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The sociocultural dimension of the Software Process Improvement Manifesto: Pilot validation by experts

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Abstract

The Software Process Improvement (SPI) Manifesto is based on three basic values: people, business focus and organisational change underpinning the philosophy of SPI. In turn, these values bring up to date certain SPI principles serving as a foundation for action in software development. The authors of this paper carried out a pilot expert validation of the sociocultural dimension of the sociocultural, technical, economic, environmental, political, legal, ethical and demographic analysis of the SPI Manifesto. Further, the authors report on the rationale and results of the pilot validation of both the survey instrument and the qualitative responses generated by the field experts, targeting to enlighten and reinforce the importance of the sociocultural dimension of the SPI Manifesto in research and development. The related literature review findings and the pilot research study strengthen this target. The pilot study with experts in particular provided stronger indications that the sociocultural dimension is considered of high importance by between 62% and 88% of the respondents, who were IT and computing professionals and software practitioners from academia and industry.

KEYWORDS

expert validation, principles, sociocultural, SPI Manifesto, STEEPLED, values

1 | INTRODUCTION

As detailed in Georgiadou et al.,[1] two manifestos were issued by expert groups of software engineers (academics and software practitioners in both cases), namely, the Agile Manifesto (AM)[2] in 2001 and the Software Process Improvement (SPI) Manifesto[3] in 2009, both of which aim to increase the quality of the software process and enhance the attitudes of software engineers and organisational culture and development practices, as these are the prerequisites for improving the quality of the resulting software products.

In that context, the next section highlights the strengths and summarises the evolving and restructuring nature of SPI Manifesto.

1.1 | Manifestos in software quality engineering: Evolutionary or revolutionary?

Twenty years after the launch of the AM and 10 years after the launch of the SPI Manifesto, a wealth of practice and criticisms abound. Nonetheless, critical proponents of the traditional and agile software development paradigms in research and practice had put on alert and tipped off

regular practices encouraged by both AM and SPI Manifesto, even earlier. More recently, in 2019, Georgiadou et al.[1] compared and contrasted the AM and SPI Manifesto in the context of the sociocultural, technical, economic, environmental, political, legal, ethical and demographic (STEEPLED) framework analysis. Earlier, starting in 2005, the principles and values of these two paradigms had been combined in various research and development projects[4,5] that focused on different aspects of the software process such as software quality,[5–8] process formality and process agility[4,9] as well as software quality deployment with scaled agility-in the-large, more recently.[10] Putting in the picture and bringing up to date the ameliorating nature of the values and principles that formed the basis of the two manifestos also fortified the need to find more on the sociocultural dimension and, thus, form the rationale to underpin this study.

Research studies on the subject proliferate and vary in focus, fortifying different sociocultural and organisational management aspects. Even so, based on previous and two more recent systematic reviews,[11,12] our motivation has been to further expose and consider research findings and analyses and contribute to the debate of the SPI Manifesto and AM in industrial research and practice.

Since the first European Software Process Improvement (EuroSPI) conference, which was held in Dublin in 1993, the main networking forum was formed enabling a continuous exchange of SPI knowledge and experience between industry and research in Europe and internationally. Messnarz et al.[13] stated that 'From each conference, ideas were created, and a pool of experiences has been set up and made available in an online library'.

During the 27 years that followed, the EuroSPI conference has evolved into System, Software Process Improvement and Innovation to System, Software, Services, Process and Product Improvement and Innovation, and later on, the notions of Safety, Security, and Infrastructure were included in Korsaa et al.[14] The most recent interpretation of SPI is as follows: System, Software, Services, Safety and Security Process and Product Improvement, Innovation and Infrastructure. Thus, SPI has evolved to $\mathbf{S^5P^2I^3}$ reflecting evolving and maturing practices, and application research in the software engineering domains.

1.2 | Complexity and multidimensionality of software systems, the software process and SPI

Software-based systems and products increasingly appear in people's daily activities and social interactions. The dynamic, complicated and complex nature of such operations can result in a multiplicity of often conflicting factors that are difficult to accommodate in the software design process and the resulting products or services. Projects, and large projects in particular, are complex, nonlinear systems with many interrelated subsystems and factors with profound impact on decision making on the stakeholders and the organisation at large.

