

# A Multidimensional Review and Extension of the SPI Manifesto Using STEEPLED Analysis: An Expert Validation

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**Abstract.** Over a decade has passed since the inception of the SPI Manifesto. The fact that the signatories of the manifesto emanate from both the academic and the industrial communities enables a robust exchange of ideas and experiences. Continuous enrichment and refinement have been evidenced in publications, industrial projects, and consultancy across both communities. The main publication fora of this cross-disciplinary collaboration have been the EurAsiaSPI conferences, which have stimulated the healthy evolution of innovative ideas and disciplinary action(s). There is a current debate aiming to review and update the SPI Manifesto after ten years of theory and practice whilst major trends and practices gained ground.

This study aims to validate the multidimensional STEEPLED (Sociocultural, Technical, Economic, Environmental, Political, Legal, Ethical, and Demographic) analysis of the SPI Manifesto, and to contribute towards a formal review and upgrade of the SPI Manifesto. The study targets the strengthening of the dimensions which are absent, mentioned, or implied, but are not explicitly specified in the SPI Manifesto. The experts are academics and practitioners or both, all with a strong track record in the SPI movement. The authors are also academics and/or practitioners and include some of the original developers/signatories of the SPI Manifesto. This paper concludes with concrete suggestions for the update, extension, and re-launch of the SPI Manifesto and proposals for the formulation of strategies for guiding SPI.

**Keywords:** SPI Manifesto, STEEPLED, Expert Validation, Systems Multidimensionality, Demographic Analysis

## 1 Introduction

Systems and (sub)processes involved in their design, implementation and maintenance/use are multidimensional per se. For many years, the technical aspects of software systems and (regular) failures of software systems and software projects were attributed to technical factors, without considering human factors. Within that assumption, a variety of stakeholders, often with conflicting interests, put forward their own views, demands and prejudices to create the intrinsic need for a socio-technical approach. In the late 80s and early 90s Software Engineers - theoreticians and practitioners - such as P. Checkland [1, 2], E. Mumford [3, 4], A. Kaposi [5] and others emphasised that software systems are not only technical, and that various stakeholders (developers, sponsors, end-users) have a variety of ways to understand, design, realize and use correct and robust systems through the prevention rather than the correction of errors. The SPI Manifesto [6] appeared to accommodate the learning and experience of over 30 years, expressed in terms of ten (10) Principles and three (3) Values. Each of the three values is informed and supported by one or more of the ten principles.

Socio-technical and environmental along with political and ethical factors are found almost everywhere in software-based systems development. The external environment of an organization consists of variables and factors (e.g. technical, socio-economic, political, and so on) that are beyond the control of the organization (Sammut-Bonnici and Galea, 2015) [7]. Because organizations operate as parts of a larger ecosystem and society all these socio-technical and other factors prompt for analysis with the aim of constantly re-aligning the organizational strategy to shifting business environments to survey, stay competitive, add business value and achieve sustainability. The ability to improve and optimize an organizational process relates to the economic and evolutionary theory of an organization, which is centered around the concept of dynamic capability (Clarke and O'Connor, 2010) [8]. The organization needs to continually transform the business routines in response to changing environments and new understandings, and the evolutionary theory of the firm suggests that this ability gives rise to the dynamism that will ultimately drive the organization to improvement and success.

In earlier papers (reported in several publications by the authors of this paper) Georgiadou et al (2019) [9], Georgiadou et al (2019) [10], Georgiadou et al (2020) [11], it was proposed that the SPI Manifesto should be (re)viewed from various perspectives regarding its dimensions. Earlier, a STEEPLED analysis and subsequent validation handled only the Sociocultural dimension.

The SPI Manifesto has been reported and published in the Wiley Journal of Software: Evolution and Process in 2012 [12] and based on the SPI Manifesto, a job role SPI Manager [13-14], and training has been developed and applied in leading organizations in Europe and Asia. The role SPI Manager is seen as a coordinator of improvement initiatives (Software, System and Service Improvement) inside an organization considering the values and principles of the SPI Manifesto. So far the SPI Manager was seen as a central role, more recent feedback from the market shows that the SPI agent role is assigned to many people in an organization and requires a com-

prehensive understanding of social skills and organizational strategies to get the SPI Manifesto successfully launched. Also, this paper proposes a tool which a SPI Manager can use to assess and improve a SPI Manifesto implementation and offers a new scale to use for such an assessment.

## 2 Research Design

### 2.1 Methodology, method and instrument

The research methodology adopted is defined in Lee [15], and is a multi-paradigmatic approach, which identifies three levels of understanding, namely the subjective, the interpretive and the positivist. It is possible that the opinions of the experts can have an element of subjectivity, nevertheless they provide a shared understanding (first level of understanding) of the main challenges involved in SPI. The validation enables the second level of understanding, and the analysis of the grading provides the positivist understanding.

For capturing primary data, the research method used is the survey, and the instrument is a questionnaire in the form of matrices depicting the relationships between the SPI Manifesto's Values and Principles, where each of the SPI Manifesto's Values is informed and supported by one or more of the ten SPI Manifesto Principles.

### 2.2 The research questions

- Does the structure of the SPI Manifesto reflect the correct relationships between the original three Values and ten Principles?
- What are the relationships ( $P_i, V_j$ ) between Principles and Values? (where  $P_i = 1, 2, \dots, 10$  and  $V_j = 1, 2$  or  $3$ )
- Are there any additional relationships (blank relationships in the matrix) and why should they be added?
- Which of the STEEPLED dimensions are encapsulated in each ( $P_i, V_j$ ) and to what degree (on a Likert scale: Very High, High, Medium, Low)?

## 3 STEEPLED Analysis of the SPI Manifesto

### 3.1 Viewing the SPI Manifesto as a System of Interconnected Values and Principles

The SPI Manifesto [6] encapsulated the collective learning and experience gained by 29 experts over 30 years prior to 2010. The Manifesto is expressed in terms of ten (10) Principles and three (3) Values. Each of the three values is informed and supported by one or more of the 10 principles.

A system's multidimensionality and "zoticality" (the ability to respond to dynamic changes), have been studied from different viewpoints [16-17]. Herein, a manifesto can be viewed as a system whose dynamic components are systematic values and

principles. Studying a dynamic system from different viewpoints enhances understanding of the interrelationships of various components and functions within. If we view the SPI Manifesto as a system of interrelationships between the Values and the Principles that constitute the Manifesto itself, one can carry out a STEELED (Sociocultural, Technical, Economic, Environmental, Political, Legal, Ethical, and Demographic) Analysis. We carried out a STEELED analysis and subsequently validated the Sociocultural dimension [11]. The study reported in this paper is validating the STEELED Analysis over all eight dimensions.

### 3.2 The Sociocultural Dimension

The Sociocultural dimension deals with influences, inspirations, effects, and impacts stemming from international, national, organizational, and professional cultures [11]. This dimension is particularly important in today's globalized and interconnected collaboration, communication and decision making through multicultural teams working together in a distributed mode within the same or different organizations and across different countries.

The organizations, groups and social systems cannot exist without human beings, and therefore cannot be defined, characterized, or measured in some objective and universal way [18]. The interpretivist paradigm aids the understanding of social and contextual situations that influence the SPI process.

Human, social and cultural factors, such as knowledge sharing, motivation, and customer collaboration, have a very strong impact on the success of software development endeavors and the resulting system [19]. On a software development team level, emergent properties of the whole team, such as social cohesion, shared beliefs, motivation, image, goals, satisfaction of members, and effectiveness in achieving tasks are challenging sociocultural factors that may influence the resulting system. Other challenging sociocultural factors influencing the rigid SPI process include fear of adverse consequences, like inflexibility, or the degree of control over personal working processes.

