty and risk (Luhmann, 1988; Curral & Judge, 1995). Some have also distinguished between trust as the willingness to accept risk and trusting behaviour as the actual assumption of risk (Meyer, Davies & Shoorman, 1995). The decision to trust or not can be affected both by cognitive and emotional elements. The cognitive element refers to a rational assessment of risk, the other party's reliability and competence, and is therefore more task-oriented. On the other hand, the emotional element refers to attraction, in the short term, and loyalty, in the long term. Its orientation is therefore more inter-personal. This view implies that trust can refer to several objects – in this case, the task (the transaction) and the trustee (the merchant). Although trust develops over time by ongoing interactions, the focus here is on initial trust, implying limited interactions and no earlier transaction with that merchant.

The elements of a trust relationship to be considered can be divided in two different categories according to the type of business relationship as mention here below:

A) B2B level:

- The internal departments of the Enterprise itself;
- The Enterprises of the Ecosystem;
- The Ecosystem;
- The configuration of VMEs.

B) B2C level:

- The Customer;
- The Enterprise;
- The configuration of VMEs.

4.3. Typology of configuration

In this section we are going to classify networks according to the typology of configuration. Different network structure and their structural priorities are going to be defined and explained. Interpretative categories that specify network configuration (for example, scale, and dimension, number of subjects involved) will be described too. Some important elements take into consideration when speaking about properties are the following ones:

- Connectedness (directly or indirectly);
- Graph theoretic distance (usually short);
- Density (usually great density of ties);
- Core/periphery structure;
- Coreness (level of participation-collaboration);
- Time (duration of the network, short, long);
- Dynamic/static structure: Flexibility, mobility.

Among the different configurations a network could take, we are going to analyse the more famous ones, i.e. the centralized and distribute one. Their major characteristics are stated here below:

1) The Centralized structure:

- Power oriented;
- Vertical, hierarchical;
- Static.

2) The Distributed structure:

- Peer to Peer, distributed, decentralised control (there is no a centralised controller to control the decision process of all agents in the system);
- Not hierarchical, horizontal;
- Dynamic.

In a hierarchical type of network, there is one dominating partner organization that controls the basic power and control of the complete network. In this network type, other partners usu-

ally follow the decisions and guidelines from the dominant partner who has the biggest capacity and capability within the network.
In a non-hierarchical network type, the entire partner organizations enjoy equal power and control in the decision-making process within the network. All the partners usually have almost equal capacity and capability.
This section needs to be expended and improved within the next updates of the deliverable.

4.4. Possible configuration of the Model

We propose to study a model about trust based on the relationships/connections among the partners. This model can assume many different configurations according to the specific behaviour of the actors involved. We will propose two different and opposite configurations of this model in order to present the two extremes of the range in which VMEs will operate. Configurations of VMEs can change a lot but will always lay inside the range of extreme structured and extreme unstructured behaviour. By specifying the model using these two extremes, we can show how the model can assume different configurations in the basis of the organisational dimension of the network. Later in the research this model will be enhanced with different configurations as we would be able to insert any other configuration between these two extremes just analysing its performance or the ecosystem.

The Hierarchical configuration

The hierarchical configuration is a structured, hyper hierarchical model in which we will find a centralized power enterprise that establishes one to one relationships with different partners (knots). In this case just one actor owns the decisions for the whole network; the governance will be centralized in one subject (i.e. Apple case study).
The elements of the relationship are static because the modality of connection has already been defined. Accordingly also monitoring mechanisms will follow particular flows without being dynamic. The governance will be centralized in one element.

The Non Hierarchical configuration

The non-hierarchical configuration can be composed by an indefinite number of enterprises in which none is the owner of the processes. The enterprises have to negotiate each transaction; they have to negotiate the connections of the knots and therefore different SLAs. Agreements will be dynamic; there will not be a vertical decision structure. This is a de-structured model with different KPIs and SLAs. Its governance consists on an emerging model and would depend on the structure of trust among knots. (I.e. Peer to Peer models like Free and Open Source Software, Arduino case study). Referring to Ingo Westphal (2012) definition of MSE:

"A Manufacturing Service Ecosystem (MSE) is a non-hierarchical form of collaboration where various different organizations and individuals work together with common or complementary objectives on new value added combinations of manufactured products and product-related services. This includes the promotion, the development and the provision of new ideas, new products, new processes or new markets. Inhabitants of such an MSE could be big OEMs, SMEs and networked organizations from various branches, ICT suppliers, universities and research centers, local public authorities, individual consultants, customers and citizens".

This definition helps us defining better the non-hierarchical structure and characteristics. Even if the structure is non-vertical, it presents anyway a formalisation standard: partners recognise to be part of the same ecosystem, agree on the same common objective and adopt an appropriate structure. The type of relationships among partners, as we said, is decentralized. One partner can play a more active role in one configuration and not in another (i.e. for example facilitation in decision making and coordination) according to the common objective the configuration is following.

4.5. Typology of Trust

Collaborative business networks develop on the interaction among enterprises which are interested in cooperating with each other in order to achieve specific tasks. The network formation can be of longer or shorter term according to the market opportunities. Trust is essential for the commitment and the creation of a relationship with a network partner.
Trust in inside and outside the enterprise are two of the central issues in VME, concisely formulated. Management of trust in both sides involves a continuous process of assessing the trustworthiness of VME members for different purpose and establishing/re-establishing trust relationships among VME members in VMEs. Trustworthiness assessment is on the basis of known information about members, collected and stored within the VME environments. Modelling trust relationships and promoting trustworthiness among members are important aspects of trust management. Two main kinds of trust will be defined as needed to be established among different organizations within the service ecosystem. We propose to divide the general concept of trust into internal and external trust.

Trust inside the enterprise (Internal Trust)

Internal trust consists in the trustworthiness measured and perceived inside the Enterprise. It means it concerns the single enterprises, the many configurations of VMEs, the internal departments of each enterprise and how they relate each other.

The main aim of establishing/re-establishing trust relationship among VME members is to enhance the efficiency and success of both their cooperation within the VME as well as their potential collaboration in virtual enterprises that will be configured within the VME. Refer to the individual achievements of each organization, the main criteria that influence the trust level among VME members contain their roles, reputations, and membership level at the VME as well as their past performance on activities related to the VME.

Trust outside the enterprise (External Trust)

External trust is referred to the marketplace. In this case we can talk about B2B and B2C situations. External trust involves the Ecosystem, the many configurations of VMEs, the single enterprises inside the ecosystem and the costumer that can be a private subject or another enterprise/system of enterprises.

In VME environment, trust must be addressed in relation to the VME members, the VME customers and the VME establishment itself, that constitute trust among "organizations" and not individuals. Accordingly, while we can benefit from the general past research on trust, we cannot directly apply theoretic approaches and/or results. Trust among organizations is a complex multi-criteria subject and relevant trust relationship establishment, trustworthiness level evaluation, trust promotion, and trust relationship modelling are different aspects covered under the general subject of trust management.

The evidence of information validity about organizations, being witnessed or certified, is of primary importance to establish trust outside the enterprise.

The methodology designed for trust management in a VME depends on the specific condition of the cooperation environment (i.e. size or organization structure/complexity). Sometimes the environment of cooperation faced to uncertainty which may result from changes in the market or global conditions that are not beyond its control and difficult to anticipate, such as volatility or unpredictability in markets. Research has shown that perceived environmental uncertainty exerts significant influence on organizational processes.

Duncan (1972) suggested that external environmental influences can be divided into environmental complexity and environmental dynamism. Environmental complexity refers to different external forces with which an organization interacts, whereas environmental dynamism refers to the rate of change in the environment and the unpredictability of environmental changes. Complexity is associated with the uncertainty inherent in a situation at a given point in time, whereas dynamism refers to uncertainty over time. In the case of VMEs, environmental dynamism may be an even more important source of uncertainty than complexity.

At the same time, Enterprise may not have enough resources to understand and develop responses for the changes arising due to environmental dynamism.

In dynamic and uncertain cooperation environments, when faced with greater fear of opportunistic behaviour by partners, firms are more likely to rely on contract-based governance as compared to trust-based relational governance.

The general arguments in favour of trust assert that it allows greater flexibility in responding to environmental changing conditions (outside the enterprise), facilitates investments in transaction or relation-specific assets that enhance productivity, and reduces transaction costs associated with costly monitoring and other formal safeguarding mechanisms.

Trust among different partners (B2B)

Given that the concept of trust plays an important role in relationship marketing, and in particular in the context of business-to-business markets, it is no surprise that the construct of trust has received ample attention in the research literature. Trust plays an important part in maintaining profitable relationships, thus understanding the nature of trust and the importance of its contribution to loyalty is of particular interest to managers and has a major impact on how business-to-business relationships are developed and managed. In the context of business-to-business marketing, trust is similarly viewed as a focal construct, for example in the context of industrial marketing and purchasing groups. In a buyer-seller relationship, both

parties must trust one another in order to maintain the relationship. If trust exists in a relationship, trust can reduce the cost of negotiating an agreement and encourages the seller and the buyer to behave in a fair manner.
For example, one of the most critical elements in B2B markets, and particularly a service market such as the advertising industry, is the development of client relationships. The complexity of the products and services and the long-term nature of business relationships in the advertising industry mean that effective and satisfactory business relationships are of the greatest importance in the marketing of advertising services. It is useful to notice that:

- Higher levels of partner satisfaction with a relationship are associated with higher levels of commitment in the relationship.
- Higher levels of partner satisfaction with a relationship are associated with higher levels of trust in the relationship.

Trust and commitment are both very important elements in ensuring long-term implement relationship-marketing strategies. It is important that companies select their partners carefully, share common values, and maintain excellent communication at all times during the relationship continuum. To ensure a cooperative relationship that is mutually beneficial, companies must also ensure that they provide resources and benefits superior to the offerings of other companies, and that they avoid taking advantage of their partners in any way.

Trust among the customers (B2C)

Historically, Business-to-Consumer (B2C) focuses on direct transactions between businesses and end consumers (Dedhia, 2001; Lawrence, et al., 2000; Riggins and Rhee, 1998; Schneider and Perry, 2000; Ah-Wong, et al., 2001), that is, the trading and transactional relationship between an organizations and an end user (Dedhia, 2001; Lawrence, et al., 2000; Riggins and Rhee, 1998). Consumers are able to purchase goods and services such as books, computer products, music, at any time that is convenient to the consumer directly.
Much of the extant literature on assessment of service quality has focused on end-consumers, rather than on business customers. Moreover, there has been a lack of research into the evaluative criteria and processes used by firms in forming service-quality perceptions.
It is good to point as an example: Adequate supply of Trust & Confidence solutions matching the demands of all B2C parties is key to develop confidences. Development and deployment of these solutions requires: 1) personal actions on the part of the consumer and the trader, and 2) collective actions on the part of the industry and the e-governance players.
For making another clear example, we can mention that: The European Commission, the Federal Trade Commission, the OECD and business sectors have all identified the establishment of Trust & Confidence as being crucial for the future of B2C e-commerce . Although previous research has focused on the strategies deployed for the organizational growth of e-commerce as a whole, few efforts have been devoted to strategies for developing Trust & Confidence in e-commerce. Mass access to the Internet coupled with trends in globalization of products and services have given birth to new e-commerce markets in recent years. There have been several optimistic projections of rapid growth for e-commerce, but the business-to-consumer (B2C) sector has failed to achieve its expected growth potential. One of the main

reasons for these disappointing results is thought to be the lack of consumer trust and confidence in e-commerce.

In the figure below all the elements that we considered on the analysis of trust model, have been highlighted in three (Time, Type and network configuration) categories. Firstly our proposed trust model considered to monitor trust in two different phases on the basis of time: Entering (design) phase and run in time phase. This action will provide useful information about MSE partners performances.
Secondly the type of trust has been analysed in relation with the enterprise environment. Internal and External have been defined according to enterprise relationship. As Trust outside the enterprise has a leading role in the MSEE Project, then it has been structured with more detail analysing specific network configurations. Therefore finally our trust model has been categorised referring to the network configuration because partners inside the ecosystem can configure in different ways in order to create new VMEs.

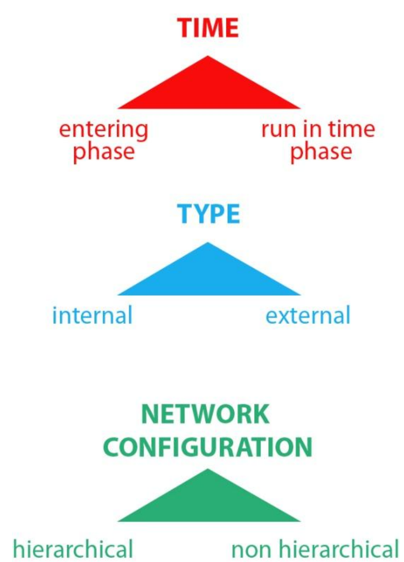

Figure 1 – Trust model conceptual schema

4.6. Level of Trust

Within the MSEE Project, trust issues can be described and monitored at different levels, responding to particular aspects of assets configurations and needing for different requirements. The various levels which will be analysed can be defined as follow:

- ME level (Manufacturing Enterprise) or Enterprise level;
- MSE level (Manufacturing Service Ecosystem);
- VME level (Virtual Manufacturing Enterprise).

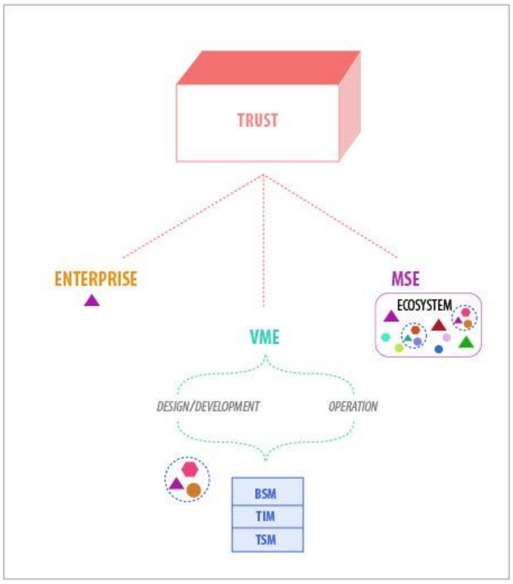

Figure 2 – The level of Trust measurement

In the following section, a precise definition of the three levels is provided[3].

Manufacturing Enterprise/ Enterprise Level

A "Manufacturing Enterprise" is a single enterprise working in manufacturing with the traditional structure (customers, suppliers). Usually there is a management and the structure could be centralised or decentralized depending on the type of management. This ME can decide autonomously its own servitisation policies and follow the evolutionary path traced by Prof. Thoben's four stages in extended products. Furthermore, this ME can cooperate with other enterprises according various types of relations: subcontractor's relations, supply chain relations, etc...

Within ME level, trust issues belong to the hierarchical configuration and can be related to Internal Trust aspects. Enterprise system is governed by Top Management in a vertical way according to a defined strategy. Internal trust belongs to internal department monitoring while external trust is related with the reputation the enterprise has within the market (customers, stakeholders, suppliers, etc…).

MSE level

A "Manufacturing Service Ecosystem"(MSE) inscribes itself inside the concept of "Manufacturing Innovation Ecosystems" (MEI) which definition has been provided by COIN project: " An innovation ecosystem can be defined as a non-hierarchical form of collaboration, in the past mostly founded on a territorial proximity like Smart Regions or Districts but nowadays extending globally worldwide, where big OEMs, SMEs networks, ICT suppliers, universities and research centres, local public authorities, individual consultants, customers and citizens work together for promoting and developing new ideas, new products, new processes, new markets".

Therefore as already said, MSE can be defined as follow: "A Manufacturing Service Ecosystem (MSE) is a non-hierarchical form of collaboration where various different organizations

[3] This information is coming from Doumeingts Guy, Gusmeroli Sergio, "Definition ME, MSE and VME" 27th August 2012.

and individuals work together with common or complementary objectives on new value added combinations of manufactured products and product-related services. This includes the promotion, the development and the provision of new ideas, new products, new processes or new markets. Inhabitants of such an MSE could be big OEMs, SMEs and networked organizations from various branches, ICT suppliers, universities and research centers, local public authorities, individual consultants, customers and citizens”[4].

Within the MSE level, trust issues belong to External trust characteristics. Partners recognise that they are part of a group, they agree on a common objective in order to develop innovative solutions/services in a defined domain. They sign an agreement to work together and to follow specific rules. Due to the fact that each partner brings knowledge and added value in the MSE, it is normal to establish some rules to preserve and protect the shared knowledge. Reputation is the key factor to promote business opportunities among partners therefore correct governance issues have to be observed in order to be considered trustworthy.

As the Ecosystem has a non-hierarchic character, MSE level will follow non-hierarchical configuration trust characteristics. The Ecosystem is self-organised, most decisions are decentralized, partner organizations enjoy equal power and control in the decision-making process within the network therefore it is not managed in a vertical sense by one of its members. Partners have to agree on the objectives and will adopt accordingly an appropriate structure to reach the mentioned objectives. Some partners can take a more active role and facilitate coordination and decisions.

VME level

A Virtual Manufacturing Enterprise (VME) is a virtual enterprise which belongs to service systems. On one side, service system can be defined as a dynamic configuration of resources (people, technology, organisations and shared information) that creates and delivers value between the provider and the customer through collaboration. A service is therefore value co-creation.

On the other side, a virtual enterprise (VE) can be defined as “a temporary alliance of businesses that come together to share skills or core competencies and resources in order to better respond to business opportunities, and whose cooperation is supported by computer networks”.[5]

Members of MSE can set up a VME in order to face and tackle business opportunities. A VME can be considered as a spin-off of the MSE but also some partners outside of the MSE can join the VME. VMEs could find in the MSE additional partners, knowledge assets, IT tools which were not foreseen at the beginning. At the End of its Life, the VME dissolves and transfers the gained knowledge and outcomes to the MSE which generated it. The number of partners in VME is limited by the characteristics of the business opportunity. The VME has different business objectives than MSE ones.

VMEs are generated and managed in order to support new product-related services and they are in charge of the design, development, testing and deployment of a new service. This involves ex-ante (idea management, filtering, business simulation) and ex-post (operations,

[4] Westphal, Ingo, “Basic thoughts on Manufacturing Service Ecosystems”, Version 1.1, 18th June 2012.

[5] See Wikipedia definition.

management, governance, dissolution) activities including the development of the relevant IT platforms and tools.