Further, many traditional and agile methodological paradigms have been appraised regarding their different emphasis and essential quality features[15,16] of the software process they support.

As pointed out by many researchers from as far back as the 80s and 90s, software development is fundamentally a human activity with many interacting elements. Kast and Rosenzweig[17] were able to study human relations and identify various dimensions, namely, technical, structural, psychosocial and managerial, environmental goals and values.

Checkland[18] developed the Soft Systems Method based on systems theory. General systems theory and decomposing systems into subsystems enhances understanding and enables the controlling of complexity. Soft Systems Method uses the CATWOE analysis (customers, actors, transformation, weltanschauung, ownership, environment). Accommodating different weltanschauungen (perspectives, viewpoints, worldviews) engendered the philosophy of making sense, understanding and resolving conflict.

As software systems and software development projects were regularly failing, software engineers concentrated their reactive and corrective rather than proactive and preventive maintenance actions on the software artefacts. Kaposi and Pyle[19] observed that systems are not only software and recognised that a holistic approach would be necessary in order to achieve faster and better progress in quality improvement.

Checkland[20] reflected in his retrospective that the relevance of SMM in managing complexity holds, but he proposed 'new appreciative settings' using the example of radical changes in the very large and complex UK National Health Service, which was 'explored with participants who engaged in debate via models of notional systems to enact the new requirements of the purchaser and provider roles'.

Fuggetta[21] concluded that one must always remember that software development 'is carried out by teams of people involved in a highly creative activity. It is, indeed, a human-centered process as many other engineering and design processes in our society'. The complexity of interactions intensifies the possibility of misunderstandings, conflicts and errors.

More recently, Clarke et al.[22] in 2016 examined both the complexity of the software process and the complexity of software development situational contexts from the complexity theory perspective. They observed that the area of situational complexity has not received adequate attention. Referring to their situational factors framework, Clarke and O'Connor[23] in 2012 identified '44 individual factors affecting software development projects, which are further broken out into 170 sub-factors'. These numbers alone clearly show the complexity and multidimensionality of software systems and the software process. Mens[24] advocated that software complexity is poorly understood and advised that interdisciplinary research is needed 'where complexity similarity comes into play: economics, management, systems engineering, sociology, ecology, network theory, information theory, chemistry, and so on'. Understanding the complexity of information and software-based systems and the

associated software development process reveals the different dimensions involved through the emergent properties of the systems components and their subprocesses.

The authors adopted this holistic (systemic) approach in their ongoing research.[5–8,10,25,26] In 2019, the authors carried out a STEEPLED analysis of the SPI Manifesto.[27] Software projects, and large projects in particular, are complex, nonlinear systems with many interrelated subsystems and factors with profound impact on decision making on the stakeholders and the organisation at large.

In order to improve the software development process and, hence, improve the resulting software service and product, it is necessary and essential to capture and understand well the Sociocultural and other contexts (e.g., national and organisational) in which the software is developed and the context in which it will be used as a final product. This need has been proved to be of paramount importance worldwide as the next section exposes with reference to some research studies in different national and organisational contexts.

1.3 | SPI and the sociocultural impact

The initial STEEPLED study and analysis of the SPI Manifesto principles aimed at understanding the software process as it is used within organisations and the software industry.[27–29] The research study resulting in this paper extends our prior SPI research analysis by focusing exclusively on sociocultural factors within SPI through exposing the opinions of software quality experts and practitioners and comparing and contrasting those with other research findings on the sociocultural dimension.

1.3.1 | Focusing on the sociocultural dimension

Recently, a number of researchers such as Yogi et al.[30] have conducted studies to explore various sociocultural factors combined with other software quality-related issues and investigate the social structure of software development activities that could, in the short or long run, affect a software project. New approaches for studying the software process effectiveness and developers' productivity, along with usability and security properties demonstrated for instance in the software developers' specifications, have argued for an increase in software quality and software process improvement in particular. For example, games are a special kind of social interaction, which can easily highlight the sociocultural activities or software development engagements that lead to a variety of measurable outcomes.[31,32]

Over the last decade, due to the digital transformation era, social games have reshaped the methods of sociocultural communication.[31,32] Accordingly, communication and collaboration with the help of a variety of groupware, peopleware and social media tools have been used as simulation platforms to perform tests on phishing-resistant systems with design quality criteria and bring along awareness of cross-cultural and gender issues when exploring the knowledge, skills and attitudes of people and information systems stakeholders.[33,34]These and other implicit sociocultural dimensions have gained popularity and have started to become an emerging subject in research and practice among software development teams worldwide for improving the software development processes.