According to Heikkila [20] the main challenge when introducing SPI in an organization lays in changing the existing systems, the working practices, the shared beliefs, and social relationships, all referred to as organizational culture. He states that "the existing organizational culture needs to suit the newly implemented process, expressed by managing human dynamics of commitment and resistance". Organizational routines, such as best practice, can become an effective way of developing software, but they can also minimize the exploration of new alternative routines [21]. Practice without process tends to become unmanageable, and process without practice results in the loss of creativity needed for sustained innovation. The inherent dilemma of balancing between formal process and informal processes seems to be a key of sociocultural issue in SPI. The deeper social routines are grounded in the organizational culture, the more difficult they are to change, the more easily they turn into an obstacle to improvement.

### 3.3 Technical Dimension

The Technical (or Technological) dimension of the STEEPLED framework deals with and analyses those variables relating to the existence, availability, and development of software-related technology. This dimension has, throughout time, included factors relating to maintainable implementations and practical metrication of the software process and product. The latter span from the computational power of software specifications to engine efficiency and software reliability metrics.

The SPI Manifesto was issued in 2010, so a decade later Technology has moved on: Cloud, Containers and Microservices, Open Source Software production and mobile devices are now all far more prevalent. Agile development has expanded from a purely software approach to a managerial approach to service-oriented and other business processes. The manifesto mentioned CMMI, SPICE, and more general quality methods such as Six Sigma, Juran and ISO 9000 as sources of improvement ideas. Value 1 (People) mentions the failure (“limited success”) of ivory tower approaches and states that people need to make “full use of their experience ... using and improving the processes they have helped to define”.

One difficulty is to identify those technical improvements that would be of greatest value to the business concerned, and be economic and practical at the same time. Principle 3 states “Base improvement on experience and measurements” but does not recommend a method for this. Principle 6 states “use dynamic and adaptable models as needed” and refers to Pries-Heje and Baskerville [22] on choosing appropriate models. Otherwise, many of the principles seem equivalent to the more generally applicable Deming’s 14 Points [23].

Measures of process capability tend to be incomplete and context-dependent. Leaving it to individual organizations to pilot and measure their own unique selection of changes implies that there is no (measured) scientific consensus on “good practice”. Ultimately, if code is to be developed and maintained to a higher standard, we require that developers and/or reviewers and/or testers operate with a greater degree of rigor. Additionally, for maximizing software quality following Software Process Improvement (SPI) guidelines, a suitable method(ology) and appropriate software tools (e.g., for reverse engineering and re-engineering) to automate the various sub-processes in the traditional software development lifecycle are of paramount importance. Agile software development and SPI approaches do not always emphasize that.

Traditional and agile software development processes and their output software artefacts require a degree of (software) quality in the form of perfectionism that is rare outside safety-critical design work. Further, because the computer generally executes the software normally without any human supervision, the end-users may experience any bugs left in it. Evidently, this is different in Free/Libre/Open Source Software Communities, where the coding and implementation details are the resulting source code from more collaborative efforts. This type of involvement includes proven professional knowledge of the team leader and personal altruistic motivation with formal and informal walkthroughs and inspections for the final products’ quality assurance.

The more recent “SQuaRE” standards (ISO/IEC 25000 series) include models for “Quality in Use” and “Product Quality” (ISO 25010: 2011) and for taking measure-

ments (e.g. ISO 25022: 2016 Measurement of Quality in Use), but have not yet been incorporated. In future editions of the Manifesto, it would be useful to guide readers towards adequate measures of process capability. Exemplary practices from non-traditional software paradigms like Free/Open Source and others like Scrum methodology from the Agile paradigm, can bring considerable improvements to a future revised and extended SPI Manifesto.

### 3.4 Economic Dimension

Economic variables have the most obvious impact on the profitability and overall attractiveness of a market or industry [7].

The external economic situation and trends will change many times throughout the lifetime of an organization, through international trade, economic growth, recession, inflation, level of unemployment, etc. These factors include the international economy, local economy, economic trends and inflation, Gross Domestic Product (GDP), interest and exchange rates, demand and supply, tax policies (including corporate taxation and product taxation), as well as channels of distribution and access to markets. The external economic changes need to be mirrored in the capital investment and product launch strategies to facilitate change through refinement and application of business processes as a key to survival.

Jones [24] argued that software improvements do not occur at random. All improvement strategies should start with a formal process assessment and a quantitative baseline of current productivity and quality levels. Management needs to calculate Return on Investment (ROI) and to collect data to demonstrate progress. Solid processes and methodologies need to be identified and established for requirements, design, development, and quality control. Exploration of new tools and approaches with steep learning curves are introduced as specialization where applicable. Focus on reusability and leadership are embraced for adding value. For every stage, an individual budget and plan is established together with ROI calculations. The Economic dimension directly influences the degree to which organizations aim to expand by outsourcing, taking part in joint ventures or by hiring and training new staff in subsidiaries [11].

Traditionally product development has been product design-driven through stable and predictable approaches, such as SPI. Today there is more focus on Customer eXperience (CX), which increasingly requires that service use (by human or automated services) is integrated into the whole lifecycle of a product.

The organization acts as a locus where competencies are continually built, managed, combined, transformed, tested, and selected. The main concerns relate to how new knowledge is materialized into new competencies and rather than examining process capability and prescribing an improvement path, an alternative view suggests that one should focus on maximizing the capability to transform the process and hence render an improved process [8]. An economical view of software engineering takes value creation activities and value-based project planning into account to support software process evolution by value-based process optimization. Yilmaz et al. [25] proposed that game theory (i.e. interactive decision theory) can be used to inves-

tigate and identify potential points of concern (i.e. conflicts, social dependencies, and actions) within the software organization and to accomplish its objectives by creating several types of mechanisms (e.g. regulatory). It is a collection of analytical methods or tools based on mathematical models to define or observe social and economic situations.

### 3.5 The Environmental Dimension

Checkland's Soft Systems Method [1] used Systems Thinking applied to Software Development, viewing a system as something existing within an environment, and composed of subsystems, (sub)components and behavioral characteristics and interactions. Stalter et al. [26], in their conceptual analysis of systems thinking applied to nursing, concluded that systems thinking is a holistic approach aiding the analysis of complex situations and systems viewed in terms of technical, spatial, time and cultural dimensions. They identified four systems dimensions namely technical, spatial, time and cultural, which they visualized in a helix model. Acampora et al. [27], in their multidisciplinary and multi-professional study on managing environmental waste, emphasized the multidimensionality of systems.

In the case of IT Systems, Jacob [28] emphasized that green strategies were developed for improving energy efficiency such as the design of Energy Efficient Data Centers and reducing the use of hazardous materials. Data Centers form an integral and vital part of an organization's overall strategy for reducing carbon emissions. Green Computing is a movement which raises awareness of the need to utilize resources effectively, and of improving environmental performance. There is, nowadays, widespread recognition of the urgency for tackling global warming and energy use. In this context, Green Computing is concentrating on reducing energy costs and on demonstrating corporate and social responsibility. Information and Communication Technologies (ICTs) require power efficiency for high performance computing. It is recognized that the ICT industry needs to improve its environmental performance. With the widespread use of ICTs and complex applications, the environmental dimension (for both hardware and software) must form an integral part of systems and their development. SPI can contribute to energy saving through environmental sensitivity and actions throughout the systems lifecycle.