Within the VME level trust issues will be apt to both Internal than External trust aspects.
As a VME is catching a new business opportunity, the ME assets implied could not coincide with ME core activity. Therefore internal department's performances and assets needs to be monitored in order to achieve trustworthiness on the above mentioned sector.
Furthermore trust characteristics will belong to the non-hierarchical configuration because the enterprises which give to shape to a VME are not vertically governed by one of its member. VME structure is much more liquid, enterprises are part of the same service system and agree on the same common objective they want to reach; accordingly they will adopt an appropriate structure.

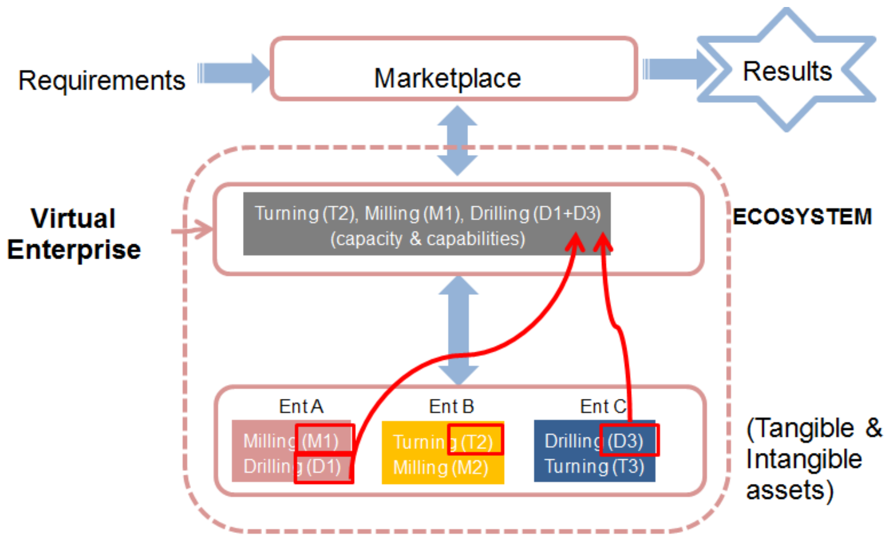

Figure 3 – Example of VME structure

The focus of the deliverable will be on Trust within the VME level which will be further discussed in the next chapters. The practical results will support this deliverable to validate the methodology which is highlighted. VME level of trust will be investigated at BSM, TIM and TSM levels following the MDSE Architecture, particularly focusing on the BSM one.

5. Trust in VME

In this chapter we are going to focus on trust issues considered at VME level. In order to do so, an introduction on the servitization process and the role of trust in VME has been provided in the following paragraphs.

5.1. Introduction on servitization process

"There is clear evidence that manufacturing firms are servitizing–either adding Services to or integrating services in their core products" (Andy Neely). This concept is called servitization where the servitiziation level goes from "tangible product" as lowest level to "product as a service" as highest level. In particularly, the servitization process starts by adding a simple service to the product and the evolution shift from pure product toward Product+Service.
An overview of the transition from product to product+service or service as a product, named as servitization process **(**K.D Thoben et al., 2001**)**, is derived from the DOW and is herewith discussed (Referring to D11.1).
First of all, for the companies to survive under nowadays market pressure, it is necessary to provide extended products and an appropriate model to link products, product related services and the needs of the users.

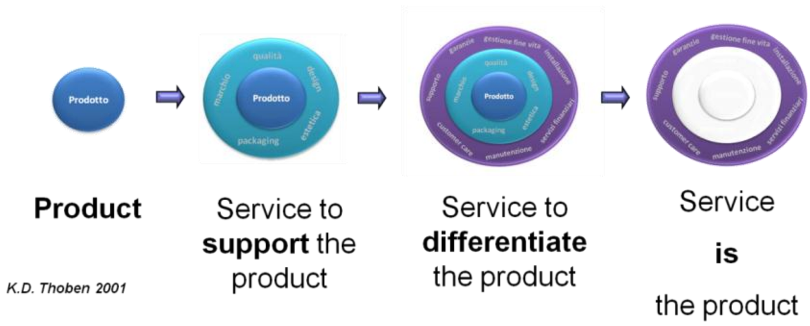

Figure 4 - Product shift to service

A smooth and steady shift is taking place from consumers buying products towards consumers buying solutions and benefits.

Customers and consumers have new and more complex requirements regarding products, therefore the role of additional services and product solutions need to be enhanced.

Both time-to-market and service-product offer leverage to gain sustained competitive advantage.

Finally, by the term *extended product* focus should be drawn on more functionalities than just the core or tangible product; therefore we aim at moving our attention from a tangible product to an intangible shell around the tangible product (i.e. Service as a Product).

The above mentioned transition represents one axe of the diagram only. MSEE has to consider also the transition from the management of a supply chain (planned, strictly controlled) to an ecosystem, where the added value is mainly due to the emergence of unexpected business possibilities (un-planned) and the openness to enterprise members within an appropriate environment.

Figure below depicts such transition phases from an OEM company, with its own supply chain, to a product+service configuration (i.e. servitization), to better tackle consumers. The company's ecosystem is still controlled and governed by the enterprise, which cannot take advantage of additional expertise and cross combination offered by other parties. By getting other SMEs involved in an adequate environment, additional services could be provided, thus leading to real service innovation within an open and unplanned ecosystem, where every player might take advantage of cross-functional business opportunities.

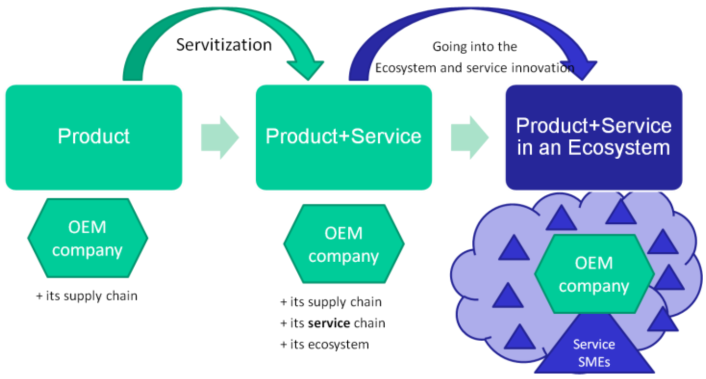

Figure 5 - From PLM to SLM synchronization

As far as SLM is to be reckoned, different service engineering components are to be defined, as described in WP 1.1 to WP 1.3, in order to properly manage the transition within the MSEE. Service lifecycle phases have been identified ranging from service identification/concept to operation/implementation/decommissioning and service components have been studied, expressed in terms of modeling (WP1.1), methodology (WP 1.2) and KPIs/SLAs (WP 1.3).

Focus of the current document is to lay the foundations for trust issues, necessary to ensure the effectiveness of servitization and facilitate relationships among ecosystem partners.
In this chapter we focus on various trust issues and concepts concerning governance framework within a virtual manufacturing enterprise environment.

5.2. The role of Trust in VME's

In the Ecosystem environment trust is fundamental to select Enterprises, help them deciding who to collaborate with in order to configure new and different VME (Virtual manufacturing enterprise). As mentioned in MSEE internal document[6], VME is defined as virtual manufacturing system. VME is generated and managed in order to support new product services.
We can refer to a VME in terms of a network of relationships. A relationship is made by specific knots and connections and trust is defined as a quality which is expressed inside this relationship. Reputation is considered a primary base for trustworthiness but trust refers also to many different factors that influence the level of trustworthiness of a firm.
Trust in collaborative environments refers to so many values, concepts and actors to be considered a multi-criteria, multi-objective and multi-actor subject.

[6] Doumeingts Guy, Gusmeroli Sergio, "Definition ME, MSE and VME" 27th of August 2012.

Trust is first perceived among individuals and later influences the enhancement and establishment of trust relationships among organizations. So we can affirm trusts among organizations which participate in networks are important pre-conditions to collaboration and cooperation. Trust consists in a useful organizing element when different actors are depending on the decisions or action of others.

The results of this study about trust will be then useful for the Enterprises that form the Ecosystem.

Trust can be used as a pre-condition for the selection to decide which firms accept inside the Ecosystem, to identify which partner is the right one to select in a VME. Then trust will also be measured to verify the trust ability of the suggested partners.

On an organizational level, many VMEs divide their responsibilities by functional separation and delegation of work. On a social level, delegation of work requires trust in the capability and willingness of others to perform their duties without supervision. Trust itself is mediated by communication involving symbolic interaction.

Especially during the start phase, when a VME is in construction, there are high-pressure environments in which networks are to be established. Without trust there will not be delegation or collaboration.

Establishing trust relationship leads to many advantages among members of a cooperation network. Among these we can mention[7]:

- Motivating cooperation network members to accept some responsibilities, even in case of uncertain or incomplete information;
- Facilitating the achievement of objectives by encouraging information exchange, knowledge sharing, tools sharing, etc., among members in a network;
- Encouraging members to avoid opportunistic behaviours within the network;
- Easing the process of creating and launching virtual organizations;
- Increasing the desired preparedness to participate in VOs (Virtual Organizations);
- Creating competitive advantage through reducing the governance costs (management costs), costs of internalization (acquisitions), transaction costs among organizations, and impacts creation;
- Enabling open communication, and conflict management;
- Helping to speed up the contract process.

Some advantages gained if trust is well managed include:[8]

- Enhancing the saving of transaction costs;
- Reducing efforts for co-ordination;
- Ensuring commitment of all partners to the common objectives;
- Creating a pleasant collaboration atmosphere;
- Increasing transparency, knowledge sharing, partners commitment and safeguarding.

[7] Referring to Ecolead, "D21.4b, Creating and Supporting Trust Culture in VBEs", 2006.

[8] Referring to thr results of the questionnaire about trust in Ecolead, "D21.4b, Creating and Supporting Trust Culture in VBEs", 2006.

We all have an inherent need to interact with other individuals and institutions. These interactions can take the form of short- to long-term relationships in which exchanges take place. However, given the other party's independence, we can never fully understand its actions, let alone control it. It is the social need for mutually beneficial relationships, coupled with the unpredictability of other parties, which creates the need for trust. Luhmann (1988) describes trust as a mental strategy that reduces the complexity of our environment and that allows us to take decisions even though their outcomes may potentially be harmful.

5.3. Trust drives to loyalty

Trust is necessary to start the process towards Loyalty. Indeed we can assume that if I trust someone, I think this entity is trustworthy. The more the trustworthiness I have towards this entity consolidates, the more its reputation strengthens. Trust need also time to be consolidated. Therefore, once created a strong reputation during time the final step is the construction of loyal relationships between me and the entity.
Sabel's (1993) notion of trust centres on the mutual confidence that parties to an economic transaction will not exploit one another when one or both of the parties are vulnerable to opportunism. This mutual assurance directed towards economic behaviour develops over time through daily observations. A shared understanding develops to the point that short-term economic interests lose their absolute motivational authority in decision making. A sense of duty and mutual dependence grows stronger, thereby promoting a business environment of risk taking and entrepreneurship under uncertainty. In this way Trust then drives to loyalty.
A review of the literature suggests the service loyalty construct consists of three separate dimensions: behavioural loyalty, attitudinal loyalty, and cognitive loyalty.
Customer loyalty research has mainly centred on the loyalty consumers display towards tangible products and is often called brand loyalty.
Refer to the items discussed in the previous chapter, trust has been conceptualized as a feature of the relationship quality. Trust is the subjective quality to assess the other's behavior. Trust is fundamental to create a relation with another agent. Therefore trust entails a pre-condition for relationships that needs to be continuously feed in order to exist.
Trust is able to develop transferrable form of confidence that we can referred to as reputation. Reliability and reputation are the main characteristics which affect the creation and development of trust.

On the other hand, reliability and reputation regard also efficiency matters. Therefore trust is a valuable component in an economic perspective. If a manufacturing enterprise is able to reach its goal on time and with a preconfigured quality standard, it means it is trustworthy.
Within the MSEE environment it is of fundamental importance to create trust among partners in order to create competitive advantages. Trust is an essential element to cooperation and credibility and it determinates the level of communication between parties. The members of the Ecosystem will take advantages on operating with partners they trust so to maximize their gains. It facilitates risk taking and it is a lubricant to economic exchange. In the ecosystem environment trust is fundamental to select the enterprises when configure new VMEs. Reputation is primary base for trustworthiness and starting point for collaboration.

5.4. Trustworthiness as Governance (focus on VME)

As we have already said, in economics and game theory, trust is considered the instrument for a transition from a static rationality of non-cooperative behaviours to dynamics of cooperation (Berg, Dickhaut and McCabe, 1995). Then trust is the vehicle to build relationships.

To limit the risk exposure of the participants, trust is built gradually, keeping the cost of an attack below a certain threshold of risk. Once the accumulated trust is above the required threshold, then it can be used as a basis for cooperation.

Dusko (2008) propose to describe trust as a process in two phases, trust building and trust service, that alternate and produce outputs. Trust building is a process of incremental testing of another party's honesty, i.e. the readiness to cooperate within the framework of a given protocol. The output of this process are the trust scores, which record whether the party behaved honestly in the past transactions. While trust service uses the trust scores to guide some further transactions: a higher trust score attracts more transactions. The feedback about their outcome can be used to update the trust scores.

Trustworthiness is tightly linked with reputation and, on the other hand, reputation and reliability are closely connected with the concept of efficiency and quality. A sane enterprise succeeds on its tasks and reaches its goals with profit on time and with a high quality standard. Therefore it can be stated that trust issues are strictly related to how an enterprise is managed, to how its governance if functioning in order to reach its objectives in a correct way.

In this document, as it has been already said, we are going to focus on trust at VME level, therefore within this chapter we are going to specify further the relations between VME governance issues and their connection with trust ones.

Indeed, as it has been already discussed, Trust is going to be analysed as an attribute of the governance framework within a wider picture on governance activities inside the virtual manufacturing enterprise environment. Governance characteristics in servitization directly and positively influence trust, and trust directly and positively influences commitment. A functioning governance framework ensures that the right processes, people and tools are in the place to enable the VMEs to stay on top of changes and ensure effective decision-making. Specifically, governance characteristics in servitization process help the VME build trust in the market by serving as repositories for knowledge about how to govern future cooperation. Governance framework specifies the rules and procedures which would lead the enterprise to assure the desired level of servitization. In the same way a good Governance framework leads to reach positive reputation in the market and among partners. On the other hand reputation drives to loyalty and therefore, to trust. Governance issues can then effectively manage trust relationships among a ME and its MSE partners during the VME creation.

These issues are able to foster trust between VMEs and customer to facilitate the development of relationships or prioritize changes and modify the volume, type or level of service to match involving user requirements for specifying anticipated changes in the course of future relationship.

The conceptual governance framework will be used as a useful structure to help both Virtual Manufacturing Enterprise (VME) and Manufacturing Service Ecosystem (MSE) to evaluate their service systems. Apart from governing service system, the governance framework will support the servitization processes and therefore, ensure and manage trust requirements linked with MSEE member's assets. Service governance framework allows regular observation and recording of activities, controlling and measuring actual performances and it presents visualization system which can guide the enterprise on taking corrective actions. The results of the conceptual framework can be then fundamental for decision making. It represents an important strategic tool for MSEE Project.

5.5. Governance issues

In this section we are going to present relevant issues related to Governance concept and framework. A clear description of governance is needed in order to understand its role inside Trust aspects, i.e. understanding what is meant with governing the service system of an enterprise. Indeed decisional and management concepts have to be taken into account when dealing with the servitization process and VME creation.
During the servitization phase it is of fundamental importance to govern and monitor all the activities related to the service system in order to reach the VME goals and so obtaining and confirming trust among MSE partners.

Governance: concept definition

Conceptually speaking, governance can be defined as the rule of the rulers, typically within a given set of rules. One might conclude that governance is the *process* – by which authority is conferred on rulers, by which they make the rules, and by which those rules are enforced and modified. Thus, understanding governance requires an identification of the both rulers and the rules, as well as the various processes by which they are selected, defined, and linked together and with the society generally. Governance can be described as a circle which encompasses cultural, technological, structural, and motivational aspects.

Figure 6 - Governance correlations

It is possible to find the major aspects of governance well captured by the following definition made by the OECD (Organization for Economic Cooperation and Development) about corporation governance:
"Corporate governance is the system by which business corporations are directed and controlled. The corporate governance structure specifies the distribution of rights and responsibilities among different participants in the corporation, such as, the board, managers, sharehold-

ers and other stakeholders, and spells out the rules and procedures for making decisions on corporate affairs. By doing this, it also provides the structure through which the company objectives are set, and the means of attaining those objectives and monitoring performance." (IBM's Unified Governance Framework (UGF) Initiative Birgit, Pfitzmann, Calvin Powers, Michael Waidner, 10/12/2007).

Governance has become a huge topic in service enterprises. Key drivers are increasing regulatory pressure, there is a need for better service management, and the desire of enterprises to monitor and influence their service performance accelerates.

Service performance in current commercial competitions and fast-changing environments also requires new governance structures. Most existing enterprise governance structures are actually geared towards business performance. This concerns aspects like strategy-making, planning, measurement of execution, and reward systems. Classically, most of this governance is done manually and at significant time intervals. Meanwhile, in service performance governance there is a huge amount of information which needs to be purified and then classified regarding enterprise objectives and goals. Hence, developing an IT infrastructure is one of the major issues which are affecting the current service governance process and redesign.

5.6. Service Modelling by decomposition methods

Before introducing the reference governance framework, two models need to be explained and analysed. In this section we are going to highlight two different models on the basis of decomposition: decomposition by level of decision and decomposition by abstraction level. First of all the hierarchical decomposition of the GRAI model within different levels of decision (Strategic, Tactical and operational) will be explained. Secondly, MDSEA method which defines a framework for service modelling structured around three abstraction levels (BSM, TIM and TSM) will be taken into consideration.

GRAI (Graph with Results and Activities Interrelated) conceptual model

GRAI model is generated by university of Boudreaux 1 to enable a complete model of the enterprise from a structural and a running point of view. GRAI model was created to give a reference conceptual structure of the production system of any manufacturing or service firm or of any organization (see D11.1 and D13.2).

GRAI model is composed by three principles:

- The first principle is the control of the system (based on the information which is received by customers or materials);
- The second principle is the decomposition of the control system in two sub-systems: the decision and the information sub-system;
- The third principle is the decomposition of the decision sub-system according to two criteria, i.e. temporal and functional.