In their 2003 research study, Beecham et al.[3] discussed the problems that were experienced by people in 12 software development companies. In total, they presented qualitative data collected from 45 focus groups that involved over 200 software staff. They looked at how different practitioner groups responded to software process improvement problems. They demonstrated their classification and the analysis of their findings using correspondence analysis, which is a graphical data representation method new to software development research. They aimed at presenting the problems practitioners are experiencing in their attempts to improve software processes. Their main finding is that there is an association between a company's capability maturity and patterns of reported problems, stating the following: 'Organizational problems are more associated with high maturity companies than with low maturity companies. Low maturity companies are closely linked to problems relating directly to projects such as documentation, timescales, tools and technology'. Their findings also confirm differences in practitioner group problems, which, however, can also be considered of a sociocultural nature. For example, senior managers cite problems with goals, culture and politics, whereas project managers are concerned with timescales, change management, budgets and estimates. Furthermore, developers experience problems with requirements, testing, documentation, communication, tools and technology.

Similarly, in their continuous research studies focusing on SPI, Wong and Hasan[36] observe that adopting the SPI initiative and realising it successfully in a software organisation is possibly the most challenging issue that the software industry faces today. According to them, it is even more challenging to implement SPI in software organisations of developing countries like Bangladesh because of the differences in norms and values of the national culture and organisational culture as compared with those of European and Western countries. A study of 10 top software companies in Bangladesh was conducted to investigate whether cultural factors hindered the process improvement programme and whether this hindrance led to deterioration of the business goals. The results showed that the lack of cultural awareness and lack of skills from the management perspective acted as barriers during the implementation of SPI programmes and so affected the business goals sought by these organisations.

Having examined a number of potentially suitable research methodologies, Coleman and O'Connor[37] borrowed grounded theory from social science and cultural anthropology to use as the most suitable approach to determine what was happening in actual practice in relation to software process and SPI, using the indigenous Irish software product industry as a test bed. The outcome of this study was a theory, grounded in the field data, that explains when and why SPI is undertaken by the software industry. The objective of this paper[37] was to describe both the selection and usage of grounded theory to investigate the human, social and organisational aspects in this study and evaluate its effectiveness as a research methodology for software process improvement researchers.

At an earlier stage, Sommerville and Rodden[38] discussed a number of social, organisational and cultural issues to be considered when introducing software process (improvement) technology. They confirm that addressing these 'soft' issues is critical if a software process technology for improvement is to be successfully used. They conclude that the developers of process technology should bear the following in mind: 'It is probably impossible to convince all members of an organization who are involved in software development that they should follow a single process model. Professionals will always want (rightly, in our view) to demonstrate their professionalism and this means that they will have their own views on the software process'. Concluding, they state that there is a need for more research into the human and organisational problems, which arise when process technology is introduced into an organisation. The quantitative, process measurement approach suggested by process improvement models needs to be supplemented by qualitative studies which focus on the people involved in the process.

Another view was expressed by Breske and Schweigert,[28] who showed a new view on SPI, from the perspective of organisational research. It was argued that in order to understand process improvement, it was imperative to look at the core discipline of which process improvement was a part: the theory of organisations.

Marvin Weisbond[29] was identified as an early influencer, whose paradigm helped define the evolution of organisations and the empowerment of people. Their analysis shows how the AM and SPI Manifesto fit into trends of organisational change management. The particular analysis also provides a very simple understanding of process quality, summarised herein: There is a need for SPI management skills and a consensus that there should be formal SPI-related roles in SPI projects. Formal education for SPI managers is needed to make sure that SPI leads to success and not to frustration.