Philipson [29] states that "the formal definition and approach to implementing Green ICT remains elusive, because most organizations are unable to properly identify what areas to address". Thus, a comprehensive and practical ICT framework can overcome this problem through quantification and metrics based on a 4x5 matrix where the four vertical pillars of Lifestyle, End User IT, Enterprise and Data Centre IT are a Low-Carbon Enabler. Each pillar is mapped onto five (5) horizontal dimensions: Attitude, Policies, Practices, Technologies and Metrics using a 5-level Capability Maturity Model. Sustainability is intrinsically connected to the environmental movement which aims to reduce waste products and materials but also of knowledge, knowhow and research results. Georgiadou et al. [30] developed a framework for quality and valorization was proposed as an integral part of a sustainability strategy, starting from ideation, through to initiation of project and ongoing review and improvement. Sustainability and Exploitation creates value, maximizes return on investment and generates societal benefits. Innovation and sustainability were also stud-

ied by Raja et al. [31] who emphasized that people, planet and profit are at the core of the concept of sustainability. Environmental concerns and policies are implied in the SPI Manifesto's Values: People and Business, whilst the Value Change is only implied and hence, needs to be made explicit to reflect recent changes in technologies and societal attitudes.

### 3.6 The Political Dimension

Software Politics does not exist as a term to include and handle the relations formed among stakeholder groups, software companies, governmental councils, software business projects, yet. In reality though, these conflicting and/or co-operative parties of interest exist and there also exist hidden principles of political dimension which global software production obeys or disobeys. In short, radicalism, conservatism and liberalism - to name but a few tendencies in software development projects - are apparent in theory and in practice, are followed consciously or unconsciously and influence the software markets, the information society and the technology-based economy at large.

Political theories and ideologies such as those of diversity, equality and feminism have been used to identify, for instance, women's ICT needs, gender and equality gaps in IT and software production e.g. [32-34]. Further political ideas such as security [35-37], justice, revolution, globalization are often praised in the justification of the creation of global capital and software markets utilizing outsourcing and free software foundations and free/libre/open source communities [38-40]. The controversies can be extended into the fields of Open Standards [38] and Creative Commons and in the IT workforce itself where people, business and change are the origins of the primary values of software process improvement.

Nevertheless, political (and other) contradictions, originating from internal or/and external factors, are by no means all bad in the case of software process and product/service improvement. As long as they are considered and acknowledged wisely they can be a source of inspiration for people-centered business success as well as the trigger to personal growth, organizational and social change.

### 3.7 The Legal Dimension

Justice, mentioned earlier (in the political dimension section) is primarily and traditionally (in philosophy) considered as a political theory (e.g. in Plato's Republic) or a concept like, for instance, liberty, equality, democracy, utopianism and the list can go on. In practice, though, there is a need for a formal means to bring about justice and law is considered to serve and distribute justice.

In fact, the philosophy of law is commonly known as jurisprudence. Analytic jurisprudence asks "what is law?" while normative jurisprudence asks "what should law be?" Nowadays, the Legal Dimension of software development can clearly be seen in the Laws and Legal Acts that are needed to protect e.g. privacy and intellectual property rights (IPRs). A recent development in ICT industry, that binds to Law for protecting privacy, is the European Union's GDPR, namely the General Data Protection Regulation, which has also been adopted in non-EU countries.



In software and IT industries the areas of cybersecurity and cybercrime [41-43] are often bound to legal regulations, not laws! In software, anti-phishing design quality criteria and contingency approaches for usable security designs, there are many requirements that are of legal nature. There is a constant battle to legally regulate the use of surveillance cameras as evidenced by the controversy and ethics of protection mechanisms in security/privacy and human rights Acts of the United Nations and other legal bodies.

There is always a question about trusting the systems of laws in a Constitution or a country, especially in Capitalism. This is because the law makers might not be knowledgeable or wise enough to make laws that cater for justice in a particular area of industry or society. This might be the reason that Aristotle differed from Plato and considered justice a virtue, and not a service or a political idea/theory (unlike Plato) in his book of *Nicomachean Ethics* [44]. Otherwise stated, what is legal (and given that justice is/should be blind!) cannot always be proper or right or good, thus ethical.

In the aftermath, regular failures of systems, in various professions, have been studied by various regulatory bodies and by individual researchers. A major question then is whether there is the need for a regulatory body for IS professionals. "Arguably, a strong regulatory body for IS professionals may help foster a stronger climate of 'responsibility' and accountability in the workplace as seen in other professions like Medicine and Law. The IS profession however, presents peculiar complexities which may make regulation difficult. To take the analogy of bridge design and construction, if the bridge fails in some way (e.g. the London Millennium Bridge) is it possible to locate the error(s) and more importantly to allocate the responsibility for the rectification/correction of the error(s)? Deliverables of one phase of the lifecycle mold the next phase and determine the quality of subsequent deliverables [45]. This complexity is even greater in IS projects where a fault may lie in any stage of the system lifecycle, e.g. specification, design, software development, implementation phase or otherwise. Further, failure may not only be due to error on the part of an IS worker, but may be, in part, due to management decisions, user misuse or a "comedy of errors".

### 3.8 The Ethical Dimension

Software development has a rather long relationship with Computer Ethics, handling the right arguments and justification of actions as a part of a decision-making process. In addition to the relationship between professional and ethical we just discussed, there is another question: whose ethics should we follow in software development processes when there are so many parties with conflicting interests and rights? It can be rather difficult to argue for or against the use of ethics and/or justice, ethics and morality, or justice as a virtue being part of ethics. Apparently, in software production the ethical dimension is/should be encapsulated in the essential assertion of what you are as a human being, not what you do. This is the essence of Ethics as a branch of Philosophy, coming from the ancient Greek word 'ethos', written 'ἦθος' and meaning character.

Pries-Heje and Johansen (Chief Editors of the SPI Manifesto) state that:

*“a principle is something that can serve as a foundation for action. The SPI Manifesto advises that the ten principles should be used to govern personal and professional behavior in relation to Software Process Improvement work”* [6].

Rahanu et al. [46] argued that the notion of ethical duty needed to be explicitly addressed in the SPI Manifesto. Although these are implied in the manifesto’s three values and ten principles, there needs to be a much more unequivocal statement with regard to how ethics, law and professionalism must govern personal behavior in relation to Software Process Improvement work. In order to become a responsible computer professional, the Impact CS Steering Committee [47] argued that one must be able to examine the standards for the rightness and wrongness of actions. In terms of personal and professional responsibility, the committee recommended the following six traditional moral and ethical concepts: 1. Quality of life; 2. Use of Power; 3. Risks and reliability; 4. Property Rights; 5. Privacy; 6. Equity and Access.

In some instances, the law will clearly apply and lead directly to the appropriate ethical conclusion. However, to rely solely on law as a moral guideline is clearly dangerous because four possible states exist in the relationship between ethics and law depending on whether a specific act is ethical or not ethical, and legal or not legal, implying that in some instances the law fails to provide moral guidance. Thus a 12th principle: Comply with Legislation could be appended to the SPI Manifesto [46].

The People Value in the SPI manifesto rightly focuses on the active involvement of the people working in an organization in order to ensure the success of a SPI initiative from the business perspective. However, it is also important to consider People in a wider context, i.e. Public Interest. The BCS Code of Conduct [48] states a number of professional duties that members should discharge regarding Public interest, and these duties include the environment. These Public Interest duties should also hold true for SPI professionals. Thus the authors argue that a fourth Value, called Society (public interest), be introduced to the SPI manifesto and that the existing Value of People (i.e. all those involved in the production, support and use) be renamed Client or Stakeholder in order to make the distinction between the duty to people within an organization and people in the wider society. Valuing people means all people involved in the production, support, and use of the system.

### **3.9 The Demographic Dimension**

The demographic dimension needs to be considered in the software process, to ensure that people alter their activities to achieve change for business success. Processes are needed to measure the effectiveness and hence to update the models relating to the actions of and the outcomes of population changes, in order to achieve the various countries’ [49] objectives of addressing unexpected events and external and internal changes. This applies, not only to large organizations but also to Small and Medium-sized Enterprises (SMEs) [50], where both culture and the ethnic background of the family could be important factors of success.