The control of the Physical system is the result of decisions taken according to various functions (to manage sales, to manage design, to manage engineering, to manage manufacturing, to manage delivery…). The decisions have various natures: strategic at long term (define the objectives), tactical at medium term (define plan the resources) and operational at short term (to perform the actions). This information is filled inside a grid called the "Functional Grid". At the cross of a function and a level of decision a decision canter is identified (shown in the Figure below).

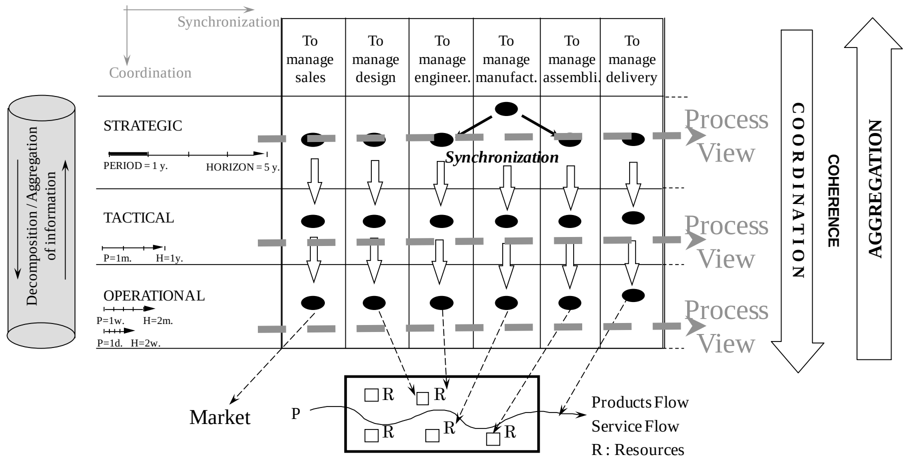

Figure 7 - The hierarchical or temporal decomposition of the Decision System

All the elements inside the decision components constitute the decision framework. The decision framework describes the context in which the decision must be made and leads to different decisions for different context.

GRAI method decomposes the functions in order to facilitate the integration among the actors. Decomposition of the functions split up into axis. The first axis is related to the structure of the control system and it can be both used for a ME, VME or MSE according to different functions identified:

- Traditional functions (commercial, design, industrialization, manufacturing, delivery...);
- The functions can change according to the Service Life Cycle phase or the VME creation, operation and decommission phases. The functions can change according to the Service Life Cycle phase and then the VME which is considered.

The second axis is related to a systemic decomposition. An activity is considered as a process transforming processed objects (that are inputs) into other processed objects (that are outputs). The controlled system transforms inputs into outputs. Applied to a manufacturing system, inputs are raw materials and outputs are finished products. The control system aims at getting an expected behaviour of the controlled system and in order to do so, the control system requests actions from the controlled system. Within this framework, it must match the overall objectives of the organization and response to external information.

The GRAI method makes use of particular tools in order to work: GRAI grid and GRAI nets.

The GRAI grid takes up the hierarchical and functional approach. It allows identifying the set of decision centres of the studied system, as well as their links. Whereas the purpose of the GRAI model is to be generic, the GRAI grid aims at the modelling of a real case. The concepts presented by the GRAI model are implemented by the GRAI grid in order to get a specific model.

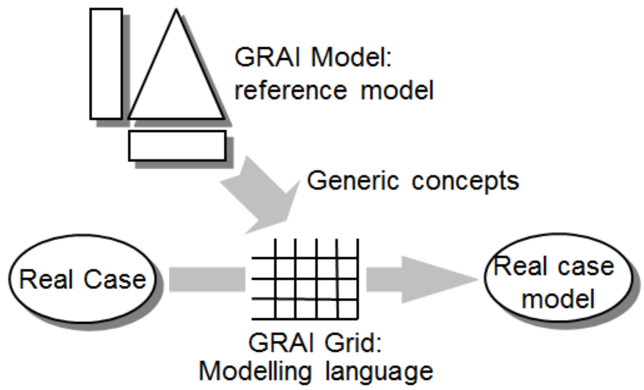

Figure 8 - GRAI GRID modelling language

The GRAI grid is presented in the form of a matrix with:

- The managerial axis or control axis which represents the various levels of decision which can be found in the organisation. Traditionally, this axis is decomposed hierarchically in several levels, according to the nature of the decisions: strategic, tactical, and operational levels.
- The functional axis which describes the various activities required to the product life cycle. However, in MSEE this axis can be adapted to service life cycle without any problem. It is decomposed into several functions which group a set of activities having a same identified finality (Engineering, Manufacturing, Quality, Maintenance, and Delivery, Recycling...).

5.7. The Model Driven Service Engineering Architecture (MDSEA) and its decomposition levels

Inspired by MDA/MDI (Model Driven Architecture/Model Driven Interoperability), the proposed MDSEA, which has been developed within MSEE Project, defines a framework for service system modelled around three levels of abstraction (see D11.1).

The three abstraction levels are explained here below:

- Business Service Modelling (BSM). This specifies the models at the global level describing the running of the enterprise or set of enterprises as well as the links between these enterprises. BSM level focuses on the representation of the service (and its functionalities) and the service system in virtual enterprise, capturing information on its related product, customer and service KPIs and values.

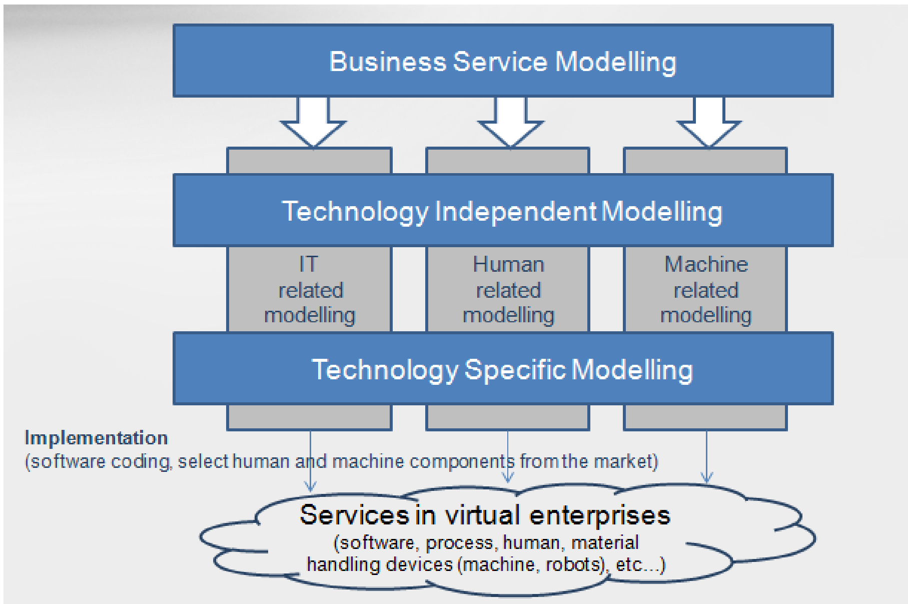

Figure 9 - MDSE Architecture

- Technology Independent Modelling (TIM). This corresponds to the models lying at a second level of abstraction, independent from the technology used to implement the system. It gives detailed specifications of the structure and functionality of the service system that do not propose technological details. More concretely, it focuses on the operation details while hiding specific details of any particular technology in order to be suitable for use with several different technologies.
- Technology Specific Modelling (TSM). This combines the specification in the TIM model with details that specify how the system uses a particular type of technology (such as for example IT platform, Machine technology Organisation structure or Human profile). At TSM level, modelling and specifications must provide sufficient details to allow developing or buying software/hardware components, implementing specific organization, recruiting human operators/managers or establishing internal training plans, buying and realizing machine devices, for supporting and delivering services in interaction with customers.

5.8. Reference Governance framework

In this paragraph we present a proposition of a conceptual governance schema in order to clarify how to manage governance issues and therefore obtain and maintain trust inside and outside the enterprise system. Indeed, it should be reminded that Trust is going to be studied as an attribute of Governance activities.

In MSEE reference governance framework GRAI and MDSEA models have been synthetized in order to create a conceptual reference framework for governance within MSEE Project (Referred to D13.2).

The classification is based on two decomposition: decomposition by level of abstraction (BSM, TIM & TSM), i.e. Model Driven Service Engineering Architecture (MDSEA) and decomposition by level of decision (Strategic, Tactical and Operational), i.e. GRAI model.

MSEE reference Governance framework will be developed to support the servitization process in order to comply the following items:

- Assess the service performances;
- Manage the efficiency in the use of resources;
- Improve revenues due to a better service offer;
- To support the service performance assessment to monitor performances, prevent error causing and redundancy or duplication of work among the main actors of service ecosystem;
- Obtain and prove the enterprise trustworthiness by monitoring and controlling its governance processes.

The mentioned framework can have a strong strategic role inside the MSEE Project because it represents a clear and open structure to share knowledge and resources among the partners inside the ecosystem and the configuration of the VMEs. Therefore the framework needs to be integrated within the MSE platform so to support service management, exchange and evaluation within the manufacturing networks. The framework will be the starting point to identify VME activities, also affecting trust and reputation issues about MSE partners.
The framework will be also used as a supporting tool for monitoring because it will be the starting point to generate specific KPIs related to the service or VME core activities (this concept is going to be explained better within next paragraphs and next chapter).
Indeed a MSEE PI methodology has been developed in order to generate specific performance indicators referred to precise objectives. In this deliverable we are focusing on VME but the same methodology can be applied both to ME and MSE. Service management needs to be able to control all the issues involved within the service system in order to ensure a maximized productivity.
By using the relevant PIs the following points can be observed:

- Adequate measures for effectiveness, efficiency, productivity and flexibility can be assessed in order to offer a satisfactory service system;
- The framework can improve the efficiency of the service system by measuring the ability of firm to reach the main goals within the VME perspectives;
- MSE members can be monitored in order to present standard service quality among MSE partners and also achieve reputation and trust among the ecosystem;
- ME assets can be measured in order to classify partners performances and so help Ecosystem partners choosing the right partner during the VME creation.

Therefore it can be stated that one of the aims of governance framework is to help defining boundaries and trust relations among ecosystem members from a top-down and a bottom to up perspective in order to identify systematic correlations among members in creating a new service allowing also them to monitor service performances.

MSEE reference governance framework has been created so to facilitate the control of the whole service system. It is important to highlight the importance of the recursive structure. Indeed the conceptual framework needs to make integration and to be coherent between different decisional levels and functional levels. Relevant PIs and KPIs can be then generated on the basis of the requirements identified inside the MSEE reference governance framework.
The servitization process requirements need to be specified into the three levels, as following the decomposition of BSM level (i.e. Strategic, Tactical and Operational). KPIs which are collected in TIM and TSM levels specify the parameters which can be used as a supporting

mean referring to technology implementation. The MDSE Architecture has been used, therefore, as a filter for PIs, in order to define in detail which parameter is affecting which functions inside the reference governance framework of a service system and at which level.

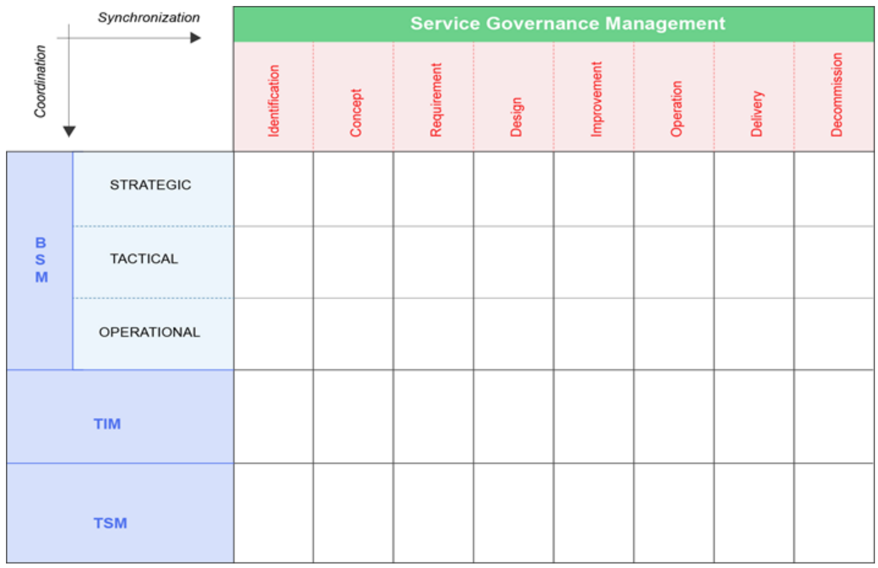

Figure 10 - Conceptual schema for MSEE Governance framework (proposition)

As it is possible to notice from our proposition of the Conceptual schema for MSEE Governance framework, several phases have been identified inside the Service governance management axis. These phases have to be considered like the "functions" which have been identified and used in the GRAI method.

These functions have been identified following the service life cycle phases studied in D11.1, (see the figure below).

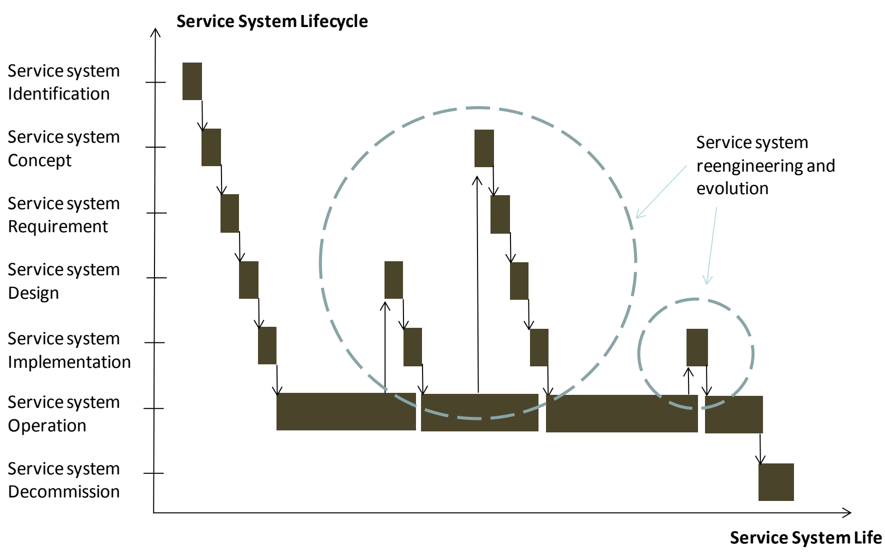

Figure 11 - Service System lifecycle phases vs. Service System life - adapted from Bernus (1995)

Service Engineering components can cover the whole service lifecycle phases from early stages, where both intrinsic and extrinsic parameters and requirements should be defined and measured, to the final decommissioning steps, which could give rise to further business opportunities (recycling, refurbishing, different use, etc).

These phases have been implemented in the SLM Toolbox developed in SP1. As it has been discussed during the MSEE Milano Meeting (23/25 January 2013), the functions can be simplified in order to set the assessment just during particular phases. As far as the SLM is concerned, we can consider upper phases related to MSE (identification, concept, requirement) and lower phases to VME and ME (design, implementation, operation, decommission).
The conceptual schema for MSEE Reference Governance framework tries to synthesize MDSE Architecture with the modelling of a service system within the servitization process. The aim of this framework is to help end users represent and describe the intended service and its system from various points of view, give structure to the whole knowledge in order to help the decision making and the controlling activities.
BSM (Business Service Model) aims at elaborating high abstraction level model from business user point of view. TIM (Technology Independent Model) gives service system specifications independently of technology for implementation. TSM (Technology Specific Model) adds necessary technology specific information related to implementation options.
Within the deliverable the focus will be on VME creation, particularly specified at BSM level.

5.9. Example of MSEE Governance applied to a VME

During the MSEE Milano Meeting (23/25 January 2013), a workshop on Governance framework has been carried out to clarify the methodology to create and select PIs within MSEE Project.
In this section we are going to present the results of the workshop which can be useful to clarify the functions to manage and monitor during the VME creation phase. Monitoring and controlling the same functions will then lead the VME to obtain trustworthiness within the entire service system partners.
The workshop has been based on the integration between different methods, i.e. on how to combine GRAI, ECOGRAI and VRM approaches. A VME creation has been taken into account as an example of integration between VRM and ECOGRAI.
MSEE governance method for VME has been applied to a generic VME creation concept. Therefore GRAI method has been used in order to analyse which functions should have been identified inside the GRAI grid. The main objectives have been identified in order to set the definition of governance rules.
Then, according to them, VRM framework has been examined in order to select the more coherent processes. According to the Process definition (see Plan-Govern-Execute by VRM), the following functions have been identified:

- Management of process;
- Management of products;
- Management of information;
- Management of finance;
- Management of assets;
- Management of personnel;
- Management of network.

Levels	**Functions**						
Functions/level info	**External info**	**Process mgmt.**	**Product mgmt**	**Finance mgmt**	**Information mgmt**	**HR mgmt**	**Internal info**
Strategic		Definition of main processes in charge of VME	Definition of main service product to perform	Budget, investment definition	Communication polity and confidentiality	Recruitment plan	
Tactical (means)		Definition of tools to support the process	Master service production service				
Operational		Short term planning					

Table 1 - VME creation GRAI grid

(VRM governance model to control VME creation).

In the above table it is possible to see a first practical example of how a VME creation governance can be structured following the GRAI grid. As it has been already explained in the previous lines, the VRM framework has been adopted to define the functions on which give structure to the GRAI grid.
Then PIs have to be identified through the integration of VRM and ECOGRAI methods.
The same methodology can be applied to specific Use cases in order to generate practical results about trust and governance and use this selection of PIs as exploitable assets from the end users.

BIVOLINO use case

During the same MSEE conference, also a MSEE Governance for VME has been presented as a reference, applying the GRAI model framework to Bivolino Use case.