In 2016, Khan and Keung[39] conducted a systematic review to identify success factors and barriers for SPI in global software development. They identified nine success factors, namely, management commitment, staff involvement, allocated resources, pilot projects, setting SPI goals, team training, information sharing, strong relationship and SPI awareness. They also identified six barriers, namely, lack of resources, inexperience staff, organisational politics, time pressure, staff turnover and lack of formal SPI implementation methodology.

In 2017, Zahra et al.[40] conducted another systematic review, which revealed the stakeholders and their respective roles. In particular, they found five important organisational factors, for example, management support, user involvement and people skills, which can bring about success. Additionally, they identified and emphasised six failure factors: 'lack of project management, abundant resources, knowledge, skills, SPI awareness and inexperience'. Regarding SPI implementation, they identified seven crucial factors, namely, domain knowledge, staff involvement, people skills, project manager's personality, team leader support, management support and user involvement.

In addition, Niazi et al.[41] in their empirical study identified related and similarly expressed seven critical factors (higher management support, training, awareness, allocation of resources, staff involvement, experienced staff and defined SPI implementation methodology) that are generally considered critical for successfully implementing SPI. They also confirmed, through the literature, the factors considered imperative for the successful implementation of SPI programs.

Niazi et al.[42] also identified (from the literature) five barriers to the success of SPI initiatives. Using a three-point scale (high, medium and low), the respondents (practitioners) from Vietnam and from Australia ranked the importance (according to their perception) of each barrier. The ranking produced by the two groups of practitioners had some similarities and some differences. Lack of support was the most common barrier by both groups. Lack of resources was perceived as highly important.

These two systematic reviews concretised SPI research in identifying success factors and barriers experienced by the industry and documented in the research publications. Apparently, this crystallised knowledge and experience enhance understanding of the issues and offer guidelines to software development organisations in their efforts to improve their software process quality and as a result to improve their software products and services. The above reports in the literature on the impact of sociocultural factors on SPI motivated us to carry out a pilot validation by software engineers and practitioners from academia and industry, in order to determine and establish the degree of importance of one of the STEEPLED dimensions, namely, the sociocultural dimension of the SPI Manifesto.

2 | STEEPLED ANALYSIS OF THE SPI MANIFESTO

In their 2019 study,[27] the authors focused on the SPI Manifesto and carried out a STEEPLED analysis of its values and principles. The STEEPLED analysis aimed to contribute to the current effort to revisit, review and update the SPI Manifesto.

TABLE 1 Current structure of the SPI Manifesto[27]

	Values		
Principles	**People**	**Business**	**Change**
1. Know the culture and focus on needs	X		
2. Motivate all people involved	X		
3. Base improvement on experience and measurements	X		
4. Create a learning organisation	X		
5. Support the organisation's vision and business objectives		X	
6. Use dynamic and adaptable models as needed		X	
7. Apply risk management		X	
8. Manage the organisational change in your improvement effort			X
9. Ensure all parties understand and agree on process			X
10. Do not lose focus			X

TABLE 2 Relationships of principles and values[27]

	Values		
SPI principles	**People**	**Business**	**Change**
1. Know the culture and focus on needs	X	I	I
2. Motivate all people involved	X	I	I
3. Base improvement on experience and measurements	X	I	I
4. Create a learning organisation	X	I	I
5. Support the organisation's vision and business objectives	I	X	I
6. Use dynamic and adaptable models as needed		X	I
7. Apply risk management	I	X	I
8. Manage the organisational change in your improvement effort	I	I	X
9. Ensure all parties understand and agree on process	I	I	X
10. Do not lose focus		I	X

Note: X = involves respective principle; I = influences respective value.

2.1 | Mapping values to principles

Georgiadou et al.[27] challenged the initial segregation whereby each of the 10 principles maps to one specific value producing the architecture of the SPI Manifesto we showed in Table 1. We maintain that such segregation is misleading. For example: Principle 8, *Manage the organisational change in your improvement effort*, ought to involve all three values, namely, people, business and change. Also, Principle 1 involves the people value, and Principle 4 involves the people value. The authors showed that these principles also involve the business value and the organisational change value[27] as shown in Table 2.

2.2 | STEEPLED internal and external factors

The internal and external factors, presented in Table 3, of the eight dimensions of STEEPLED were identified and their possible effects were illustrated by applying the STEEPLED analysis to the segregation case study.[27]

In view of the recent coronavirus pandemic, we have now reflected on the societal effects and updated Table 3 by introducing globalisation and epidemic/pandemic diseases.