In larger organizations, the implementation of change is likely to be more affected by older people, compared with people of the “digital age”. Younger workforces tend to accept and adopt technology changes more easily than the older workforce. Again the younger population might be more active in wanting necessary change, not only political and legal but especially environmental. Considering the different organizational/system processes, such as mentoring [51], it is necessary to adapt (sub) processes related to imposing “rules” for addressing and managing risks associated with external factors such as a pandemic. Different processes are needed to encourage diverse sectors to learn new ways, such as using social media and celebrities to reach the young. Different approaches are needed to reach other ages and various communities as is the case of a pandemic like Covid-19, certain communities perceive risk in different ways [52]. For example, processes are needed to measure the effectiveness and hence to update the models relating to the action of the population in order to achieve the various countries’ objectives in addressing the pandemic.

## 4 Collection and Analysis of Data

### 4.1 Relationships of SPI Manifesto Values and Principles

For each of the eight STEELED dimensions a number of relationships define the way in which a principle informs the Value. For each dimension there are potentially 30 relationships (but not always required or plausible) of the form  $P_iV_j$  where  $i = 1$  to 10 and  $j = 1, 2, 3$  are depicted inside the relevant relationships in the relevant matrix/table. As established in [10] some of these relationships were either mentioned explicitly or implied in the SPI Manifesto.

The validation by experts revealed additional dimensions to those identified by the authors in [10], which are shown in italics in sections 4.2-4.9, together with a graphical representation showing the distribution of the results. The importance placed by the experts of each relationship is graded on a Likert scale: Very High (VH), High (H), Medium (M) or Low (L). The relationships and the respective grades are shown in Figures 1-8.

The current structure of the SPI Manifesto manifests that each Principle only involves one of the three Values. The results of the STEELED analysis, however, show that there are many more interconnections between the three Values and the ten Principles of the manifesto. In [10,11], we propose interconnections that not only directly involve the principles, but interconnections that influence the principles.

The experts (practitioners and academics) were asked to grade the importance of each original interconnection and the interconnections proposed by [10,11] but they were also able to grade any possible interconnection, if they thought it important. All interconnections (relationships) are shown in the sets shown at the beginning of Sections 4.2 to 4.9. The relationships (tuples) for example (P7V1), (P7V2), (P7V3), (P8V1), (P9V3), (P10V3)} are highlighted.

Table 1. STEEPLED Analysis of the SPI Manifesto [10]

	Values		
	V1. People	V2. Business	V3. Change
<b>PRINCIPLES</b>	Must involve people actively and affect their daily activities	Make business successful	Is inherently linked with change
<b>P1 Know the culture and focus on needs</b>	Sociocultural [S] Ethical [Et] Demographic [D]	Political [P] Economic [E] Sociocultural [S] Demographic [D]	Ethical [Et]
<b>P2 Motivate all people involved</b>	Sociocultural [S] Ethical [Et] Environmental [En] Economic [E] Demographic [D]	Economic [E] Demographic [D]	Sociocultural [S] Ethical [Et]
<b>P3 Base improvement on experience and measurements</b>	Economic [E] Political [P] Sociocultural [S] Demographic [D]	Economic [E] Demographic [D]	Technical [T] Economic [E]
<b>P4 Create a learning organisation</b>	Sociocultural [S] Ethical [Et] Economic [E] Technical [T] Demographic [D]	Economic [E] Sociocultural [S] Demographic [D]	Sociocultural [S] Demographic [D] Technical [T]
<b>P5 Support the organisation's vision and objectives</b>	Ethical [Et] Sociocultural [S] Demographic [D]	Political [P] Economic [E] Demographic [D]	Sociocultural [S] Political [P]
<b>P6 Use dynamic and adaptable models as needed</b>	Technical [T] Economic [E]	Technical [T] Environmental [En]	Technical [T] Environmental [En]
<b>P7 Apply risk management</b>	Economic [E] Legal [L] Ethical [Et]	Technical [T] Political [P] Ethical [Et] Legal [L]	Technical [T] Political [P] Ethical [Et] Legal [L]
<b>P8 Manage the organisational change in your improvement effort</b>	Ethical [Et] Demographic [D]	Technical [T] Economic [E] Demographic [D]	Political [P] Sociocultural [S] Ethical [Et] Environmental [En] Legal [L] Economic [E]
<b>P9 Ensure all parties understand and agree on process</b>	Demographic [D] Sociocultural [S] Ethical [Et]	Demographic [D] Political [P] Sociocultural [S] Ethical [Et]	Political [P] Sociocultural [S] Ethical [Et] Environmental [En] Legal [L] Economic [E]
<b>P10 Do not lose focus</b>	Demographic [D] Legal [L] Ethical [E]	Demographic [D] Legal [L] Ethical [Et]	Political [P] Ethical [E] Sociocultural [S]

#### 4.2 Sociocultural Dimension: Existing and additional relationships

The Sociocultural Dimension is involved in the following relationships:

{(P1V3), (P2V1), (P2V2), (P2V3), (P3V2), (P3V3), (P5V2), (P6V2), (P6V3),

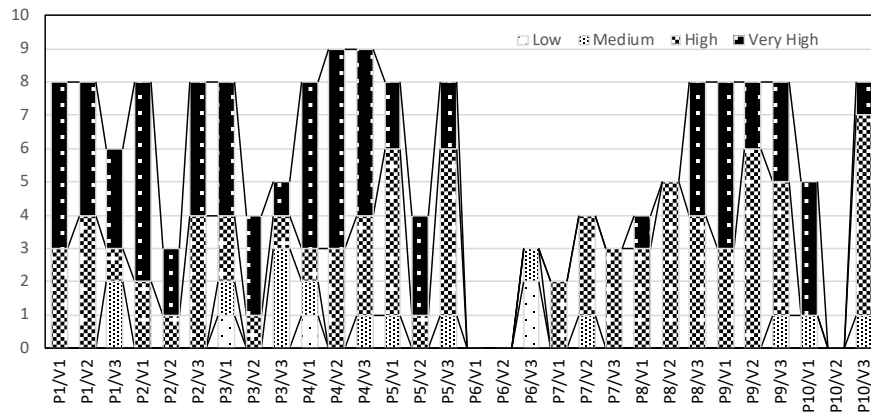


Figure 1: Profile of the Importance placed by the Experts on the Sociocultural Dimension

The results of the expert validation of the sociocultural dimension show the level of agreements with the proposed interconnections (Georgiadou et al, 2019; 2020). In particular, principle P1 ‘Know the culture and focus on needs’, P2 ‘Motivate all people involved’ and principle P4 ‘Create a learning organization’ were considered very important to value V1: People. Principles P8 ‘Manage the organizational change in your improvement effort’ and P9 ‘Ensure all parties understand and agree on process’ were similarly considered very important for change.

The experts also proposed totally new interconnections as follows: P1 ‘Know the culture and focus on needs’, P2 ‘Motivate all people involved’, P3 ‘Base improvement on experience and measurements’ and principle P4 ‘Create a learning organization’ were considered to be very important for Value V2: Business and V3: Change. Principles P8 ‘Manage the organizational change in your improvement effort’ and P9 ‘Ensure all parties understand and agree on process’ were considered very important for Value V1: People and V2: Business.