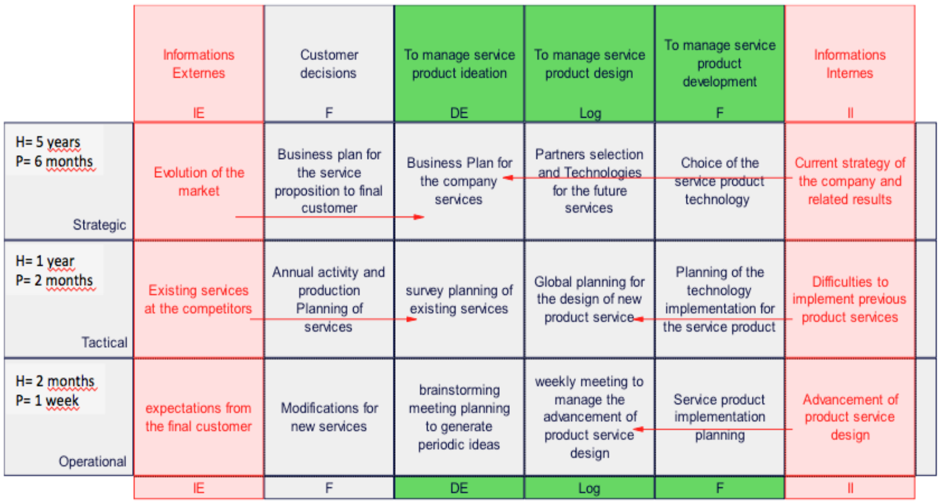

Figure 12 - Control of the service product life cycle

In the above figure the control of the service product life cycle has been structured following the GRAI grid. While in the following figure the exploitation of the service system is presented. As it possible to notice, functions have been identified; objectives and tasks have been specified too according to the level of decision (strategic, tactical and operational).

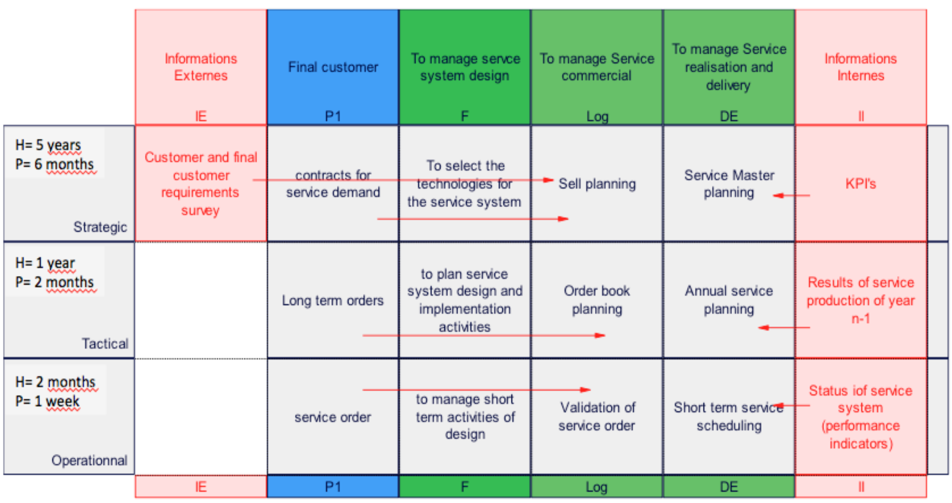

Figure 13 - Exploitation of the service system

GRAI method has been defined to represent activities and decision tasks, which give rise to objectives (see Actigram).

GRAI grid takes into account functions and classifies them into different levels of decision (BSM, strategic, tactic and operational) taking into account how each decision center is affected. Specific PIs will be generated at this level.

Then when entering the IT system, the whole information needs to be translated into the TIM level.

Different PI (definition, formula, computation, etc…) will be determined at TIM level, at this level the indicator will be of an IT system, i.e. an IT level information system.

Based on TIM level then, the information needs to be translated into the TSM level where the ICT formula is defined, where all the technology details are described.

The SLM Toolbox will be used to support the GRAI method referring to service life management phases. Indeed, as, previously mentioned, referring to SLM phases, upper phases will be related to MSE definition (identification, concept, requirement) and lower phases to VME and ME assessment (design, implementation, operation, decommission).
Such a method has been defined to be the MSEE Governance for VME and MSE to be used as reference for VME and MSE.

5.10. VME Governance: integration with Trust

Within this deliverable, as it has been already discussed, the focus will be on Trust at VME level and, therefore on VME creation, particularly specified at BSM level.
Manufacturing companies need to evaluate their current level of servitization and then, recognize the requirements for moving to the upper level. Change management practices are needed to implement promoting the process too. Rapidly changing market environment and business conditions often require a fast response by organizations to deliver new service or modify current one. Defining a detailed governance framework will help the actors involved handling the process of servitization and therefeore obtaining trustworthiness among partners. Indeed, as, it has already been reminded, Trust has been studied as an attribute of governance a wider governance picture. Therefore according to servitization process goals, specific elements need to be identified. The governance framework process for servitization can be synthesized as described in the below roadmap following the decomposition by level of decision through the GRAI grid:

- Define the Decisions;
- Define the Functions;
- Define the Objectives;
- Define the Actions.

A further step is also needed to be taken into consideration. As it has been studied and discussed in D13.2 “Service Driven KPIs and SLAs for governance - M15 - V0.2”, the business processes which will be affected by the servitization process have to be identified also through the VRM method in order to be coherent and aligned with the agreed MSEE PI Method (see next chapter).

	Functions						
Functions/ level	External info	Function1	Function2	Function3	Function4	Function5	Internal info
Strategic							
Tactical (means)							
Operational							

Table 2 - Example of Governance Reference Framework (BSM level)

Decisions, functions and objectives are going to be identified in order to specify precise requirements the service has to comply.
All the found requirements can be grouped inside a list of specifications which we can refer to as "criteria". When creating a VME, those criteria have to be found inside the Ecosystem offer, i.e. VME servitization criteria have to match with MSE partner's capabilities.

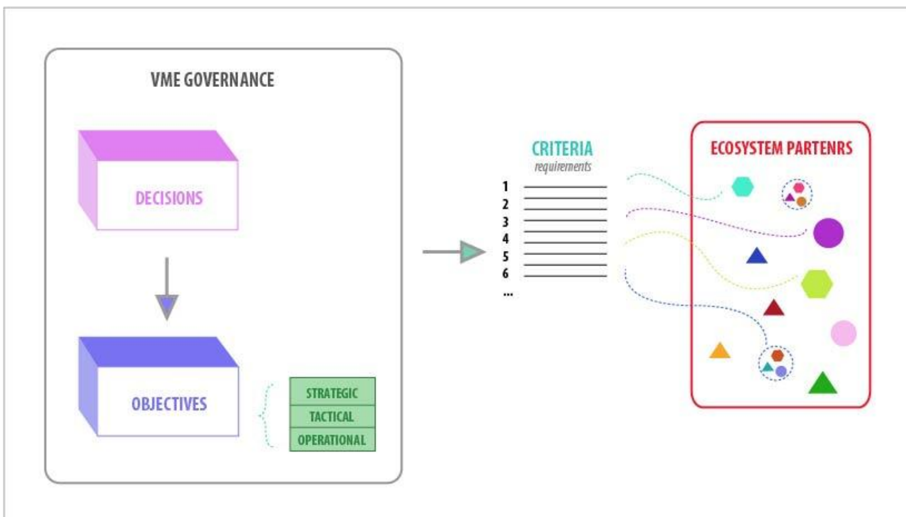

Figure 14 - Link between VME Governance issues and MSE assets

Trust is therefore a fundamental strategic element while choosing the more appropriate partner in creating a VME. Also, it should be emphasized at this point that trust will be used in the rest of decisional levels (Tactical & Operational) in VME according to strategic level's appropriate results. As it has been discussed in previous paragraphs, trust drives to reputation and reputation is coming from efficiency, reliability and quality. Trust issues are deeply connected with the capabilities a firm is able to assure, the ability of reaching the goals it preset and the standards it configured. Therefore relevant aspects of MSE actors can be monitored using concrete metrics derived from business objectives. Their reputation can be measured by performance indicators which can monitor specific capabilities and specific PIs can be generated in order to measure the above mentioned capabilities (in the next chapter this concept will be further discussed).

As it is possible to see from the below figure, trust will intervene in the moment a ME has to choose its partners in the VME creation.

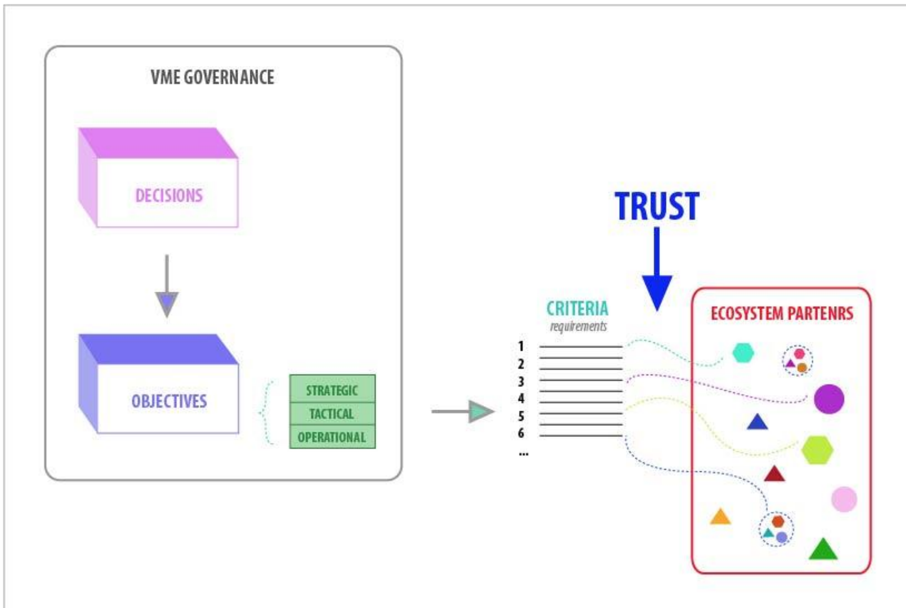

Figure 15 - Trust in VME creation

The link between VME criteria and MSE partner's assets is affected by Trust mechanisms and, as trustworthiness is depending on reputation, the more trustworthy partner will be the most appropriate one to choose.

As is has been previously discussed, MSE members can be monitored to present standard service quality among MSE partners and therefore achieve reputation and trust among the ecosystem.

ME assets can be measured too in order to classify partners performances and so help Ecosystem partners choosing the right partner during the VME creation.

The measurement method will involve the creation of ad hoc PIs following the MSEE PI method (this methodology will be further described within next chapter) which is able to generate particular PIs accordingly with specific VME objectives.

In fact, by using the relevant PIs the following points can be observed:

- Adequate measures for ME effectiveness, efficiency, productivity and flexibility can be assessed in order to offer a satisfactory service system;
- The ability of MEs to reach their main goals can be measured in order to asses their level of trust within the VME perspectives.

These issues are going to be further discussed and described within next chapter focusing on trust measurement methods and tools.

5.11. Practical example: Servitization process (Indesit Use case)

In this section we are going to present the first feedback we received from Indesit about the creation of its VME. Defining VME objectives is the first step towards the comprehension of VME goals and therefore to the achievement of trustworthiness.

Indesit Company is moving from traditional manufacturing enterprise which manufactures products and sells to customers (external market) to Service Virtual Manufacturing Enterprise in which customers are considered as part of the VME. The Indesit scenario[9] focuses on creating a Product+Service by enhancing one of the core company products, the washing machine (WM). The scenario is defined as a “Carefree Washing Service”, where the WM integrates a set of features able to support the customer in traditional washing activities and to realize a “carefree” use of the same product by providing additional services (e.g. machine remote monitoring, soap control, feedback on usage, personalized best practices, tailored marketing offers, personalized soap offer and furniture). Indesit’s actual servitization level is rather low (servitization level 2), as it is limited to selling the physical product and few basic services, which are offered in a traditional way (e.g. warranty, technical support, service call center, on-line registration and documentation download etc,…). Since Indesit is still marginally in the Product+Service phase at the present moment, the MSEE scenario has a challenging objective: to move to level 3 of servitization and investigate also the potential of a Product2Service scenario. The new service-oriented scenario implies also a change of the current ecosystem, which is composed mainly of internal actors and few external entities involved only in R&D phases. New external partners will be involved to support new services as service providers (i.e. at least an HW-SW component supplier, an Utility, a Detergent producer). The Indesit scenario can be summarized by the following figure, providing the overall idea of the main services and the involved actors. The following figure represents the general business scenario where the Indesit servitization process will take place. The product, the services, the customers and the home network are the main elements. The scenario has been also investigated from the company viewpoint as well as the customer viewpoint.

Figure 16 - INDESIT Scenario

In particular, Indesit scenario is focused on the provision of the following macro functionalities:

[9] Referring to D52.2 User Requirements Analysis for Virtual Factories and Enterprises - M15.

- WM Monitoring: control of the WM status, global WM data, last cycle data, user habits, by web or mobile applications;
- Best Practice Proposals: provision of personalized feedback and useful advices elaborated on the basis of real user actions and "errors/inefficiencies";
- Marketing Offers: provision of interesting marketing offers elaborated on the basis of the specific user profile and his/her washing habits;
- Detergent supply: provision of personalized detergent offers on the basis of the specific user profile and his/her washing habits, suggestions of ad-hoc WM-related products, and on-line order.

They are to be implemented with the support of the MSEE assets. This will affect the three impact categories: Manufacturing, Organization and IT.

Manufacturing impact: the machine needs to be enhanced with further functionalities and components like the zigbee module and the new main board. The zigbee module sends data to a local gateway Connectivity to allow the data passage to the web; the main board reads and stores data thanks to some firmware modifications and upgrading of the setting files.

Organization impact: the ecosystem needs to be properly defined and organized through the partner selection, to choose the best solution, the marketing and R&D collaboration, to realize a feasible product-service offer, and Service Lifecycle Management (SLM) to manage product-service lifecycles.

IT impact: the product architecture requires new technological components and new software applications like data storage from the machine to the web, data elaboration and management to have feedback from customers and delivery platform to deliver services to final users.

The Indesit VME referring to the Carefree Washing Service is a sub-set of the Indesit MSE. It is composed by different members for their competence that cooperate to obtain as sharing value added the exploitation of servitization process.

In the below figure it is possible to see a synthetic scheme of VME for Indesit pilot.

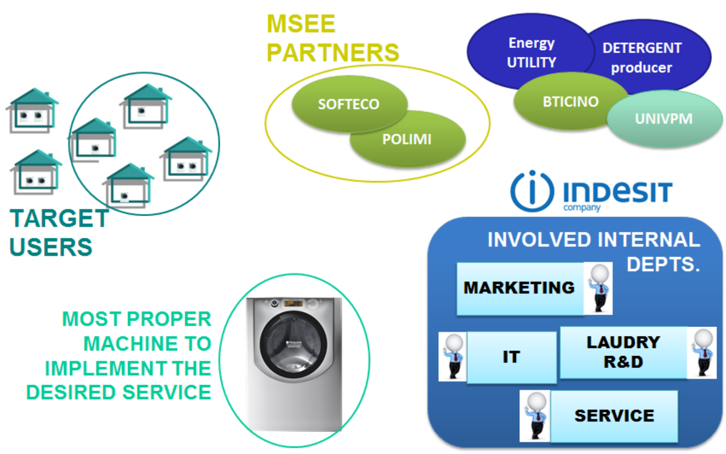

Figure 17 – INDESIT VME

The Virtual Manufacturing Enterprise for Indesit Company is composed by different actors, some of that are both internal and external members of Indesit and one brand (Hotpoint). The internal departments of Indesit that are involved in the VME are: Marketing, Laudry R&D, Service and IT. The Marketing and Service department attend in the definition of best practice and co-marketing actions; the Laudry R&D develops the proposal of new services and customized products; the IT department provides the network infrastructure; the Service department is involved in the delivery product-service system.

The MSEE partners are POLIMI and SOFTECO, respectively the scientific and technological partners for Indesit during the servitization process. The external Indesit partners are: UNIVPM, BTICINO, an energy utility and a detergent producer like P&G. Also the customers are involved in the VME. Their support is in the Washing Service System validation throught the KPIs and Pis measurement. Moreover, they are the first users of the Smart Aqualtis prototype and the mobile application connected with the WM.

In the below table we propose a first classification of Indesit objectives, functions and processes within the VME environment. This table is the starting point towards the generation of Indesit VME governance reference framework which will be the basis to select and extract VME criteria (the ones affecting trust) related to VME objectives. Specific PIs will be generated coming from the objectives, i.e. indicators which can measure MSE partners' requirements standards to be reached. PIs will be then used to measure trustworthiness of MSE partners according to specific objectives the VME has to comply within VME creation.

VME					
Indesit FUNCTIONS	**VRM Business processes affected/supported by MSEE**	**SERVITIZATION** – objectives	**Strategic - Tactical - Operational** objectives	**KPIs** to be improved)	**MSEE affection Ratio**
product service IDEATION	Analyze the consumer needs and the market where Indesit is operating (decision making) **M1 - M3 - N2 - N3** **GC03** - Govern Customer Relations, Information (IDEATION)	Increase of service sales Generation of new ideas Offer differentiation Service personalization Technical support in service system Consumer satisfaction	S: business plan for service proposition to final consumers T: preliminary assessment of the existing services in term of customer satisfaction; analysis of service configuration (to differentiate and personalize the service) O: brainstorming meeting to generate new ideas periodically; co-creation of product-service solutions	*Identification of consumer needs; Number of New Ideas; Customer satisfaction.*	*Identification of consumer needs (+20%)* *Demand forecasting accuracy (+20%)* *Brand sales growth (+15%)* *Customer growth rate (+20%)*
product service system integrated DESIGN	Identification of all data, statistics and information which are involved in the Carefree Washing Service **R1 - D1 - D4 - D7** By the existing WM, implementation of a needed physical HW and SW modifications **D3**	Technical Feasibility Economical Sustainability Environmental Sustainability Service customization Interoperability Service Efficency	S: selection of product-service design methodologies, selection of technological innovations, choose of the most proper partners T: definition of the new product-service funtions and design specification to be implemented; planning and reorganization of service activities O: implementation of the selected technologies, application of product-service design methods and tools, design of new product-service functions; Service Lifecycle Management	*Efficiency in designing (time); Effectiveness in designing (iterations)*	*Efficiency in designing (time) (-20%)* *Effectiveness in designing (iterations) (-20%)* *Number of new ideas (+40%)* *Number of new features (+30%)*
product service system IMPLEMENTATION	By the existing WM, implementation of a needed physical HW and SW modifications **B3**	Washing machine optimization	S: modifications project T: action plan to apply the modification in the production process O: implentation of modifications		
product service system COMMERCIALIZATION	Definition of actions to support the customer use of the Carefree Washing Service **U1 - U5 - U7**	Increase in service sales Creation of new strategic/commercial partnerships Consumer satisfaction	S: service sell planning; VME organization T: order planning; VME management O: validation of service orders; partnership agreements	*Demand forecasting accuracy; Brand sales growth; Number of new registrations.*	*Number of new registrations (+30%)* *Customer satisfaction*

product service system DELIVERY	Design and implementation of a software to provide the Carefree Washing Service **R3 - D2** Measurements the feedback to the customers and the performance of the service **M2** Manage the VME **GV01 - GV07 - GV10 - N7 - S4**	Creation of new strategic relationships with suppliers Consumer loyalty	S: general planning of the service delivery, planning of the specific service actions (e.g. marketing offers, customized contracts, etc.); partner relationship organization T: annual service planning, planning product-service evolution; partner relationship management O: short term service scheduling, high efficiency performance; partner relationship agreement	*Time to market for new service system; Service system performance.*	*Time to market for new product+services (-30%)*
product service system DISPOSAL		Economical Sustainability Environmental Sustainability Recycling/Reusing Creation of new strategic relationships	S: creation orselection of a disposal consortia; planning of disposal modalities T: definition of disposal policies, definition of the product treatment and/or reuse O: implementation of the best disposal policy	*Number of product recycling/reusing (% increase)*	

Table 3 - Indesit case: Servitization process

Inside the table, it has been decided to highlight in red all the processes affected by MSEE Project in order to better understand which are the exploitable assets and practical results Indesit is expecting (see MSEE affection ratio column).
The VME modelling is a process still under development therefore it is not possible to provide at this point a final list of criteria of requirements. As it has been described in previous paragraphs the list will be generated after a specific agreement on servitization decisions, objectives, functions and processes. The information will be gathered and updated within next months of research and will be presented in the updated version of this deliverable.