In addition to the direct impact of a pandemic in terms of deaths, Evans[43] pointed out the indirect consequences of the pandemic such as lost productivity and economic implications, which 'are detrimental not only to public health systems but to trade and travel, food and agriculture industries, various market types and retail chains'. Thus, a health crisis has sociocultural, economic, ethical, legal and demographic dimensions too. As a result, Evans suggests remedy policies through 'proactive management approaches, health policy framework addressing many of the social determinants of health, education and health literacy, national and international shifts in investments, public and private partnerships'.

TABLE 3 STEEPLED dimensions, external and internal factors (extended from Georgiadou et al.[27])

STEEPLED dimension	External factors (national & international)	Internal factors (organisational)
Sociocultural (S)	Population growth, demographics, age distribution, career attitudes, power distance, norms, globalisation, epidemic and pandemic disease	Empowerment, career progression, bias & unconscious bias, experience, skills, knowledge sharing, multicultural teams, social responsibility
Technical (T)	Automation, rate of change, upgrades, outsourcing, R&D, innovation	Knowhow, skills, types of projects (size, complexity), experience, training, equipment, development methods, lack of skills (millennium bug)
Economic (E)	Economic growth, interest rates, inflation, living standards and income level, competition, globalisation, epidemic and pandemic disease	Resources, salaries, purchases, income, pension schemes, policy on overtime
Environmental (En)	Climate change, ecology, epidemic and pandemic disease	Ergonomics, health and safety
Political (P)	Labour law, trade restrictions, sanctions, impact on health & safety, impact on education, unemployment	Organisational structure (power distance), rivalries, nepotism, shortage of staff
Legal (L)	Regulations, Laws: Employment, consumer, health and safety, discrimination, epidemic and pandemic disease	Intellectual property, commercial confidentiality (non-disclosure agreements), whistleblowing
Ethical (Et)	Ethical rules, moral rights, codes of conduct, health and safety, social responsibility, epidemic and pandemic disease	Internal adherence to ethical rules, codes of conduct, training, awareness, social responsibility, wellbeing, bias
Demographic (D)	International upheaval (wars, national disasters, movement of people, immigration/emigration, brain drain), epidemic and pandemic disease	Loss of organisational tacit knowledge, shortage of technical skills

Having completed a STEEPLED analysis of the SPI Manifesto,[27] we continued to identify the multifaceted interconnections. This analysis contributes to the ongoing effort of the software engineering community to improve the quality of the software development process and the quality of software products and services. Additionally, this study contributes to the current debate and effort of the SPI experts to review and revise the SPI Manifesto.

3 | A PILOT STUDY WITH FIELD EXPERTS

3.1 | STEEPLED analysis and SPI

The aim of a STEEPLED analysis is to help organisations understand the rich contextual situation in which they are operating. Earlier versions of this type of analysis (such as PEST and PESTEL) used this multidimensional approach in order to organise and deepen the understanding of the various factors and issues involved thus aiding strategic planning. STEEPLED analysis has been used successfully in large national and international projects such as those referred to by Kalous,[44] which relates to education and by Patil et al.[45] for a country-wide project in Bangladesh. The STEEPLED analysis of the SPI Manifesto[27] is a continuation of our ongoing research studies aiming to contribute to the community's effort to review and strengthen the SPI Manifesto.

3.2 | The STEEPLED dimensions

The sociocultural dimension in general deals with influences, inspirations, effects and impacts stemming from international, national, organisational and professional cultures. These are particularly important in today's globalised and interconnected working relationships with multicultural teams within the same or different organisations and across different countries.[25] The fast rate of technical changes brings many challenges in automation, security, training, innovation, global collaboration and research and development. The economic dimension affects the degree to which companies will invest in new infrastructure and expand by outsourcing, taking part in joint ventures or by hiring and training new staff through the creation of subsidiaries. The environmental dimension of an organisation considers issues such as global warming and ergonomics within the organisation. Political instability and disruption affect all industries, at large. Legal safeguards are inevitable for the organisation, the customer and the employees. However, even when companies are operating within the law, they may embark on unethical practices.[46] The ethical dimension helps decision makers reflect on and consider whether their actions are morally acceptable regardless of their legality. Finally, the demographic dimension needs to be taken into consideration because of local and global instability, immigration, emigration, brain drain of highly

trained and qualified people from a particular country, war and so forth, which can affect organisations and whole countries, resulting in lack or scarcity of suitable technical skills, as well as loss of tacit knowledge built up within the organisations. These useful insights provide bottom up identification and classification of the factors affecting the implementation and quality of SPI.