#### 4.3 Technical Dimension: Existing and additional relationships

The Technical Dimension is involved in the following relationships:

{(P1V2), (P3V3), (P4V1), (P4V2), (P4V3), (P5V1), (P5V2), (P6V1), (P6V2), (P6V3), (P7V1), (P7V2), (P7V3), (P8V2), (P9V2), (P9V3), (P10V1), (P10V2)}

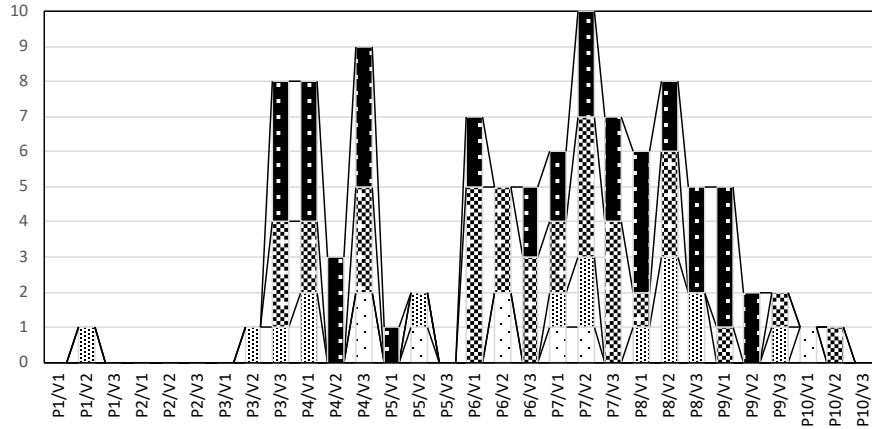


Figure 2: Profile of the Importance placed by the Experts on the Technical Dimension

Apparently, technology can be used in support of most of the SPI Manifesto Principles. The main areas where respondents believed tools could be employed, differing from the original paper [10], were for the Business Value (V2), in creating a learning organization (P4) and supporting the organization’s vision and objectives (P5). Further support that technology/tools could provide is believed to be in the People Value (V1) in using models as needed (P6) and applying Risk Management (P7). Overall, one can see that the key SPI Manifesto Principles involved in the Technical/Technological Dimension are P4, P5, P6, P7, P9 and P10 while, according to the responses the particular principles (P4-P10) seem to mostly affect values People (V1) and Business (V2) while Change (V3) is less affected by Technology and or technical factors in general.

**4.4 Economic Dimension: Existing and additional relationships**

The Economic Dimension is involved in the following relationships:

- {(P1V2), (P2V1), (P2V2), (P2V3), (P3V1), (P3V2), (P3V3), (P4V1), (P4V2), (P4V3), (P5V1), (P5V2), (P5V3), (P6V1), (P6V2), (P6V3), (P7V1), (P7V2), (P7V3), (P8V2), (P8V3), (P9V1), (P9V2), (P9V3), (P10V1), (P10V2), (P10V3)}

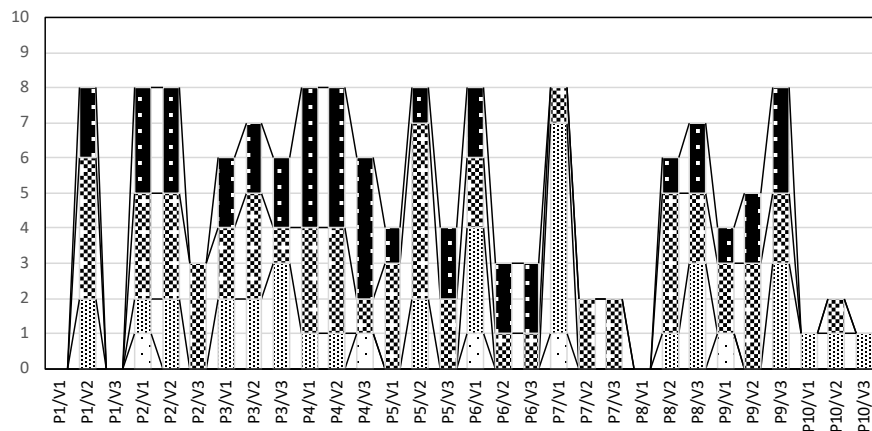


Figure 3: Profile of the Importance placed by the Experts on the Economic Dimension

The expert validation of the economic dimension showed the level of agreement with the proposed interconnections. Principles P2 ‘Motivate all people involved’, P3 ‘Base improvement on experience and measurements’, P4 ‘Create a learning organization’ and P9 ‘Ensure all parties understand and agree on process’ were considered important for all three values People, Business and Change.

The experts also proposed totally new interconnections as follows: P4 ‘Create a learning organization’, P5 ‘Support the organization’s vision and objectives’, P6 ‘Use dynamic and adaptable models as needed’ and P7 ‘Apply risk management’ in particular for the Change value. The proposed new connections were motivated by arguments, such as ‘financial models can help predict trends and change can be modelled which can help minimize problems and losses’.

#### 4.5 Environmental Dimension: Existing and additional relationships

The Environmental Dimension is involved in the following relationships:

{(P1V1), (P1V2), (P1V3), (P2V2), (P2V3), (P3V1), (P3V2), (P3V3), (P4V1), (P4V2), (P4V3), (P5V1), (P5V2), (P5V3), (P6V1), (P6V2), (P5V3), (P7V1), (P7V2), (P7V3), (P8V2), (P8V3), (P9V3), (P10V1), (P10V2), (P10V3)}

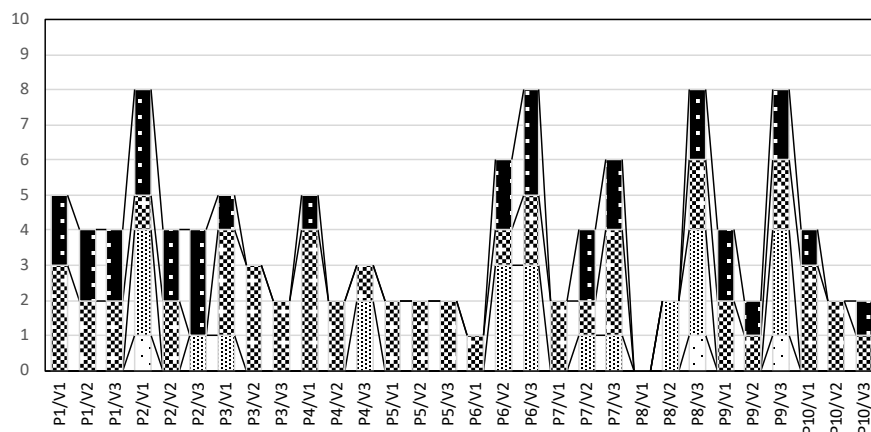


Figure 4: Profile of the Importance placed by the Experts on the Environmental Dimension

Currently, only 8 relationships involving the Environmental dimension are implied in the SPI Manifesto. However, the expert validation revealed that another 18 relationships exist. These results could be interpreted as growing awareness and recognition of the need to address the responsibilities of the ICT industry for example in tackling global warming and reduction of energy costs through Green Computing strategies. Process improvement generally leads to better products and services. The qualitative results of the validation show that a large proportion of the experts consider the environmental dimension of either Very High or High importance. In particular, relationships (P1V1), (P1V2), P1V3), and (P2V2) scored only Very High or High grades (no Medium or Low entries). One interesting profile is that of (P2V1), i.e. P2 ‘Motivate all people involved’ and V1: People, where 70% of all respondents consider this rela-

tionship important. In fact 43% of the experts believe it to be of Very High Importance, another 43% consider it to be of Medium Importance, and 14% consider it of Low Importance. Other significant profiles of the importance of this dimension is the relationship (P6V3) with 43% grading it as Very High, 28.5% as High and 28.5% as Medium. Similarly the same grading was awarded to (P9V3). These results show that ensuring all parties understand and agree on process (P9) combined with Change (V3) requires attention. As some of the experts emphasized Change is fraught with dangers, manifested as resistance from certain parties especially if they are not consulted or involved in the decision to change the status quo.