6. MEASUREMENT AND ASSESSMENT OF TRUSTHWORTHINESS

Towards a Trust Measurement method

In this chapter we focus on the assessment of trust at VME level which is very important step within MSEE Project.
In order to perform meaningful analyses of trust requirements, MDSEA (Model Driven Service Engineering Architecture) method is used deliberately for decomposing trust concept in various levels for service oriented production systems through PIs definition according to MDSE Architecture classification by level of abstraction.
This document activity will take into consideration a methodology to analyse trust through governance processes which will be used as an appropriate structure to help VME to evaluate their service systems. In order to accomplish trust measurement method the basic idea behind of this methodology is to achieve trust within the enterprise, in this way, enterprises will be able to provide the required information to enable to create trust relationships and meet customer priorities.
Trust will be measured in two different phases:

- Trust ex ante. It depends on past reputation, actions, performances and stable reputation;
- Trust in run time. It depends on momentary trustworthiness and it can be investigated basing on the traceability and performances of the model of relationships among the enterprises forming a VME.

Basic parameters for trust ex ante can be developed a-priori respect to the establishment of a VME and can be used by the trustor in order to create a particular VME.
Specific parameters for the run in time phase require to be dynamically defined and are used to measure trustworthiness in process.
To measure the level of trustworthiness of the enterprise within the MSE environment we need to specify its level of trust during the entrance in the system and its performances in run in time phase. Thus a distinction is made between the level of entering the servitization process and the monitoring of servitization performances. Specific KPIs will be defined at each level.
On one hand will be presented basic, general trust indicators suitable for every configuration of VMEs; on the other hand, other indicators will be defined for specific tasks described by VME objectives.
Once evaluated the level of trust of configurations, will be possible to identify which configuration is optimal to realise a specific tanks. This aspect of trust measurement results very useful in case the market requires specific services to be offered as well as in case the Ecosystem decide to impose a new service in the market (technology push or market pull theories).
According to the different configurations of the VME (hierarchical and non hierarchical), subjects involved, relationships and level of trust change accordingly. The various configurations, and so, the level of trust due their shapes, are completely depending on the goals of the configuration.

6.1. Assessment of trustworthiness in Entering and Run in time phase

Measurement of trustworthiness can be highlighted in two different phases. In first phase we will need to measure the level of trust of a potential member in the moment the enterprise decides to join the ecosystem.
In order to enter the ecosystem, an enterprise has to fit to a specific standard and complete with particular norms defined by the ecosystem itself. This mean a minimum standard of trustworthiness is required by the ecosystem in order to accept or not a new partner inside the system. In order to be able to perform meaningful assessment, it should be emphasized at this point that the term servitization has been used deliberately because servitization process is strictly related to the creation of VMEs. Indeed, within the MSEE Projects a VME is created with the goal of offering a service and its servitization process describes and is finalized to the VME generation. Therefore, in order to assess the enterprise trustworthiness in BSM-TIM and TSM level we need to define a set of parameters as quantity and quality KPI's. The specific minimum level of trustworthiness can be defined then according to the goals the ecosystem wants to reach. We have first started identifying the parameters defining the "first classification" presented in this chapter.
We identify the most important level of trust an enterprise has to reach in order to be trustworthy: Quality and Reliability (technical/functional) have been identified to be the core issues together with the delivery on time capability.
For the entering phase we use the parameters taking into account the last three years of activity of one enterprise. This is useful to know the historical situation of the enterprise and to help defining its level of trustworthiness in the moment the ecosystem has not interacted yet with the partner and so has not any knowledge and data related to trust about this partner. Similarly to online reputation models (i.e. eBay) once a new member wants to enter the system, it will not present a level of trustworthiness defined by the ecosystem.
To overcome this lack of information we propose the ecosystem oblige the partners who want to join the alliance to measure their trustworthiness level according to MSEE trust measurement method.
Therefore by defining, accepting and providing to the potential partner a structured method to measure the level of trust of the enterprise, the ecosystem will manage to accept in just "certificated" partners. In this way it is possible to ensure the certain level of trust the ecosystem need to reach inside its structure.
Second phase will be started as run in time phase, after accepting a member the ecosystem will need to monitor his performances during this phase. This is fundamental to monitor the ecosystem performances. The parameters which need to propose will be provided at this time related to the run in time phase and not referred to the last three years.
A classification of the level of trustworthiness can be proposed deriving from the measure of all the parameters presented in the previous paragraphs.

6.2. Trust assessment in ME, MSE &VME

To establish of long-term relationships among service provider and their customers, we need to have deep consideration to trust. Generally, trust is a key factor within service organizations and in business transactions, as it facilitates risk taking by measuring the service performances. Trust has some main specification which we can highlight them like; limit the risk exposure of the participants, trust is built gradually, keeping the cost of an attack below a certain threshold of risk. Also, in the different environments like in ecosystem environments, trust is fundamental to select enterprises, help them deciding who to collaborate with in order to configure new and different MSEs and also VMEs.

From a performance assessment point of view, manufacturing enterprises (ME) have been an object of interest for research and practice to reach trust trough measuring enterprise performances. In the last years manufacturing enterprises have been seen not only from the technical perspective, but also from a broader point of view. They are nowadays understood as highly complex entities which embed assets, resources, production facilities, humans, rules and standards and methods etc. In fact research first started to focus on the manufacturing enterprises, and then it went broader to the whole values of enterprise, finally arriving to the understanding of a Manufacturing Service Ecosystem (MSE) and different aspects of collaboration among partners. As a consequence of this high level of characterization, an integrated manufacturing ecosystem is also an aware enterprise; meaning that changes in the internal or external environment should as soon as possible be reflected in the objectives and in its actions, this will ensure that the activities of all the components contribute to the overall objective in a coordinated way. Within this characterization, a performance measurement system (PMS) is a fundamental tool for achieving a high degree of integration since it can be employed as the foundation of an integrated and iterative strategic management system that will allow the ecosystems to measure and assess its performance against its strategic objectives according to customer requirements and priorities. At the same time, it will assist in the decision making and the design of action plans.

As the PMS is so important for Virtual Enterprises, it can be argued that it is a type of decision support system that provides a set of important indicators to assess the enterprise state. There are in the literature different methodologies to develop a measurement system, but they are all focused on the problems of individual enterprises. Currently available studies do not take into consideration the peculiarities of virtual enterprises such as the assessment of the coordination mechanism among the enterprises (and the other parties involved), the efficiency of the inter-organizational processes or the relationships among the personnel. Figure below shows the position of a PMS within a virtual enterprise integration project.

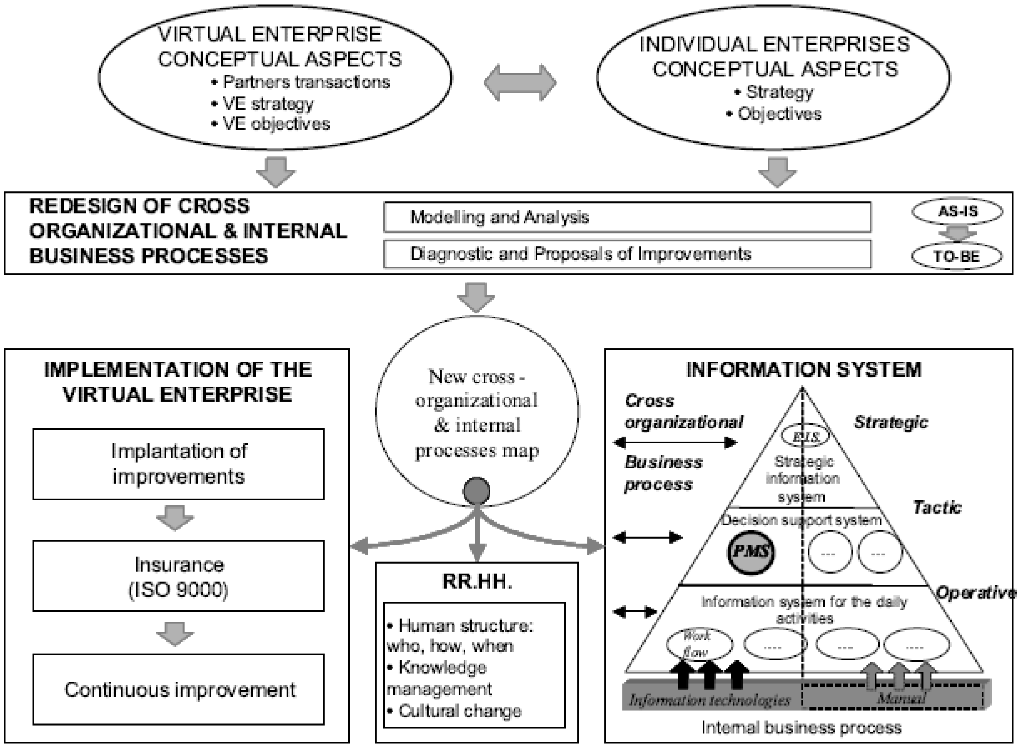

Figure 18 - Position of a PMS in a Virtual Enterprise [Chalmeta and Grangel 2003]

It should be emphasized that a performance measurement depends in the premises of the measurement system used. Enterprises challenge the premises of the methods developed in the past, therefore the applicability of existing measurement systems in this area is questionable. First it is necessary to take into account that performance, and related generated values can be seen from different point of view (individual participant perspective, the network co-ordination perspective, the surrounding environment...). Key performance measures for virtual enterprise include usually effective process time, throughput, flow time, utilization or work in progress. This is a small sample of a lot of possible performance indicators or metrics. They could be grouped in three clusters, namely financial measures, industry specific metrics and individual metrics.

It is interesting at this stage to consider the role of governance framework according to trust requirements and sheds light on how governance framework assesses the service performances. Indeed, manufacturing enterprises have usually a defined product development process, but they lack a sufficiently defined service development process as found in traditional service companies. Many enterprises recognize that the existing corporate structures and processes do not allow for efficient development and market positioning of innovative services. In addition, they are faced with the problem of being poorly equipped with appropriate approaches, methodologies and tools for an efficient development of services. Other problems can be identified in a high complexity of services, missing of organizational structures, lack of innovative climate and inadequate qualifications. It should be emphasized at this point that the lack of service corporate structure and service performance monitoring is cause of errors, redundancy and duplication of work between the main actors of service enterprises. In order to increase service sector efficiency through the structuring of service objectives, functions and variables service governance framework are required.

By adopting the reference governance framework we will be able to rely on a useful method to help the virtual manufacturing enterprise members in evaluating their enterprises. Apart from analyzing the service system, the framework will provide, collect and share the results of the controlling activities among service ecosystem members. Governance framework will allow regular observation and recording of activities, controlling and measuring actual performances and presenting a visualization system which can guide the VME on taking corrective actions. The results of the governance framework, then, can be used for achieving trust within the virtual manufacturing enterprises. In this way, enterprises will be able to provide the required information to enable to create trust relations and meet customer priorities and needs.

In order to create high value services through trust relationship in virtual manufacturing context, all actors need to learn how to combine their complementary core competencies across sectors, and how to share highly specialized knowledge about new functions, features, and processing procedures. To follow the mentioned requirements, all actors need to clarify members' duties and roles by setting boundaries, conditions, penalties and expectations. In this respect, the ideas of knowledge and competence as services are currently gaining growing attendance. Scalability, flexibility and adaptively are essential factors to meet the needs of interdisciplinary, dynamic, and dispersed actors in virtual manufacturing ecosystem. Also problems like bureaucracy, inefficiency or missing process quality are tackled by functional modules that are encapsulated by business as well as IT services. Therefore, Virtual Manufacturing Enterprise monitoring and governance can be used as a set of guidelines to adapt, coordinate and safeguard autonomous action performed by different actors, collectively working in a joint plan determined by collaboration, where risks, resources, responsibilities and rewards are shared to achieve a common goal.

Meanwhile, governance framework is due to optimize the resources and support decision making. Determinate what are the relevant KPIs to monitor the virtual manufacturing enterprise is a key issue. Then the analysis of data helps improving the whole enterprise performance management. Audit results give fundamental indications about performance trend analysis. Corrections, corrective actions and follow-up activities can be easy developed according to the results. Audit criteria score interprets the service goals and responds to the definition of the specific strategic planning. Figure below shows how enterprises can support the market orders according to their different capabilities by collaborating and sharing within ecosystem environment.

Also, a high service quality offer will meet customer needs and priorities while remaining economically competitive. Improved service quality may increase economic competitiveness too. The already proposed schema about VME structure will be able to achieve this aim by understanding and improving service processes; identifying problems quickly and systematically.

6.3. Definition of PIs, SLAs, SLOs

PI's: characteristics and description

The evaluation of the production system performances becomes more and more important in the current economic context. Until the 80's, the concept of industrial performance was only linked to the minimization of production costs. Then, the production system performances evaluation consisted in controlling the costs using essentially analytic accounting. The "Stiglitz Report" (Stiglitz, Sen, & Fitoussi, 2009), commissioned by the French former President Sarkozy, is a clear signal of the global concerns about the shortcoming of present tools of economic and social performance measurement, mismatch between market prices and things (or qualities) that society (i.e. people) value, and the nature of societal goals (Referring to D13.1). This evolution has created new requirements for the performances evaluation of a production system in order to improve the effectiveness the coherence and the accuracy; Therefore, System controlling is a discipline which studies how to reach the mentioned results. A System Control is a device, or set of devices to manage, command, direct or regulate the behaviour of other devices or system (http://www.answers.com/topic/control-system#ixzz1tWDOfRK2).

The role of a Performance Indicator System is to allow the decision makers to know the status of the production system (Referring to D13.1). They must use the performances indicators as a control tool, i.e. to measure the efficiency of their actions and to react in the appropriate response time, in coherence with the global objectives of the production system (Figure below).

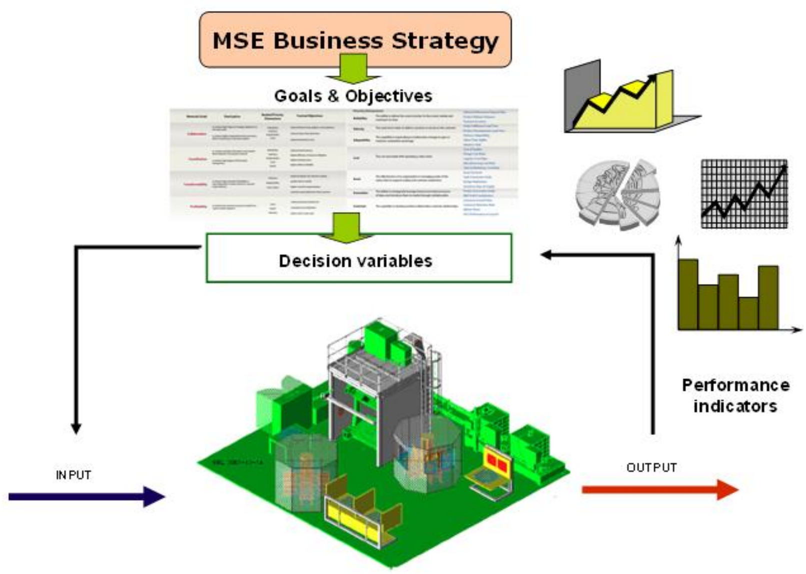

Figure 19- Principles of Performance Indicators in a production system

The figure above shows the importance of performance measurement within MSEE Project: the business ecosystem needs to transform inputs (information, raw material, requirements…) in outputs: product and related services.

Then, the performance indicators are implemented in the controlled ecosystem to evaluate its performance.

6.4. The use of PI's within an enterprise environment

A performance indicator is a quantified data which measure the efficiency of decision variables in the achievement of objectives defined at a considered decision level and in coherence with the defined business strategy (Ducq.Y, V. B.2005). "Definition and aggregation of a performance measurement system in three Aeronautical work shop using the ECOGRAI Method".

Several kinds of PI's can be defined. The first kind is the KPI's for results. These are measuring directly the achievement of objectives. Let's consider for instance total amount of turn over raised by service against overall organization revenue. The second kind is the progress KPI's. These are measuring a progress in the achievement of the objective. For example: total number of service occurrences per month and average service value vs. organization monthly objectives. So, these two kinds of KPI's are complementary.

The second typology concerns the decision level (Strategic) and relevant KPI's. Indeed, in order to control the system, it is necessary to measure strategic KPI's which are measuring the performance of the whole controlled system. Then, tactical PI's are required to measure middle term PI's. Finally operational PI's are required to measure the performance of a part of the system at the daily routine work tasks and usually referred to short term.

KPI's are those which are the most important to measure in order to know the achievement of the strategy. These are strategic PI's.