However, in this paper, we are concerned with a meta-level of SPI involving the fundamental principles and values encapsulated and supported by the SPI Manifesto and to a similar degree to the AM.

3.3 | Dimensions, external and internal factors

Each of the eight STEEPLED dimensions consists of both external and internal factors. The external factors are usually known and relevant to the whole industry at both national and international levels, whereas the internal factors are directly involved with the internal regulations and working practices.[27]

Due to the fact that today almost all human activity is supported by software systems and products that are affected in multiple ways by these internal and external factors, it is important to understand their systemic and dynamic nature and how they can improve the quality of the software development process and the resulting software product and services. For example, organisations find themselves operating in an ever-increasing globalised world. The task of developing and deploying software for enterprise systems that support supply chain management may well require the interconnection of a pipeline of companies, both upstream and downstream that all operate under their own internal/external factors within varying respective international environments.

The STEEPLED analysis technique is one way of increasing this understanding. It is important that an organisation understands the competitiveness of its business environment and identifies its strategy's potential profitability. Only when an organisation understands the forces in its environment or industry that can affect its profitability can the business be able to adjust its strategy accordingly and thus develop and deploy the appropriate software systems to enable the strategy's fruition. Porter[47] identified five forces that can make up the competitive environment and impact profitability.

These key sources of competitive pressure within an industry are incorporated in the external and internal factors that are listed in Table 3. Apart from the work of Georgiadou et al.,[27] which constitutes the backbone of this study, other sources included our own earlier research cited in this paper. The construction of Table 3 was enriched by insights gained from several systematic reviews such as Khan et al.[39] and Zahra et al.[40] as well as studies on failure factors and cross-cultural studies by Niazi et al.[41,42] In Georgiadou et al.,[27] we used a case study regarding Brexit to illustrate the internal and external factors of the eight STEEPLED dimensions and their possible effects on the case.

3.4 | STEEPLED: Dimensions and interactions

In Georgiadou et al.,[27] having identified the major external and internal factors for the SPI Manifesto regarding all eight dimensions, we further carried out a STEEPLED analysis, which showed that there are many more interconnections between the three values and the 10 principles of the SPI Manifesto than those shown in Table 2.

In contrast to Table 1, which associates each principle to only one of the three values, Table 2 shows these interconnections. For example, the sociocultural dimension is involved in all three values and in eight of the 10 principles. Similarly, the ethical dimension involves all three values and eight principles (not the same eight) highlighted in Table 2.

Our conviction is that the 10 principles of the SPI Manifesto need to be imbued with ethical duties and rights. Kallman and Grillo,[48] for example, present normative ethical principles that can be used as a guideline for respecting the duties and rights of all stakeholders and participants of the software development process.

Spinello[46,49] dealt with the relationship between law cybernetics and ethics and emphasises that there exist unjust laws that do not provide moral guidance. Because of this possibility, we consider that in a STEEPLED analysis for SPI, the values and principles not only adhere to legal rights and duties but also to ethical responsibilities and entitlements.

4 | RESEARCH METHODOLOGY

The research methodology was based on interpretivism as per Cornford and Smithson[50] combining qualitative and quantitative methods for deducing and interpreting data and facts in order to clarify and explain the significance of phenomena, situations and dimensions under research. In so doing, secondary data were collected from published papers (theoretical as well as case studies from industry). The primary data were obtained from the survey questionnaire with field experts. The software engineering research studies principles proposed by Pfleeger and Kitchenham[51] for constructing questionnaires were considered and used throughout the study. Hence, closed questions as well

as the opportunity to provide feedback in free text format were utilised. The target respondents were IT and computing specialists from academia and industry. The survey yielded data about their views, as advocated by Lethbridge,[52] and were used to draw inferences from these data regarding existing relationships and their perceived importance. According to Galliers,[53] 'The use of surveys permits a researcher to study more variables at one time than is typically possible in laboratory or field experiments, whilst data can be collected about real world environments'. The target respondents were information technology and information systems specialists and experts from academia and industry. The survey sought data about views of software engineers/practitioners. The quantitative analysis approach, as advocated by Lethbridge,[52] was used to draw inferences from the gathered data regarding existing relationships and their perceived by the respondents importance.