**4.6 Political Dimension: Existing and additional relationships**

The Political Dimension is involved in the following relationships:  
 {(P1V1), (P1V2), (P1V3), (P2V1), (P2V2), (P2V3), (P3V1), (P3V2), (P3V3), (P4V1), (P4V2), (P4V3), (P5V1), (P5V1), (P5V2), (P5V3), (P6V2), (P6V3), (P7V1), (P7V2), (P7V3), (P8V3), (P9V1), (P9V2), (P9V3), (P10V3)}

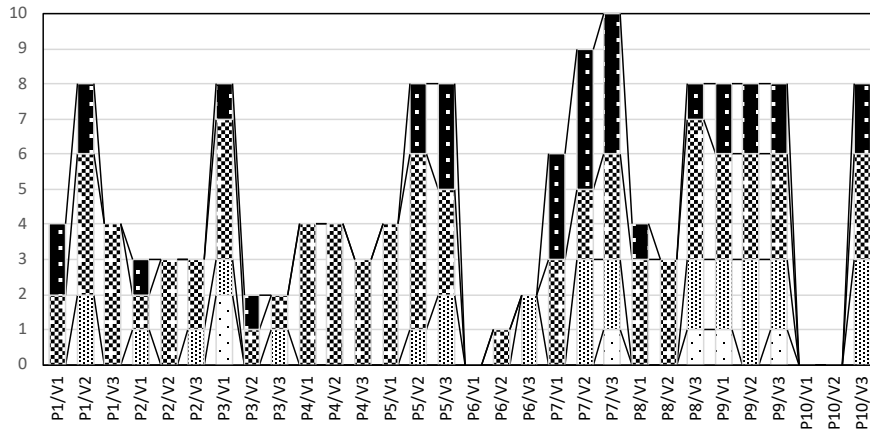


Figure 5: Profile of the Importance placed by the Experts on the Political Dimension

According to the SPI experts’ responses the Political dimension seems to play a central role regarding the Principles and Values of the SPI Manifesto. Thus, checking the collective data as depicted by their answers, it can be seen that opinions span a wide range of involved Principles and Values. Indeed, the twenty-five relationships revealed in this research study are briefly mentioned as pairs of Principles and Values shown in the set above. Refining, however, the original revealing information shaping from the experts’ opinions and observing an overall emphasis given, one can further formulate some closer and generally agreeable relationships, mentioned and briefly described next.

Hence, the significantly influential relationships between the SPI Manifesto’s Principles and Values, in regard with the Political dimension can be viewed in the following pairs: (P1V1), (P1V3), (P2V1), (P2V2), (P2V3), (P3V2), (P3V3), (P4V1), (P4V2), (P4V3), (P5V1). This is a total of eleven (11) relationships revealed from the



processed data collected from SPI experts' opinions. Undoubtedly, all three Values (V1 = People, V2 = Business and V3 = Change) are inter-related and influenced by all the Principles of SPI Manifesto. In reality, though, the highly influential relationships for People, Business and Change are equally formed on the basis and practice of five (5) only equivalent SPI Manifesto Principles, those of P1, P2, P3, P4 and P5. These findings are a clear indication of the need to consider the enrichment of the SPI Manifesto with a Political (and perhaps a Philosophical as well) layer in order to encapsulate the necessity of mapping the essential political intentions and considerations of the software development processes, artefacts and services to those relevant meta-requirements of the software development quality assurance.

#### 4.7 Legal Dimension: Existing and additional relationships

The Legal Dimension is involved in the following relationships:

{(P1V1), (P3V3), (P5V1), (P5V2), (P5V3), (P7V1), (P7V2), (P7V3), (P8V1), (P8V2), (P8V3), (P9V1), (P9V2), (P9V3), (P10V1), (P10V2), (P10V3)}

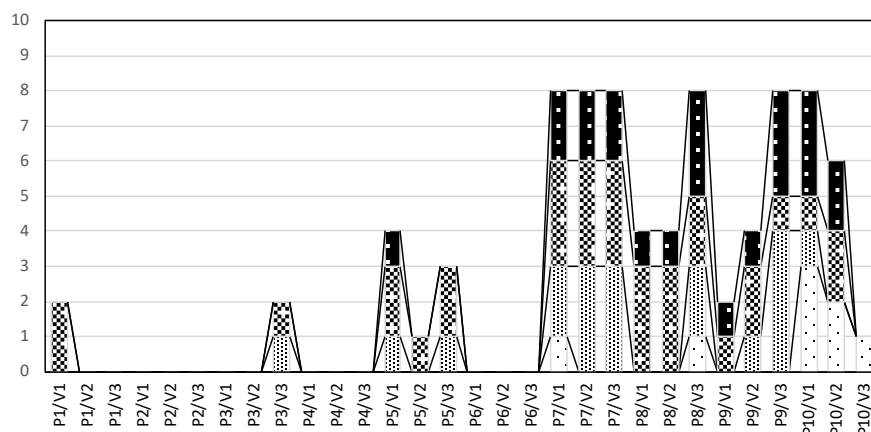


Figure 6: Profile of the Importance placed by the Experts on the Legal Dimension

Unlike the previously mentioned dimensions for this evaluation analysis, the Legal dimension is not, apparently, a central concept in the responses of the SPI Manifesto experts. That having been said, one should emphasize that it is only concluded by considering and observing the overall illustration of the collective data generated by the SPI experts for the purposes of this research study. In a more analytical manner of reference all the following seventeen (17) pairs of SPI Manifesto Principles and Values are inter-related and inter-acting, up to some degree, regarding the Legal dimension of the STEEPLD multidimensional analysis framework: (P1V1), (P3V3), (P5V1), (P5V2), (P5V3), (P7V1), (P7V2), (P7V3), (P8V1), (P8V2), (P8V3), (P9V1), (P9V2), (P9V3), (P10V1), (P10V2), (P10V3). Selectively though, the highly influential from all of them are the following six: (P3V3), (P5V1), (P5V2), (P5V3), (P8V1), (P8V2).

Although in the particular evaluation construct there is a number of scattered existing relationships between a number of SPI Manifesto Principles and Values, in reality there are only six notable relationships involving only three SPI Manifesto Principles (P3, P5 and P8), which equally influence all the three Values, that are People, Business and Change, of the SPI Manifesto. Therefore, the SPI experts, reflecting on their experience and knowledge, consider that in regard to the Legal dimension, People, Business and Change are highly influenced by the SPI principles and practices of P3: basing improvement on experience and measurements, P5: supporting the organisation's vision and objectives and P8: managing the organisational change in improvement effort. These findings clearly indicate that the Legal considerations in the software development process should be considered (perhaps along with the Ethical and/or Political) as an integral and of vital significance part or as a new layer of a future update of the SPI Manifesto.