KPI's can be defined as measures that provide managers with the most important performance information to enable them or their stakeholders to understand the performance level of the organization. KPI's should clearly link to the strategic objectives of the organization and therefore help monitor the execution of the business strategy.

KPIs serve to reduce the complex nature of organizational performance to a small number of key indicators in order to make performance more understandable and digestible. Here below some best practices dealing with KPIs are presented:

- Clearly understand what indicators are required for learning and improvement and focus on those;
- Separate out the external reporting indicators if they are not relevant internally to avoid confusion and data overload;
- Create the right culture to drive high-performance.

In the next chapters, we will focus on MSEE PI Method that has been selected to support the generation and selection of KPI's inside the MSEE Project as stated in the introduction. In this way KPIs will be clearly linked to the strategy. Once the strategic objectives have been agreed, defined and mapped, it is possible to design KPIs to track progress and gain relevant insights to help manage and improve performance. KPIs will then provide the answers to the decision models questions.

6.5. SLAs and SLOs: characteristics and definition

Service Level Agreements (SLA) is closely related to trust issues, which are of great importance to properly manage the relationship between business partners. In particular, in a service businesses composed of many different and potentially unknown partners, the absence of a consolidated collaborating experience with some service providers imply the need to make predictions regarding their reliability. In next paragraphs we will start to define SLA, Service Level Objectives (SLO) and Service Level Management (SLM) and their correlation with together according to trust requirements.

SLA definition

A service level agreement (SLA) is a technical contract between two types of businesses, producers and consumers. In simple cases, one consumer forms a SLA with a producer. In more complex cases, a consumer may form a SLA that defines a set of producer businesses (Referring to D13.1).

An SLA promises what is possible to deliver and deliver what is promised. The Service Management lemniscates shows the role and the importance of SLA as means for bridging a gap between User & Service Provider. A SLA supports a communication about services and forms a basis for implementation of the Service process.

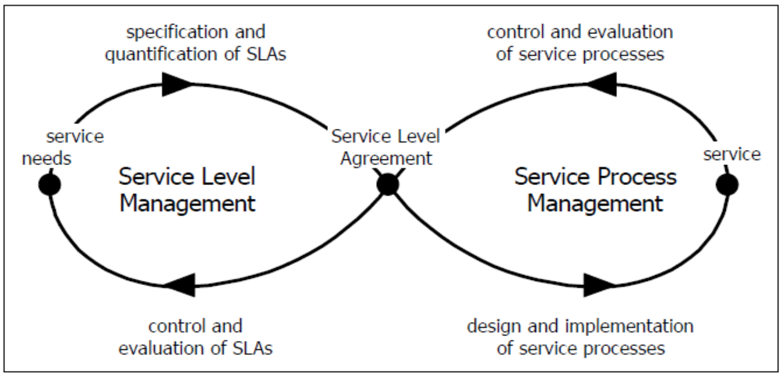

Figure 20 - SLA role in Service structure

The SLA defines a clear relationship between the customer and the provider by setting boundaries, conditions, penalties and expectations.
SLAs promote trust between service consumers and service providers and encourage service reuse by facilitating the formal creation of service-level objectives and other contractual terms and conditions. These objectives capture the expectations that service consumers can have from their respective providers. As previously stated, SLA is a generic document which drives the definition of Key Performance Indicators (KPI's) at the service, application, system and network level. Defining these KPI's facilitates the proper tools selection, process definitions and skills (people, process and technology) for an organization (Edward Wustenhoff, "Service Level Agreement in the data center" April 2012).
This concern is illustrated in the work of: they compare the possibility for human users, in the traditional world of business services, to partly estimate the trustworthiness of providers "relying on cues like brand of the provider and word of mouth recommendations", with the difficulties in scaling up this approach in an Internet of Services context "where services are automatically composed and delivered with limited human intervention, and explicit trust and security properties are becoming a key for a broad adoption of service technology"
The authors identify three possible sources of information to assess the level of trustworthiness of a service provider (i.e. the service information supplied by the provider himself, feedback from other users and run time data about providers and their offerings collected by the service platform), and propose to use USDL's service descriptions to collect data from the first two types of sources.
The importance of partners trustworthiness is underlined also by, who list trust among the critical success factors needed to reach the objectives of business partnerships, described "as a set of processes to aid inter organizational collaboration and improve performance".
Trust is hence an important element to establish openness in communication, long term commitment and in the end drive results for all the parties involved in a business ecosystem.

Analysing maintenance outsourcing services, assert that relationships has to be based on a service-level agreement that represents a mutually agreed view of the service specifications and delivery. In their perspective "a true partnership relationship between the plant and the service provider based on mutual trust must be well understood. Even if this kind of contract calls for the spending of considerable amounts of time and the making of great efforts, the connected risks to the parties are reduced and trust in the relationship is created". So, SLA must define performance level that will have to be measured using PI's and KPI's.

The main problem of SLA is to define a set of coherent performances. This coherence must be ensured first at the objectives level. The various objectives must be linked and the level of these objectives must be coherent between the various parts of the services. This coherence might be identified through the service system modelling and the decision modelling.

The importance of KPI's and SLA's is that they can provide required solutions in required time. By using them, management can take preventive action instead of having to cure the problems.

Link between SLA and SLO

Service Level Agreements (SLAs) have been a common product in support of services offered by service providers for many years. SLAs also are now being considered for non-communications (network) services and are being adopted both internally and externally to define the agreed performance and quality of the service or product and as an important part of a customer relationship management (CRM) program. To achieve quality and performance targets for the products or services may require the enterprise to establish and manage the number of technical goals that ensure the SLAs will be met. To reach the targets, while the SLAs are set in generalities and business goals, the measurable performance indicators are set as specific technical objectives (referring to D13.2).

Hence, Service Level Objectives (SLO) is measurable performance indicators that are often included as a part of a service level agreement. A service level objective is a key element of a service level agreement between a service provider and a customer. SLOs are agreed as a means of measuring the performance of the Service Provider and are outlined as a way of avoiding disputes between the two parties based on misunderstanding. The SLO may be composed of one or more quality-of-service measurements that are combined to produce the SLO achievement value. As an example, an availability of SLO may depend on multiple components, each of which may have a QOS availability measurement. The combination of Quality of Service (QOS) measures into a SLO achievement value will depend on the nature and architecture of the service. In order to accomplish above objectives, SLOs should generally be specified in terms of an achievement value or service level, a target measurement, a measurement period, and where and how measured. Nevertheless, there is often confusion in the use of SLA and SLO. The SLA is the entire agreement that specifies what service is to be provided, how it is supported, times, locations, costs, performance, and responsibilities of the parties involved. SLOs are specific measurable characteristics of the SLA such as availability, throughput, frequency, response time, or quality.
Finally, the both SLA and SLO should be an integral part of the business planning and execution process, without it the business objectives are unlikely to be achieved, ongoing performance cannot be determined, corrective action taken, or future plans made.

6.6. PI's and SLA's at specific Model Driven Service Engineering Architecture (MDSEA) levels

In order to accomplish the related objectives of WP13 and make a link among trust models and the decomposition of decisions, Model Driven Service Engineering Architecture (MDSEA) has been used to define the KPI's and SLA's which affect trust. Therefore, to be able to define a certain configuration of trust relationships according to its characteristics MDSE Architecture will be highlighted in next paragraphs.

Two different methods on the basis of decomposition are proposed in order to classify the PI's and be able to perform meaningful analyses of trust in service oriented production system: decomposition by level of decision and decomposition by abstraction level represented in D13.1 & D13.3:

- The hierarchical decomposition of the GRAI (Graph with Results and Activities Interrelated) model with different (Strategic, Tactical and operational) levels explained. As mentioned in D13.1 & D13.3 the GRAI conceptual reference model is a recursive structure which allows representing with the same concepts, the global and the local models of a manufacturing system in an enterprise. In fact, this model defines the various concepts that will be represented in the GRAI graphical formalisms;
- The Model Driven Service Engineering Architecture (MDSEA) method defines a framework for service modelling around three abstraction levels (BSM, TIM and TSM) also see Deliverable D11.1. MDSEA developed in MSEE project, and attributes allow three level of abstraction to be defines.

It should be emphasized at this point that the term of MDSEA method is used deliberately for decomposing trust concept in various levels for service oriented production systems. Performance indicators must be defined related to the three kinds of components: IT, Organization/Human resources and Physical means resources. Several indicators maybe applied for an organization but just a few are meaningful in terms of process control, improvement, efficiency, effectiveness and business performances, in general sense. There are some enterprises with several indicators at different levels but all the information which are collected to the regular basis may be overwhelming and not supporting the management in the decision making process to cover the trust requirements. Therefore it is recommended to sort out the KPI's only which can effectively contribute to define necessary information for every level of business model. Let's us to assume that indicators have been defined at BSM level only (e.g. turnover, EBIT, WIP, etc...): in this case organization should define an appropriate deployment policy to share these indicators within all levels of the organization to support the trust requirements. In other terms BSM indicators should be translated into TIM ones which are strongly bounded to the previous indicators and the results of each will contribute in the same direction to meeting the organization objectives: if we want to increase the EBIT at TIM level we must increase total output of the production and reduce operational costs. To do that indicators at TSM level should be defined which are consistent with TIM ones. Therefore the operator at CNC machines should be aware that this PI's are the numbers of pieces manufacture per day and total number of scrap/rework downgrading.

The criteria of these performance indicators will then be related to traditional performances as cost, quality, lead time or other kinds of performances as interoperability, flexibility and environment which can support governance framework in order to prepare trust relationship. Meanwhile, establishing trust relationship through MDSEA leads to facilitate the achievement of objectives by encouraging information exchange and knowledge sharing among members in enterprises.

Finally, the results of the MDSE Architecture decomposition, then, can be used for achieving trust within the enterprises. In this way, enterprises will be able to provide the required information to enable to create trust relations and meet customer priorities.

6.7. MSEE PI Method

During the MSEE Milano workshop (22-25 January 2013), the MSEE PI method to create and select PI's has been agreed among partners. PI's will be generated and selected according to a Reference Governance framework which has been identified in previous deliverables as a supporting decisional tool to govern MEs, VMEs and MSE's. As far as the use of MSEE PI method to link with trust is concerned within the VME level trust issues will be apt to both Internal than External trust aspects.

As explained in the previous deliverable (D13.2), some methods have been identified to create a reference framework for service governance: GRAI method has the main role to establish the new framework. Mentioned method will be synthesized with some part of MDSE Architecture to represent and describe the service governance framework and its interaction with the external and the internal information. It should be emphasized that the GRAI method has been selected in order to synthesize coherently various governance concepts (at a detailed and global level) in one generic model and facilitating the integration between decisional levels and functions.

The result of GRAI method will give to shape a new conceptual framework for service governance. This new framework needs to be structured, as previously explained, within the MDSE Architecture in order to classify PI's into different level of decompositions; it means decomposition by level of abstraction (BSM, TIM and TSM) and decomposition by level of decision (Strategic, Tactical and Operational) which was explained in previous sections. Therefore the PI's generation method needs to be coherent with this scientific background. The conceptual governance framework will be used as a useful structure to help both Virtual Manufacturing Enterprise (VME) and Manufacturing Service Ecosystem (MSE) to evaluate their service systems. Service system evaluating creates the conditions for sharing resources within the network of enterprises and allow to them to achieve trust and reputation in order to enter the ecosystem and align themselves for the interaction with partners and to determine how such an ecosystem is perceived by the market.

ECOGRAI and the Value Reference Model (VRM) are the methods which will be used to design, select and implement specific PI's according to the precise objectives identified by the Reference Governance Framework. This method can be applied to a single ME, within VMEs but also referring to MSE Ecosystem.

As mentioned in the previous paragraphs, in order to design and implement the PI's, ECOGRAI method will support the enterprise and service organizations by generating deci-

sion requirements. ECOGRAI offers no predefined processes or PI's list but consists in a methodological approach based on GRAI method governance approach. Therefore ECOGRAI will help identifying appropriate indicators according to the defined methodology.
On the other hand VRM will be used as a framework that provides pre-defined business processes to be identified and then used as input for the GRAI method. In this way VRM will offer support to the end user on selecting which are the main processes to take into consideration while structuring their service system governance. In fact VRM is a classical reference model that is providing a catalogue of building blocks for the definition of processes and KPI's. As such, VRM provides pre-defined KPI's, which are used by ECOGRAI to create a consistent set of KPI's that is aligned to the required decisions.
Therefore VRM framework and ECOGRAI approach will be integrated in order to provide a more coherent and useful set of PIs. The governance reference model is needed to support the definition of service/use case objectives so to govern the selection of processes from the blocks provided by VRM.
In the following, a list of actions is presented in order to specify and clarify the MSEE method to generate and select PI's:

1. The Governance model has to be defined (through GRAI grid) and will be then used as a reference to govern the process selection through VRM according to the precise service/use case's objectives;
2. The VRM framework will be used to identify the affected business processes for each use case (plan-govern-execute), which are used to define the processes and functions in GRAI grids;
3. ECOGRAI will be used to define the decisions inside decision canter's based on a discussion with pilots and to define the objectives and decision variables of each decision
4. At this point, priority dimension are identified for each process and pre-defined PIs will be selected (through VRM). Both methods will be used, and it will be possible to pass from one to the other in order to reach the maximum efficiency on PIs design and implementation.

Specific PI's will be generated following ECOGRAI which is based on GRAI method and therefore relays on the service/use case definition of main objectives and goals through GRAI grids. VRM will be then used again to integrate relevant elements to add like priority dimensions and related PI's, domains, metrics, etc… In fact in VRM the definition of the goals for each process is described using the VRM Priority Dimensions.
In particular ECOGRAI will be used to define the decisions inside the decision canter's based on Use case's objectives and also to help identifying the objectives and decision variables of each decision. On the other hand VRM will suggest specific KPI's referring to the business processes and priority dimensions previously selected to fill the GRAI grid.
Use cases will select matching indicators from the list of KPIs suggested by VRM Framework for the process steps/activities. Therefore ECOGRAI method will be used to integrate missing elements, and cover the gaps and open issues derived from VRM.
Finally, as a further step we propose to validate this MSEE PI's methodology through the Use cases. A definition of objectives and functions needs to be provided by the Use cases in order to help us defining their governance rules with which we can select the processes and the PI's from VRM. Following the same governance rules we can generate specific PI's using

ECOGRAI method. After this phase Use cases will be involved again in order to test all the defined PIs so to maximize their efficiency. In the below figure MSEE PI Method process is shown.

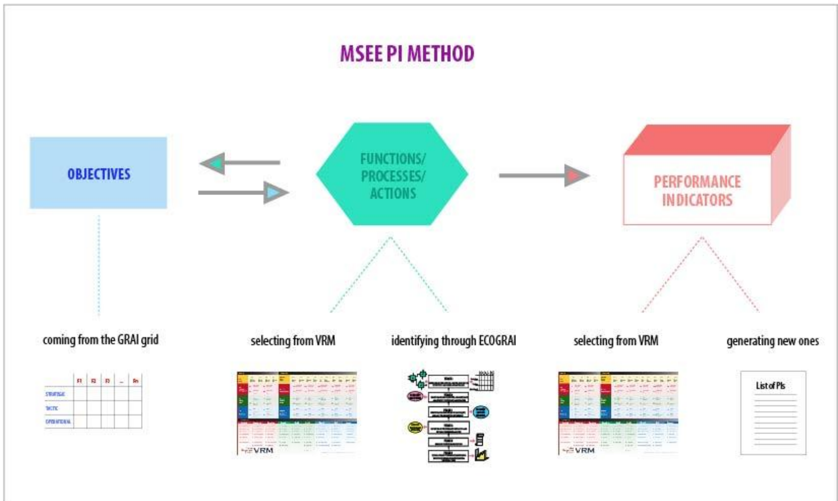

Figure 21 – MSEE PI Method

It is interesting at this stage to consider the future Roadmap for following the method and collecting data to reach practical results from different use cases. It can be stated that by following the Roadmap we will try to achieve trust in order to meet customer priorities. For mentioned Roadmap the following items can be observed:

1. Investigate Use case servitization process (Use case+ POLIMI and IMS/I-VLab);
2. Define the Use Case Service Governace framework (Use case+ POLIMI and IMS/I-VLab);
3. Adopt the MSEE PI method in order to generate specific PIs (POLIMI);
4. Match Use Case Requirements (Use case+ POLIMI);
5. Validate the results with the Use Cases in order to improve their efficiency (Use case);
6. Optimization of the PIs (POLIMI).

In order to accomplish roadmap process in the next section we will start to clarify the links between measurement methods and trust.

6.8. Integration between the Measurement methods and Trust

One of the main aims of D13.4 is to develop internal procedures to allow the enterprises achieve trust and reputation in order to enter the ecosystem and align themselves for the interaction with others. In this respect, we tried to lay the foundation for reference governance framework related to service ecosystem. The reference governance framework which was defined in previous deliverables is based on establishing methods and tools to select, identify and use proper KPI's within an ecosystem to support trust requirements. Accordingly, the framework will support enterprises to control their goals and decision-making processes with-

in service ecosystem in order to accomplish this objective, in D13.1 and D13.2 we define the mentioned framework to focus on how relevant KPI's and SLA's can be then generated on the basis of the requirements identified inside the framework in order to to help the service governance. Also, the governance framework attributes allow supporting the relationship within actors offering, utilizing and sharing services within ecosystem by bringing information on how the ecosystem will assess its partners and on how enterprises will act with others in order to create new VMEs. The proposed governance framework will play a strategic role in supporting MSEE Project. Indeed it will provide useful information on the modality trust affects enterprises and the ecosystem.
In order to be able to perform meaningful interaction of trust especially in VME in one side and measurement methods like governance framework, SLA's and KPI's in other side, various types of KPI's need to measure the trust performance during the process of monitoring of ecosystem. Also in SLA's generation processes, which represent contractual performance indicators, and to their interaction with KPI's in the ecosystem, which should essentially control internal processes and be consistent with the customers' requirements, we need to highlight relevant interaction with trust requirements. Finally, the proper integration among measurement methods with trust will be able to support the enterprise in order to provide the required information in the correct timing to enable the full usage of KPI's and SLA's during the relations with others, achieving trust and reputation within the ecosystem.