4.1 | Research design

Khan et al[39] as well as our own ongoing research, which identified the substantial failure factors, informed the construction of the research instrument—a questionnaire. The STEEPLED analysis of the SPI Manifesto carried out by Georgiadou et al.[27] shows that each cell involves several of the eight dimensions (see Table 4). Each principle involves one, two or all three values, and each relationship between a principle and a value involves a number of STEEPLED dimensions as can be seen in the questionnaire (see Appendix A), which was based on the STEEPLED analysis of the SPI Manifesto.[27]

There is a total of 30 relationships between the EuroSPI Manifesto's 10 principles and three values. The first three of the relationships (shown next) are expressed below, and they are also depicted in tabular form in the body of the questionnaire.

- The dimensions involved in the relationship of Principle 1 and value people are sociocultural, ethical and demographic.
- The dimensions involved in the relationship of Principle 1 and value business are political, economic, sociocultural and demographic.
- The dimension involved in the relationship of Principle 1 and value change is ethical.

Similarly, all the remaining 27 relationships are shown in the respective cells in the questionnaire. As can be seen, the sociocultural dimension forms part of 15 out of the 30 relationships. Similarly, all the remaining 27 relationships are shown in the respective cells in the questionnaire.

4.2 | Representation and analysis of the survey results focusing on the sociocultural dimension

The pilot validation aimed to elicit responses from the respondents on whether they agreed with our suggestion that the sociocultural dimension formed part of the shown relationships, and in the case they considered this dimension important, they then were asked to rank the importance. The respondents were asked to use a Likert scale of 1–4 to indicate the strength of the relationship of each principle and the respective value by entering in each cell: 1 for *Low*, 2 for *Medium*, 3 for *High* or 4 for *Very High*. Using an even number of choices ensures that respondents *do not sit on the fence*; that is, they do not tend to choose the entry in the middle.

A total of 30 software engineers/practitioners were contacted. Seventeen responses were received, five of which were responses from academics from the software engineering and information systems field, and 12 responses from software engineers/practitioners.

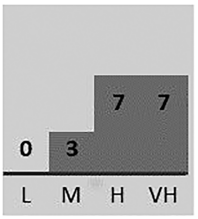
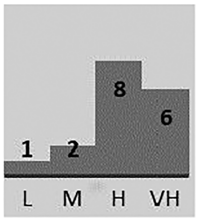
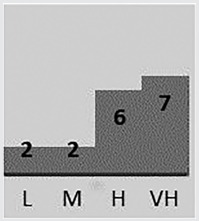
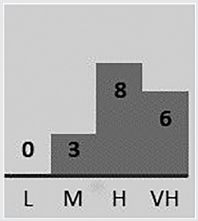
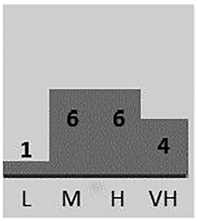
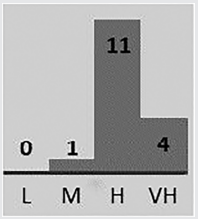
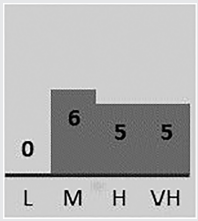
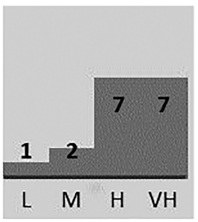
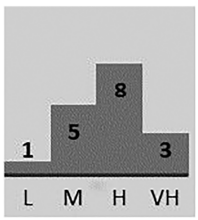
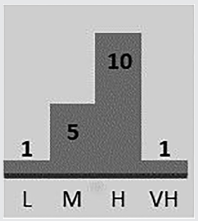
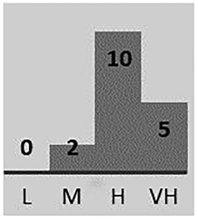
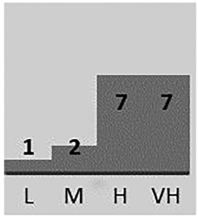
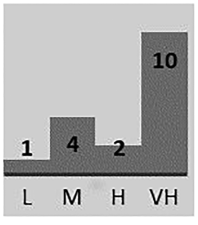
All the results are shown in Table 4 in the form of histograms. In every case, the degree of importance of the sociocultural dimension is considered to be either of high importance, of very high importance. These results, however, can only be considered as indicators because the sample size is small, but more importantly, the respondents did not provide us with demographic information—most probably because we prompted for contact details under the heading Optional. Nonetheless, at that stage of pilot validation, the demographic information was not considered to be of significance when we know that they are all field experts (software engineers/practitioners) and participated as respondents in a pilot study, providing us with their expert feedback for improving the next phases of the research study.