#### 4.8 Ethical Dimension: Existing and additional relationships

The Ethical Dimension is involved in the following relationships:

{(P1V1), (P1V2), (P1V3), (P2V1), (P2V2), (P2V3), (P4V1), (P4V2), (P4V3), (P5V1), (P5V2), (P5V3), (P6V2), (P7V1), (P7V2), (P7V3), (P8V1), (P8V2), (P8V3), (P9V1), (P9V2), (P9V3), (P10V1), (P10V2), (P10V3)}

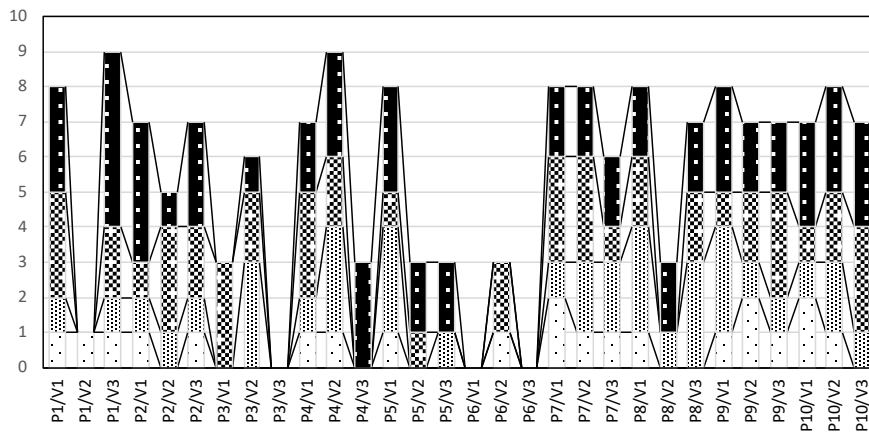


Figure 7: Profile of the Importance placed by the Experts on the Ethical Dimension

Eight (8) out of the 25 relationships involving the ethical dimension had already been identified. The experts' opinion therefore shows seventeen (17) new relationships as relevant. This means that the Manifesto should be extended to include at least the most significant relationships in its updated version. The most significant scores involve (P1V1) where 43% of those responding consider it of VH importance and 28.5% consider it of high importance. Similarly, (P4V3) 37.5% consider it of VH importance and 12.5% of H importance. Interestingly (P10V3) was 37.5% scored as VH, 25% scored as H. At the other end (P6V2), i.e. P6: Use dynamic and adaptable models as needed and V2: Business, scored as M (Medium) by 25% - no other

scored was recorded. The profile overall shows a wide spread of scores and it involves many relationships. We can conclude that the experts are aware of ethical issues and therefore the Manifesto should explicitly be enriched with the addition of the at least the most important ones according to the experts. As mentioned in section 4 the Legal, Political and Ethical dimensions could perhaps be clustered together thus simplifying any future analysis.

#### 4.9 Demographic Dimension: Existing and additional relationships

The Demographic Dimension is involved in the following relationships:

{(P1V1), (P1V2), (P1V3), (P2V1), (P2V2), (P2V3), (P3V1), (P3V2), (P3V3), (P4V1), (P4V2), (P4V3), (P5V1), (P5V2), (P5V3), (P6V1), (P6V2), (P6V3), (P7V1), (P7V2), (P7V3), (P8V1), (P8V2), (P8V3), (P9V1), (P9V2), (P9V3), (P10V1), (P10V2), (P10V3)};

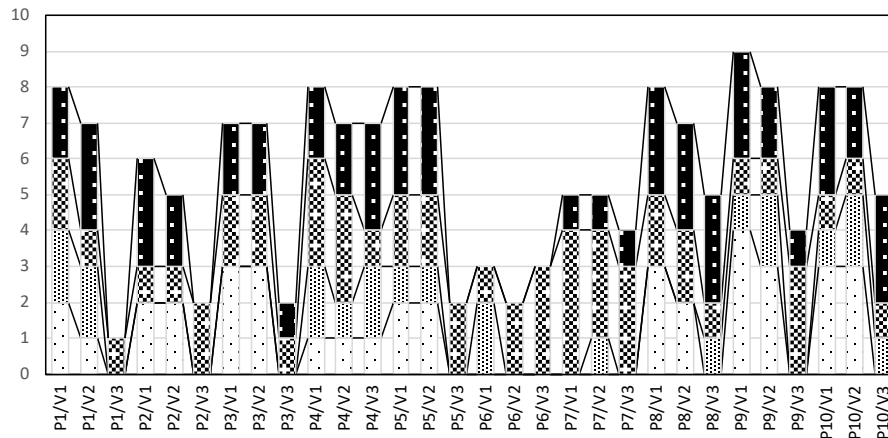


Figure 8: Profile of the Importance placed by the Experts on the Demographic Dimension

The responses for the Demographic Dimension were as follows. All the Change Values identified in the Manifesto were also identified as important by the experts with the partial exception of Principle 10, “Do not lose focus”, thus confirming the view that successful change could not be achieved without considering the Demographic Dimension. The only Low values were found related to the People and the Business values, although these were easily outnumbered by the other positive scores. The three proposed new relationships all received High and Very High rating for P7: “Apply risk management”, indicating that the Demographic Dimension for all the three Values should be considered. The other new Change Values of P3: “Base improvements ...” and P8: “Managing the organizational change ...” were also similarly rated as important, also the final proposed Change Value of P10: “Do not lose focus” had no Low ratings.

## 5 Extending the Existing SPI Manifesto

### 5.1 Modifications and Additions

Findings and proposals from earlier research by the authors [9-11, 46] together with the results of the expert validation of the STEEPLED Analysis of the SPI Manifesto are combined in the following proposals:

Value 3: Change is currently described as “Is inherently linked with change”. The authors propose that this Value can be expressed as “Enable continuous improvement through adaptability” in order to avoid the current tautology, and also to emphasize the importance of awareness and responsiveness to change.

**Table 2.** Proposed Structure of the SPI Manifesto

	VALUES			
	<i>V1: Stakeholders</i>	V2: Business	V3: Change	<i>V4: Society/Public Interest</i>
<b>PRINCIPLES</b>	Must involve people actively and affect their daily activities	Make business successful	<i>Enable continuous improvement through adaptability</i>	<i>Exercise Social Responsibility for societal benefit</i>
P1. Know the culture and focus on needs	Sociocultural [S] Ethical [Et] Demographic [D]	Political [P] Economic [E] Sociocultural [S] Demographic [D]	Ethical [Et] Political [P] Economic [E] Sociocultural [S] Demographic [D]	<i>Economic [E] Political [P] Ethical [Et] Demographic [D]</i>
P2. Motivate all people involved	Sociocultural [S] Ethical [Et] Environmental [En] Economic [E] Demographic [D]	Economic [E] Demographic [D]	Sociocultural [S] Ethical [Et]	<i>Economic [E] Political [P] Ethical [Et]</i>
P3. Base improvement on experience and measurements	Economic [E] Political [P] Sociocultural [S] Demographic [D]	Economic [E] Demographic [D]	Technical [T] Economic [E]	<i>Economic [E] Demographic [D]</i>

	VALUES			
	<i>V1. Stakeholders</i>	V2. Business	V3: Change	<i>V4: Society/Public Interest</i>
<b>PRINCIPLES</b>	Must involve people actively and affect their daily activities	Make business successful	<i>Enable continuous improvement through adaptability</i>	<i>Exercise Social Responsibility for societal benefit</i>
P4. Create a learning organisation	Sociocultural [S] Ethical [Et] Economic [E] Technical [T] Demographic [D]	Economic [E] Sociocultural [S] Demographic [D]	Sociocultural [S] Demographic [D] Technical [T]	<i>Sociocultural [S] Ethical [Et] Economic [E] Demographic [D]</i>
P5. Support the organisation's vision and objectives	Ethical [Et] Sociocultural [S] Demographic [D]	Political [P] Economic [E] Demographic [D]	Sociocultural [S] Political [P]	<i>Ethical [Et] Economic [E] Technical [T] Demographic [D]</i>
P6. Use dynamic and adaptable models as needed	Technical [T] Economic [E]	Technical [T] Environmental [En]	Technical [T] Environmental [En]	<i>Economic [E] Legal [L]</i>
P7. Apply risk management	Economic [E] Legal [L] Ethical [Et]	Technical [T] Political [P] Ethical [Et] Legal [L]	Technical [T] Political [P] Ethical [Et] Legal [L]	<i>Technical [T] Political [P] Ethical [Et] Legal [L]</i>
P8. Manage the organisational change in your improvement effort	Ethical [Et] Demographic [D]	Technical [T] Economic [E] Demographic [D]	Political [P] Sociocultural [S] Ethical [Et] Environmental [En] Legal [L] Economic [E]	<i>Political [P] Ethical [Et] Legal [L] Economic [E]</i>
P9. Ensure all parties understand and agree on process	Demographic [D] Sociocultural [S] Ethical [Et]	Demographic [D] Political [P] Sociocultural [S] Ethical [Et]	Political [P] Sociocultural [S] Ethical [Et] Environmental [En] Legal [L] Economic [E]	<i>Sociocultural [S] Ethical [Et] Environmental [En] Legal [L] Economic [E]</i>
P10. Do not lose focus	Demographic [D] Legal [L] Ethical [E]	Demographic [D] Legal [L] Ethical [Et]	Political [P] Ethical [E] Sociocultural [S]	<i>Ethical [Et] Economic [E]</i>
<i>P11. Ensure personal behavior adheres to morality, ethics and professionalism</i>	<i>Sociocultural [S] Ethical [Et] Demographic [D]</i>	<i>Economic [E] Technical [T]</i>	<i>Sociocultural [S] Ethical [Et] Demographic [D]</i>	