As mentioned in previous sections in this study we sheds light on trust at VME's and, particularly specified at BSM level. There are several important reasons for stressing the importance of methodology creation to reach trust measurement method at VME's on BSM level, this methodology help enterprises deciding who to collaborate with in order to configure new and different VMEs.
First, standard service quality, which is generally expressed as the degree to which perceived service, meets customers' expectations, requires reliability, and has important consequences. These include its effect on enterprise performance, its importance in customer retention, the underlying requirement to manage customer expectations, and to keep service quality promises to develop long-term relationships with their customers.
Second, from a management point of view, trust relationship creation through service performance measurement is also important in terms of resource utilization, because its occurrence generates the costs of correcting and eliminating service failures, costs that, in turn, affect the financial results of the enterprises. Finally, from a marketing point of view, the development of the paradigm of relationship marketing emphasizes the need for an enterprise to establish lasting relationships with customers, suppliers, and employees through trust, relationship commitment, and cooperation. This justifies the need to focus on the possible impact of trust, commitment, and cooperation on service performance measurement.

It should be emphasized at this point that the trust measurement method used deliberately to highlight trust measurement procedure in VME's at BSM level. A good starting point for following the trust measurement method can be borrowed from VME governance where we need to specify the decisions which come from end user's core activities or main objectives. Relevant objectives should be highlighted in VME's at BSM (Strategic, Tactical & Operational) level according to decision requirements in terms of specifying the trust measurement criteria. As mentioned in previous sections in "criteria" we can collect all relevant requirements which come from decisions, objectives and functions in VME. KPI's have important

roles in this step because of several issues which we highlighted a couple of them; the first issue is that KPI's will use to measure the achievement of objectives. The second issue is about the KPI's which can measure the progress of objective's achievement.
The mentioned issues about KPI's in previous paragraphs will support trust measurement method to use them as a guidelines to adapt, coordinate and safeguard autonomous action performed by different ecosystem members where risks, resources, responsibilities and rewards are shared to achieve a common goal.

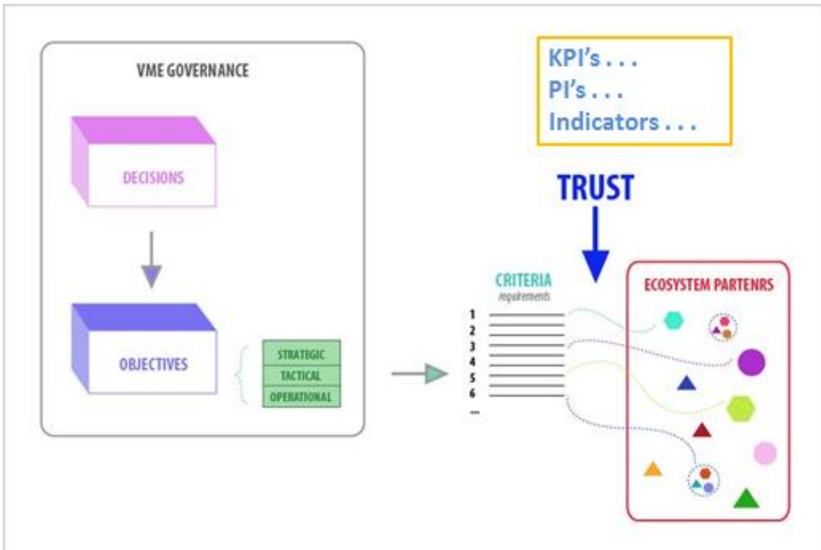

Figure 22 - Trust measurement in VME creation

For instance, we can refer to Indesit case that is moving from traditional manufacturing enterprise which manufactures products and sell to customers (external market) to service Virtual Manufacturing Enterprise in which customer are considered as part of the VME. Trust measurement method can be highlighted to support main actors' correlation as a part of VME in ecosystem to reach the objectives.

Finally, as far as the use of trust measurement method is concerned the mentioned method can measure the trust procedure in VME's at BSM level. Also, in further steps we will develop trust measurement method to cover the rest decomposition levels of abstraction according to MDSE Architecture classification.

6.9. PI Table Proposition

In the below Table the MSDE Architecture has been used to classify quantity and quality PIs inside one unique model. The MSDE Architecture has been used as a framework to define in detail which parameter is affecting trust and at which level within the enterprise environment. Related PIs are presented in three levels, as following the decomposition of BSM level (i.e. Strategic, Tactical and Operational). It can be stated that the remain KPIs which are collected in TIM and TSM levels specify the parameters which can be used as a supporting mean reffering to technology implementation.
The list of PIs which can affect trust through the efficiency of the service system has been provided as a starting point Polimi propose to analyse further during the research activity. These Pis have not been generated following the MSEE PI method because they have been

proposed before a final agreement on the methodology would have been reached during Milano Meeting. Therefore these indicators rely on the elaboration of classical metrics and parameters used within the production system. Anyhow the list contains effective indicators which represents an important starting point End users can rely on when processing their information and start validating MSEE tools and methodologies.

Within this table the PIs have been also related with more appropriate End Users case studies (i.e. Ibarmia, Indesit, Bivolino and TP Vision), therefore the PIs are classified for measuring each case study specifically.

Uses cases represent useful examples to be used to validate the indicators we already generated. The basic idea behind this validation is to optimize the indicators and the whole efficiency of the process.

Apart from the end user cases, MSE context has been considered too. The Ecosystem plays a great role in defining trust within VME objectives. Therefore the Ecosystem needs to be monitored as well as single enterprises. In the below table some PIs have been addressed to monitor the Ecosystem but further research is needed in this field within the next updated version of the deliverable.

KPIs	**Use Cases**				**MSE**
BSM **(Business Service Modeling)**	**Ibarmia**	**Indesit**	**Bivolino**	**TP Vision**	
STRATEGICAL					
Stable service mission regularly /week or month			X	x	
Long-term culture and value referred to the SLA		x	X	x	X
Service Brand value		x	X	x	X
Service capabilities	X	x	X	x	
Service guarantee	X	x	X	x	
Service Financial capital guarantee	X	x	X	x	
Service functionality (resources and industry expertise, human capabilities and knowledge, Skills, Seniority, Reusability of resources, R&D, Design Expertise_ human related field)	X	x	X	x	X
Service Innovation	X	x	X	x	X
Service Law and regulation	X	x	X	x	X
Service Standards (internal controls and audit systems) and best practices		x		x	
Service Responsibility (safety issues, reliability, guarantee, recall campaigns, reliability factor (e.g. 100000 km/car), complaints and service breaches)	X	x	X	x	X
Cost (Enterprise investment, service operation cost etc.)	X	x	X	x	X
Service Control Management System	X	x	X	x	X
Service performance goals feasibility	X	x	X	x	X
Service Support management tools	X	x	X	x	X
Service Relationship tools among suppliers/customers	X	x	X	x	X
Number of incentives		x	X	x	X
Number of new services/introduced services			X	x	X
Number of new service requirements added by R&D / total number of new requirements	X	x	X	x	X
Number of projects developed in co-design/ total number of projects developed	X	x	x	x	X
Number of people involved in the service process with full access to service data/total number of people involved in the service process	X	x	x	x	X

number of service designers / numebr of employees engineers	X	x	x	x	X
Service costs/total costs	X	x	x	x	
BEP	X	x	x	x	
NPV to analyze the profitability of service investment	X	x	x	x	X
Profits from new services/profits from all services on market	X	x	x	x	
Expected number of years of presence on the market	X	x	x	x	X
Time to market	X	x	x	x	X
service Development Lead Time	X	x	x	x	X
Service Delivery Value	X	x	x	x	X
Service Chain Agility	X	x		x	X
Service cost ratio / total cost	X	x	x	x	X
Marketing cost ratio / total cost	X	x	x	x	X
Servivce Asset Turnover Cash / total turnover	X	x	x	x	X
Service Innovation Index	X	x	x	x	X
R&D Profit / total profit	X	x	x	x	X
Customer Growth Rate	X	x	x	x	X
Nr of transactions/partner					X
Nr transaction/industry sector					X
Administrative costs/partner, revenue	X	x	x	x	X
Organizational (e.g. size and competencies)	X	x	x	x	X
Financial (P&L, Operational cash flow, turnover related to latest 3 years)	X	x	x	x	X
ICT Technologies (Interoperability, Platform, Security standards)	X	x	x	x	X
Number of resources and industry expertise (human capabilities and knowledge, Seniority, Reusability of resources)	X	x	x	x	
Health and Safety Issues	X	x			
Price	X	x	x	x	X
MSE Turnover (Turnover/partner, Turnover/industry sector, SLAs)	X	x	x	x	X
Number of knowledge exchange events (forum, conferences) / Number of events	X	x	x	x	X
R&D projects in cooperation with customers / R&D project	X	x	x	x	X
Number of new ideas developed in the past years		x	x	x	X
TACTICAL					
Customer satisfaction rating	X	x	x	x	
Number of customer survey / month or year	X	x	x	x	X
Service Employee turnover	X	x	x	x	
Service Employee satisfaction level	X	x	x	x	X
Service Social/Relational (reputation, brand identity, satisfaction level)		x	x	x	X
Service Retention bonds / total service price	X	x	x	x	X
Price	X	x	x	x	
ICT Technologies related to the Service (Interoperability, Platform, Security standards)_ IT related field	X	x	x	x	X
Service Information sharing tools				x	
Human Resources management tools	X	x	x	x	X
Services Maintenance	X	x			
Service Investments/profit	X	x	x	x	X
Service Control Management tools	X	x	x	x	X
Number of Service Accessibility tools	X	x	x	x	X

Service Documentary tools (create data base)	X	x	x	x	X
Service Flexibility, disaster recovery, resources reconfigurability, etc	X	x	x	x	X
Service Quality Management tools	X	x	x	x	X
On time Service Delivery	X	x	x	x	X
Number of new introduced services			x	x	X
Cost ratio service operation / total cost	X	x	x	x	X
Cost Ratio Logistics / total cost	X	x	x	x	X
Number of recruited partners					X
Number of partners by type of organization					X
Reaction to complaints	X	x	x	x	X
Nr of complains/partner					X
Association fees	X	x	x	x	X
R&D (investments in Technology)					
Quality and reliability	X	x	x	x	X
On time delivery					X
Number of applications/industry sector					X
Nr of contracts/industry sector					X
Value of incomes generated per period	X	x	x	x	X
Mean value of incomes per patent				x	X
Financial backlog (short, medium, long term)	X	x	x	x	X
Operational cash flow	X	x	x	x	X
Turnover	X	x	x	x	X
Repository Size for Tangible and Intangible assets management	X	x	x	x	X
Number of Periodical Issuing of MSE KPIs and SLAs	X	x	x	x	
Number of communication events (forum, meetings, Advs)					
Number of tangible and intangible assets available as a service	X	x	x	x	X
Claiming costs	X	x	x	x	
Number of new services implemented / number of projects generated	X	x	x	x	X
OPERATIONAL					
Number of adopted Service International / national quality standards	X	x	x	x	X
Operational cash flow	X	x	x	x	
Number of Service Technological facilities (tools and device)	X	x	x	x	X
Service maintenance employee / hour	X	x	x	x	X
Service maintenance employee / month	X	x	x	x	X
Number of tools for evaluating the service quality (checklists etc)	X	x	x	x	X
Number of HW/SW for Controlling service processes	X	x	x	x	X
Number of Aftersale services / service (number of repair shops, number of customer services, etc)	X	x	x	x	X
Intangible factors management tools for service (to evaluate direct knowledge, long-term relationship, shared values, direct experience)	X	x	x	x	X
Service On time delivery (Internet base services)	X	x	x	x	
Number of entries and exits in the Ecosystem					X
Number of entries and exits by type of organization					X
Number of complaints/partner					X
Average time to address the problem	X	x	x	x	
Number of established agreements					X

Number of satisfied/unsatisfied agreements					X
Number of conflicts arisen					X
Number of conflicts solved					X
Mean revenue for exploited result					X
Timeframe in which the result is exploited					X
SLA	X	x	x	x	X
Contract costs/partner revenue					X
Legal costs/partner, revenue					X
Claiming costs	X	x	x	x	
Recalls	X	x	x	x	X
Business hold/partner					X
Number of contracts	X	x	x	x	X
Number of suppliers				x	X
Number contracts breached					X
Number of long-term strategic collaboration partnerships					X
Number of partnerships per country					X
Number of approved patents,		x		x	X
Number of pending patents		x		x	X
Patent/partner	X				X
Patent costs/partner	X				X
Mean number of partners involved in a patent					X
Number of copied services without agreement	X	x	x	x	X
Number of communication channels (blogs, platforms, internal mail system, posts)				x	
Number of physical and online events organized for service development / year					X
numebr of service events attended/partner					X
Number of service events participants/event					X
Number of service events unattended/partner					X
Number of customer filled surveys/partner	X				X
Number of received feedback and suggestions/partner	X	x	x	x	X
Number of shared documents	X	x	x	x	X
Number of enquiries to the knowledge management data-base/partner/month					X
Number of expert advice					X
Number of upgrading occurrences on the knowledge management database/partner/month					X
Number of services, patents, white papers, percentage of respons-es to demands for each stakeholder,					X
Number of assets put at MSE's disposal					X
Number of VME joining/partner					X
Number of VME dissemination actions					X
Number of newsletters					X
Number of press releases, Number of appearance in the media					X
Number of published news/partner/month					X
Number of used communication channel					X
Number of information requests/partner	X				X
Number of inherited assets/outputs/contacts					X
Number of created spin-offs					X

Number of joint-ventures	X	x		x	X
Mean share capital when creating a spin-off					X
SLA for ICT	X	x	x	x	X
Uptime	X	x	x	x	X
MTTR/service	X	x	x	x	X
MTTF/service	X	x	x	x	X
MTBF/service	X	x	x	x	X
Band width capacity					X
Number of transaction to the repository					X
Number of Failure logs					X
number SLAs related to tangible and intangible assets	X	x	x	x	X
Number of R&D researches	X	x	x	x	X
Value of new services implemented/turnover	X	x	x	x	X
TIM (Technical Independet Modeling)	X	x	x	x	X
Service guarantee	X	x	x	x	X
Organizational functionality for service (Number of R&D missions, Customer focus, etc)	X	x	x	x	X
Customer satisfaction rating	X	x	x	x	X
Number of Service Communication/Information exchange tools (communication channels, HW/SW facilities, available protocols etc)	X	x	x	x	X
Number of R&D missions/partner	X	x			X
Subgoals for customer satisfaction	X	x	x	x	X
Type of standards/partner	X	x			X
Number of collaboration activity (internal and external)/partner	X	x	x	x	X
Upgrading technology/service/year	X	x		x	
Service Performance Management (number business goals attended/proposed, number business subgoals attended/proposed, positive feedbacks, monitoring main outputs, evaluating performances)	X	x	x	x	X
Service Periodical Control Processes	X	x	x	x	X
Use and update of service information/partner	X	x		x	X
Anthology of relationships with supplier and customers	X	x	x	x	X
ServiceOrder fulfillment time/partner	X	x	x	x	X
Web ordering downtime/partner	X	x	x	x	X
Number of tools for evaluating the service quality (checklists etc)	X	x	x	x	X
Service Monitoring performance tools (human/automated system monitor, analytic tools, anomaly detections)	X			x	X
IT oriented service architecture/ IT infrastructure capability/partner	X	x	x	x	X
Number customer or suppliers complaints/partner	X	x			X
Number of standard tasks for service operation/total number of tasks	X	x			X
Number of tested parts/ number of supposed critical parts	X				X
Number of times that a design had to be reworked	X	x	x	x	X
Number of projects ongoing at the same time/partner	X	x	x	x	X
Number of new services/ projects/partner	X			x	X
Number of alternative solutions to new designs	X	x	x	x	X
Customer satisfaction rate/partner	X	x	x	x	X
Service Delivery Performance/partner	X	x	x	x	X
TSM (Technical Specific Modeling)					

Type of standards adopted/partner (domestic and international certificates issued by original manufacturers)	X	x	x	x	X
ICT Technologies tools/partner (Platform, Security standards)_ IT related field	X	x	x	x	X
Information sharing tools/partner (i.e. network tools like Joinme, Facebook, etc..)	X	x	x	x	X
Service Performance Management tools/partner (number service goals attended/proposed, number service subgoals attended/proposed, positive feedbacks, monitoring main outputs, evaluating performances like for example Service delivery softwares)	X	x		x	X
HW/SW for Controlling service processes/partner	X	x			X
Service documentation tools/partner (reports , record retentions, paper based/digital Drawing, technical specifications, cd, external hard/software, etc)	X	x	x	x	X
type of IT architecture-IT infrastructure/partner (i.e. C++, Java, etc…)	X	x	x	x	X

Table 4 - Use cases table

6.10. PI classification table

In this section a classification of categories which can help identify the parameters affecting trust is presented. These categories have then been used to support the PIs Table in order to facilitate the identification of the parameter to use in order to monitor trust through service governance inside the enterprise environment.

First of all we tried to identify the core requirements an enterprise has to comply to be considered trustworthy. Then we analysed further aspects concerning the concept of trust in an enterprise environment. This classification has to be meant as the first step towards the identification of specific PIs and SLAs.

As we said the parameters will be then divided in two main categories: the ones measuring the trust for the entrance of a member in the Ecosystem/ formation of VMEs, and the ones measuring trust in the run in time phase.

As long as the research goes deeper, the classification will collect more elements, evaluate more details and classify more precisely the parameters involved.

In an overall sense, two core families of parameters that affect the level of trust of one partner to another. This classification includes the parameters that are at the very base of construction of trust; without which it would not be possible to establish a generic relationship of trust. The classification is presented as follow:

- Quality and reliability (i.e. technical/functional quality, price, health and safety issues, reliability, like for example guarantee, recall campaigns, reliability factor (e.g. 100000 km/car), complaints and law breachs in the last 3 years);
- On time delivery (i.e.SLAs, supply chain efficiency, OTD internet based services).

In a second level of detail, after the minimum amount of trust is reached, trust starts to be affected by other, secondary parameters. A detailed list is provided here, as follow:

- Administrative (Administrative Issues, Organization, Employing, Security, Execution, Safety Issues, etc…);
- Financial (Financial Accounting, Cash Management, Purchasing, Selling, Commercial, Payables, Budgeting, Costing, Receivables, Financial Consolidation, Bills of materials, Order to cash, Activity Based Costing, Project costing, Billing, etc…);
- Legal (Contracts, Claim Processing, SLAs, Partners and Customer transaction, etc…);
- Management (Business strategy, Risk Management, Work orders, Scheduling, Workflow management, Quality control, Project management, Service Life cycle manage-

ment, Resource management, Enterprise management, Process control management, Activity management, Performance governance management, etc…);
- Service Operation (Service processes, Service flow, Service operation, On time delivery, Service tools, Maintenance, Service accessibility, Service Life cycle management, etc…);
- Marketing & Sales (Marketing, Advertisement, Communication, Events, etc…);
- Logistics (Storage, Supply chain, Inventory, Service delivery, Packaging, Warehousing, Transportation, etc…);
- After sale (Support Services, Maintenance, Service training, Assistance, Availability of service clinics, etc..);
- ICT (ITC tools, Communication, ordering, Service processes, Infrastructures, Standards, etc…);
- Human Resources (HR process management, Expertise, Seniority, Training, Separation, Retirement, Recruiting, Payroll, Placement, talent Management, etc…);
- Design (R&D activities, Project planning, Resource planning, Design activities, Service development activities, etc…);
- Customer Management (Customer services, Customer satisfaction, Customer relation, Contact information, Support, Customer interfaces, Recalls, Claim, etc…).

In the below figure we can see a sample specification of a classification proposed by ECOLEAD to analyse the trust inside an enterprise. ECOLEAD proposes to analyse some perspectives in order to identify the requirements an enterprise has to reach. Furthermore they go deeper in the details of the specific quantity and quality parameters affecting trust.

Perspective	Requirements	BASE Criteria
1. Organizational	Organizational strength	Size of an organization
		Organization coverage
		Competences
		Personnel expertise
2. Social	Community participation	Activities participated
		Community service contribution
	Community compliance	Community standards complied
3. Financial / Economical	Capital	Cash
		Physical capital
		Operational capital
	Financial stability	Cash in
		Cash out
		Profit/Loss
		Operational costs
	VO -Collaboration based financial stability	Cash in
		Cash out
		Profit/Loss
	Financial standards	Auditing standards
		Auditing frequency
4. Technological	ICT- infrastructure	Network speed (Broadband)
		Interoperability
		Availability
	Technology standards	Protocol supported
		Software standards
		Hardware standards
		Security standards
	Platforms	Operating systems
		Programming languages
	Platform experience	Applied in VOs
		External project applied
		Duration held
5. Managerial / Behavioural	Stable management	Years in power
		Management structure
		Frequency of power change
	VO-Collaborative behaviour	VO opportunistic behaviour occurred
		VO successful collaborations
		VO participation as organizer/leader
	Reliability	Quality
		Adherence to delivery dates

Figure 23 – Sample Specification

(from Ecolead, "D21.4b, Creating and Supporting Trust Culture in VBEs", 2006).

In the previous PI Table the indicators which affect service governance and trust have been presented according to MSDE Architecture. In this section, after defining relevant categories which compose and give structure to the service governance, and therefore affect trust, the PI list has been classified accordingly.

KPIs	**CATEGORIES**											
BSM	ADMINISTRATIVE	FINANCIAL	LEGAL	MGMT	SERVICE OPERATION	MARKETING &SALES	LOGISTICS	AFTERSALE	ICT	HUMAN RESOURCES	DESIGN	CUSTOMER MGMT
STRATEGICAL												
Stable service mission regularly/week or month					X							
Long-term culture and value referred to the SLA				X								
Service Brand value				X								
Service capabilities					X							
Service guarantee								X				
Service Financial capital guarantee		X										
Service functionality (resources and industry expertise, human capabilities and knowledge, Skills, Seniority, Reusability of resources, R&D, Design Expertise_ human related field)					X					X	X	
Service Innovation											X	
Service Law and regulation			X									
Service Standards (internal controls and audit systems) and best practices				X	X							
Service Responsibility (safety issues, reliability, guarantee, recall campaigns, reliability factor (e.g. 100000 km/car), complaints and service breaches)					X			X				
Cost (Enterprise Investment, service operation cost, etc…)		X		X	X							
Service Control Management System				X	X							
Service performance goals feasibility				X	X							
Service Support management tools				X	X							
Service Relationship tools among suppliers/customers				X			X					X
Number of incentives		X		X								
Number of new services/introduced services				X		X					X	
Number of new service requirements added by R&D / total number of requirements											X	
Number of project developed in co-design/ total number of project developed											X	
Number of people involved in the service process with full access to service data/total number of people involved in the service process										X		
Number of service designers/ number of employees	X									X	X	
Service costs/total costs		X										
BEP		X		X								

NPV to analize the profitability of service investment		X		X								
Profits from new services/profits from all services on market		X				X						
Expected number of years of presence on the market				X		X						
Time to market				X		X						
Service Development Lead Time				X							X	
Service Delivery Value						X	X					
Service Chain Agility							X	X				
Service Cost Ratio/Total cost		X		X								
Marketing Cost Ratio/Total cost		X				X						
Service Asset Turnover Cash/Total turnover		X										
Service Innovation Index						X			X		X	
R&D Profit/Total profit		X				X			X		X	
Customer Growth Rate						X						X
Nr of transactions/partner							X					X
Nr transaction/industry sector							X					X
Administrative costs/partner, revenue	X	X										
Organizational (e.g. size and competencies)	X			X		X						
Financial (P&L, Operational cash flow, turnover related to latest 3 years)		X										
ICT Technologies (Interoperability, Platform, Security standards)									X			
Number of resources and industry expertise (human capabilities and knowledge, Seniority, Reusability of resources)				X						X		
Health and Safety Issues	X			X						X		
Price		X										
MSE Turnover (Turnover/partner, Turnover/industry sector, SLAs)		X		X								
Number of knowledge exchange events (forum, conferences)/ number of events				X							X	
R&D projects in cooperation with customers/ R&D projects											X	X
Number of new ideas developed in the past years											X	
TACTICAL												
Customer satisfaction rating					X							X
Number of customer survey/ month or year						X						X
Service Employee turnover		X										
Service Employee satisfaction level	X			X						X		
Service Social/Relational (reputation, brand identity, satisfaction level)				X		X						X
Service Retention bonds/Total service price		X										
Price		X										
ICT Technologies related to the Service (Interoperability, Platform, Security standards)_ IT related field									X		X	
Service Information sharing tools					X				X			
Human Resources management tools				X	X					X		
Service Investments/profit		X										
Service Control Management tools				X								
Number of Service Accessibility tools					X				X			X
Service Documentary Tools (create database)				X	X				X			
Service Flexibility, disaster recovery, resources reconfigurability, etc				X	X							
Service Quality Management tools				X	X						X	

On time Service Delivery					x			x				x
Number of new introduced services				x		x						
Cost Ratio for Service Operation//Total cost		x									x	
Cost Ratio Logistics/Total cost		x					x					
Number of recruited partners	x			x								x
Reaction to complains			X			x		x				x
Nr of complains/partner			X			x		x				x
R&D (investments in Technology)		x									x	
On time delivery					x		x		x			x
Number of applications/industry sector				x							x	
Nr of contracts/industry sector		x	X	x								
Value of incomes generated per period		x		x								
Mean value of incomes per patent		x		x							x	
Financial backlog (short, medium, long term)		x										
Operational cash flow		x										
Turnover		x										
Repository Size for Tangible and Intangible assets management				x								
Claiming costs		x	X									x
Number of new services implemented/ number of projects generated				x							x	
OPERATIONAL												
Number of adopetd Service International/national quality standards	x		X						x			
Operational cash flow		x										
Number of Service Technological facilities (tools and device)						x			x		x	
Service maintenance employee/month								x		x		x
Service maintenance/month								x		x		x
Number of tools for evaluating the service quality (checklists, etc)				x								
Number of HW/SW for Controlling service processes					x				x			
Number of Aftersale services/service (number of repair shops, number of customer services, etc)								x				x
Intangible factors Management tools for Service (to evaluate direct knowledge, long-term relationship, shared values, direct experience)				x								x
Service On time delivery (Internet base services)					x			x	x			
Number of entries and exits in the Ecosystem	x	x	X	x								
Number of entries and exits by type of organization	x	x	X	x								
Number of complains/partner		x	X					x				x
Average time to address the problem			X	x							x	
Number of established agreements			X	x		x						
Number of satisfied/unsatisfied agreements		x	X	x		x						x
Number of conflicts arisen			X	x								x
Number of conflicts solved	x		X	x								x
Mean revenue for exploited result		x		x								
Timeframe in which the result is exploited	x	x		x							x	
Contract costs/partner revenue		x										
Legal costs/partner, revenue		x	X									
Claiming costs		x	X	x								x
Recalls		x	X		x	x						x

Business hold/partner	x	x		x								x
Number of suppliers	x		X	x			x					
Number contracts breached		x	X	x								x
Number of long-term strategic collaboration partnerships				x							x	
Number of partnerships per country	x	x	X	x		x	x		x			x
Number of approved patents											x	
Number of pending patents											x	
Patent/partner				x							x	
Patent costs/partner		x									x	
Mean number of partners involved in a patent				x						x		
Number of services copied wthout agreement		x	X	x								
Number of communication channels (blogs, platforms, internal mail system, posts)					x				x			x
Number of service event attended/partner	x			x			x		x	x		
Number of service events participants/event	x			x			x		x	x		
Number of service event unattended/partner	x			x			x		x	x		
Number of customer filled surveys/partner			X	x		x						x
Number of received feedback and suggestions/ partner											x	x
Number of shared documents									x	x	x	
Number of enquiries to the knowledge management database/partner/month				x					x	x	x	
Number of expert advice										x		
Number of upgrading occurrences on the knowledge management database/partner/month				x	x	x						
Number of services, patents, white papers, percentage of responses to demands for each stakeholder,				x	x	x		x				
Number of assets put at MSE's disposal	x			x	x							
Number of VME joining/partner	x		X	x								
Number of VME dissemination actions	x		X	x								
Number of newsletters	x		X	x					x			x
Number of published news/partner/month				x								x
Number of used communication channel									x		x	x
Number of information requests/partner				x							x	x
Number of inherited assets/outputs/contacts		x	X	x								
Number of created spin-offs		x	X	x								
Number of joint-ventures		x	X	x								
Mean share capital when creating a spin-off		x										
SLA for ICT	x	x	X	x					x			
Uptime				x	x				x			
MTTR/service				x	x							
MTTF/servce				x	x			x			x	x
MTBF/service				x	x			x			x	x
Band width capacity					x				x			
Number of transaction to the repository				x	x				x			x
Number of Failure logs				x	x				x			x
Number of SLAs related to tangible and intangible assets	x	x	X	x	x				x			
Number of R&D researches				x						x	x	
Value of new services implemented/turnover		x		x								
TIM												

Service guarantee			X			x		x				x
Organizational functionality for service (Number of R&D missions, Customer focus, etc)				x							x	x
Customer satisfaction rating				x				x				x
Number of Service Communication/Information exchange tools (communication channels, HW/SW facilities, available protocols, etc)					x				x			
Number of R&D missions/partner											x	
Subgoals for customer satisfaction				x				x			x	x
Type of standards/partner											x	
Number of collaboration activity (internal and external)/partner	x		X	x			x		x			
Upgrading technology/service/year		x		x					x		x	
Service Performance Management (number business goals attended/proposed, number business subgoals attended/proposed, positive feedbacks, monitoring main outputs, evaluating performances)				x	x				x		x	x
Service Periodical Control Processes				x	x							
Use and update of service information/partner				x	x			x	x			x
Anthology of relationships with supplier and customers				x	x	x			x			x
Sservice order fulfillment time/partner				x					x			
Web ordering downtime/partner				x					x			
Number of tools for evaluating the service quality (checklists, etc)				x	X	x		x	x			x
Service Monitoring performance tools (human/automated system monitor, analytic tools, anomaly detections)			X	x	X	x		x	x		x	x
IT oriented service architecture/ IT infrastructure capability/partner									x			
Number of customer or supplier complaints/partner			X	x					x			x
Number of standard tasks for service operation/total number of tasks				x	X						x	x
Number of tested parts/ number of supposed critical parts				x	X			x	x			x
Number of times that a design had to be reworked											x	
Number of projects ongoing at the same time/partner		x	X	x								
Number of new service/projects/partner		x	X	x	X	x	x	x	x		x	x
Number of alternative solutions to new designs/partner											x	
Customer satisfaction rate/partner												x
Service Delivery Performance/partner			X	X	X			x	x			x
TSM												
Type of standards/partner (domestic and international certificates issued by original manufacturers)			X		X				x			
ICT Technologies tools/partner (Platforms, Security standards)_ IT related field			X	X	X			x	x		x	x
Information sharing tools/partner (i.e. network tools like Joinme, Facebook, etc..)					X				x			
Service Performance Management tools/partenr (number service goals attended/proposed, number service subgoals attended/proposed, positive feedbacks, monitoring main outputs, etc)		x	X	X	X	x	x	x	x		x	x
HW and SW for Controlling service processes/ partner					X				x			
Service documentation tools/partner (reports, record retentions, paper based/digital Drawing, technical specifications, cd, external hard/software, etc)	x		X	X					x			
Type of IT architecture-IT infrastructure/partner (i.e. C++, Java, etc…)					X					x		

Table 5 – KPI's Classification Table

7. Conclusion

The main aim of this deliverable is to develop internal procedures so to allow enterprise to have the correct approach toward a system where many actors can be involved, having data, information and methods such to align with those required for interactions with the other actors of the system.
After liability, trust and reputation models have been analysed, this deliverable stressed out clearly that trust is an extremely complex issue in the development of a service system. Internal and external enterprise relationships represent complex factors which involve trust requirements.

We propose to analyse trust through governance processes so to provide enterprises an appropriate way to help a VME on evaluating its service systems.
A correct and functioning Governance framework can provide an efficient supporting tool for the management of an enterprise. Therefore this drives an enterprise to reach its goals acquiring positive reputation among the market and its partners. Service governance framework allows regular observation and recording of activities, controlling and measuring actual performances. The results of the conceptual governance framework can be then fundamental for decision making. Therefore it represents an important strategic tool for MSEE Project.
VME objectives will have to be defined in order to specify precise requirements the service has to comply according to End user main goals and objectives. All the found requirements can be grouped inside a list of specifications which we can refer to as “criteria”. When creating a VME, those criteria have to be found inside the Ecosystem offer, i.e. VME servitization criteria have to match with MSE partner’s capabilities.
Therefore the proposed methodology will define a certain number of requirements to look for among partners according to the precise VME objectives. This will hold strategic suggestions to the members of the Ecosystem in the moment they will be analysed in order to become a member of a new VME. Indeed Trust will intervene in the moment an enterprise has to choose its partners in the VME creation.
Trust is therefore a fundamental strategic element while choosing the more appropriate partner in creating a VME. Indeed drives to reputation, and reputation is coming from efficiency, reliability and quality. Trust issues are deeply connected with the capabilities that a firm is able to assure, the ability of reaching the goals it preset and the standards it configured.
Relevant aspects of MSE actors can be monitored using concrete metrics derived from business objectives. Their reputation can be measured by performance indicators which can monitor specific capabilities and specific PI’s can be generated in order to measure the above mentioned capabilities.
Within the MSEE Project we propose to measure and monitor this efficiency through KPI’s, SLA’s and SLO’s. As same as Governance monitoring, we can therefore measure trustworthiness through enterprise efficiency.
Following specific VME objective, particular criteria will be identified and, according to that, KPI’s will be generated and used in order to identify which partner is the right one to involve in the VME creation. Indeed depending on the monitoring of requirements, each MSE partner can be classified from a higher to lower level of assets responding to those requirements. Of course higher responding leads to higher level of trustworthiness.

Following the mentioned Trust measurement methodology we will be able to support the enterprise in order to prove quality and quantity standard, and therefore reach trustworthiness among partners when creating a new VME. PI's and SLA's will be used to monitor and control performances both at design and a run time phases. In this way, enterprises will be able to provide the required information in the correct timing in order to enable the full usage of KPI's and SLA's during the operational phase and the relations with other partners.

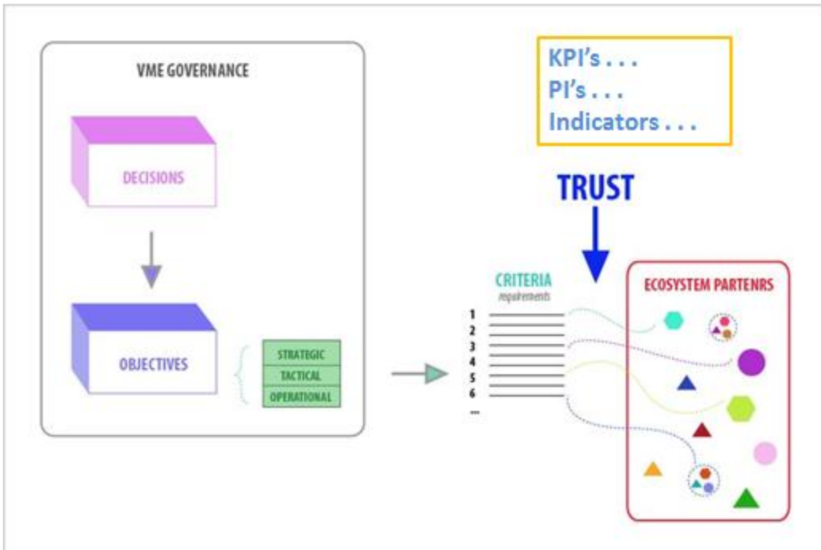

Figure 24 - Trust measurement in VME creation

Establishing trust relationship leads to many advantages among members of the Ecosystem, among these we can mention:

- Facilitating the achievement of objectives by encouraging information exchange, knowledge sharing, tools sharing, etc… among members in a network;
- Easing the process of creating and launching virtual organizations;
- Increasing the desired preparedness to participate in virtual organizations;
- Creating competitive advantage through reducing the governance costs (management costs), costs of internalization (acquisitions), transaction costs among organizations, and impacts creation;
- Enabling open communication, and conflict management;
- Reducing efforts for co-ordination;
- Ensuring commitment of all partners to the common objectives;
- Creating a pleasant collaboration atmosphere;
- Increasing transparency, knowledge sharing, partners commitment and safeguarding.

Practical results will be needed in order to validate the mentioned methodologies. In the updated version of this deliverable we suggest to validate trust issue through MSEE PIs methodology proposal and the Governance framework within a real condition in an enterprise environment. We propose to validate this MSEE PI's methodology through the Use cases.

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