VALUES				
	<i>V1. Stakeholders</i>	V2. Business	V3: Change	<i>V4: Society/Public Interest</i>
PRINCIPLES	Must involve people actively and affect their daily activities	Make business successful	<i>Enable continuous improvement through adaptability</i>	<i>Exercise Social Responsibility for societal benefit</i>
<i>P12. Comply with legislation</i>	<i>Economic [E] Political [P] Sociocultural [S] Demographic [D] Legal [L]</i>	<i>Economic [E] Political [P] Technical [T] Legal [L]</i>	<i>Technical [T] Economic [E] Legal [L]</i>	<i>Technical [T] Economic [E] Legal [L]</i>

In [46] the authors suggested that a fourth Value, called Society (public interest), be introduced to the SPI manifesto and that the existing Value of People (i.e., all those involved in the production, support and use) be renamed Clients or Stakeholders in order to make the distinction between the duty to people within an organization and people in the wider society. Valuing people means all people involved in the production, support, and use of the system.

Although these are implied in the Manifesto's three values and ten principles, there needs to be a much more unequivocal statement with regards to how ethics, law and professionalism must govern personal behavior in relation to Software Process Improvement work. In [9] the authors proposed that an 11th principle should be appended to the SPI Manifesto. This principle should cut across all SPI values in order to imbue them with the six moral and ethical concepts. In doing so, SPI activities such as: Determining Business Needs; Conducting Process Improvement Assessment; the Tailoring and Creation of Processes; Deployment; etc., which all relate to one or a number of the existing ten principles can become sensitized to ethical obligations and rights. Thus a 12th principle: Comply with Legislation could be appended to the SPI Manifesto [46].

The results of previous research [9-11] as well as the results of the Expert Validation reported in this paper creating proposals for adaptation, evolution and update of the SPI Manifesto are shown in Table 2.

## 5.2 SPI Manifesto Assessment and Coaching Tools

This new concept described in the paper opens a door for top management SPI consultancy and guidance. The partner ISCN plans to configure the above method into an ISO 33020 compliant assessment of SPI Manifesto implementation using an N/P/L/F and capability level scale and the criteria explained in Table 2 above.

Example process and an example practice to be rated:

**Process / Principle: P1. Know the culture and focus on needs.**

**Practice P1.BP1** Consider the aspects of Sociocultural [S] , Ethical [Et], Demographic [D] in P1 when implementing “Value 1: Must involve people actively and affect their daily activities”.

Assessors will rate this practice and if they feel anything is missing will document a finding. Like in a standard ISO 33020 assessment tool an assessment report will be generated.

For ratings lower than F an action will be defined.

Also the capability levels of ISO 33020 will be implemented. The model still needs to be elaborated for higher capability levels. For example. on level 2, possible metrics for “P1. Know the culture and focus on needs” are:

Sociocultural [S]

... acceptance rate of SPI by people anonymously measured

Ethical [Et]

... business ethics and review of application annually

Environmental [En]

... growth in multidisciplinary, multi-competent, multi-technology empowered teams structures

Economic [E]

... growth rate in terms of business in the area where SPI Manifesto is applied

Demographic [D]

... inclusion rate for teams integrating different experience levels, age, and gender Etc.

As in SPICE assessments, organizations can come up with targets and trends and the assessor will rate what targets are there, are tracked and corrective actions are done at level 2.

## 6 Conclusion

### 6.1 The research questions answered

All four research questions were answered. Does the structure of the SPI Manifesto reflect the correct relationships between the original three Values and ten Principles? The answer to this question is that adaptations are necessary to reflect changes in terms of all the eight (8) STEEPLD dimensions.

What are the relationships ( $P_i, V_j$ ) between Principles and Values? (where  $P_i = 1, 2, \dots, 10$  and  $V_j = 1, 2$  or  $3$ ). Are there any additional relationships (or blank relationships in the matrix) and why should they be added? The answers to these two questions can be seen in section 4 where all tuples (relationships) are listed as a set with all new tuples highlighted.

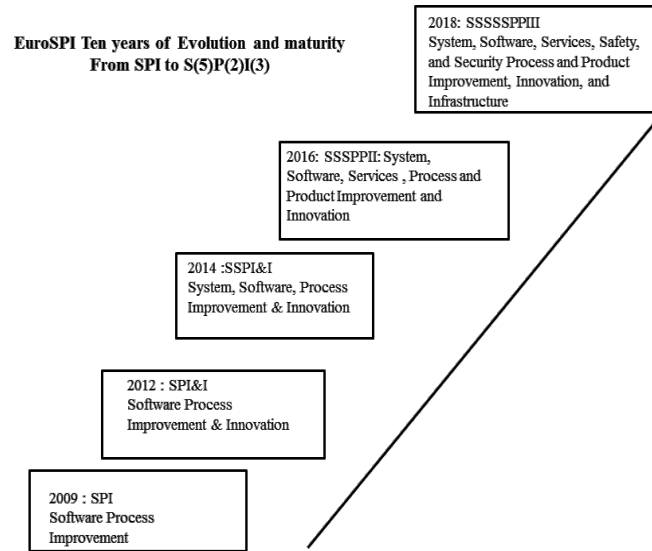


Figure 9: The Evolution and Maturity from SPI to S(5), P(2), I(3) [10]

Which of the STEEPLED dimensions are encapsulated in each  $(P_i, V_j)$  and to what degree (on the Likert scale Very High, High, Medium, Low) ? This question was by far the most challenging. The expert validation provided us with the qualitative responses which we converted to a quantitative equivalent using the frequencies of each answer (weighted averages) in order to rank each relationship. In essence all relationships are important with some being more important than others. Thus, in using this type of analysis it will be possible to focus the improvement effort on issues relating to the implementation of strategies and processes in practice.

The multidisciplinary, holistic and multidimensional approach we followed enabled the identification of patterns, subsystems, components and factors as well as their interconnections.

Further work is planned starting with a longitudinal study (over 5 years in retrospect) by involving the EuroSPI community (especially the delegates to the EuroSPI, and EurAsiaSPI.. Capturing and analyzing the opinions and suggestions we will contribute to the debate on the review of the SPI Manifesto. Based on the evolution and maturity growth (shown in Figure 9) of the conference itself [10], we will focus on the experiences and innovations achieved since the birth of the SPI Manifesto. In order to achieve this aim, we need to develop automated tools starting with a preliminary self-assessment pilot tool as a preamble to a formal, professional assessment in the field.

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