Grouping these two responses (H and VH), it can be seen that the sociocultural dimension is considered important by 62% to 88% of the respondents in our sample. These high scores are in line with our expectations, which were based on prior research.[1,4,5,27,35,38]

The first relationship between values and principles is (V1, P1), which involves three dimensions, namely, sociocultural, ethical and demographic as shown in Table 4. In the case of the sociocultural dimension, it can be seen that in order to understand the value of people, it is necessary to know their culture and to focus on their needs. The degree of importance of the sociocultural dimension was scored *High* or *Very High* by 82% of the respondents.

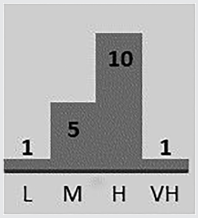
The second relationship (V2, P1) involves Principle 1 and value business. The dimensions of this relationship are political, economic, sociocultural and demographic. The degree of importance of the sociocultural dimension was scored *High* or *Very High* by 82% of the respondents. Similarly, relationship (V3, P1) involves Principle 1 and value change. Here, the dimension involved is ethical. The sociocultural dimension is NA (not applicable).

TABLE 4 Results of the validation of the importance of the sociocultural dimension

		Values		
	Principle (Pn)	**People**	**Business**	**Change**
P1	Know the culture and focus on needs			
P2	Motivate all people involved			
P3	Base improvement on experience and measurements			
P4	Create a learning organisation			
P5	Support the organisation's vision and objectives			
P6	Use dynamic and adaptable models as needed			
P7	Apply risk management			
P8	Manage the organisational change in your improvement effort			
P9	Ensure all parties understand and agree on process			

(Continues)

TABLE 4 (Continued)

		Values		
	Principle (Pn)	**People**	**Business**	**Change**
P10	Do not lose focus			

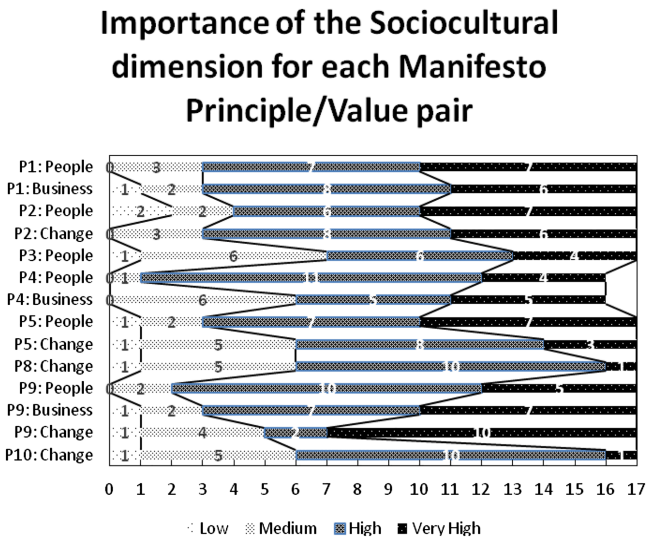


FIGURE 1 Distribution of the importance of the sociocultural dimension for each manifesto principle/value pair

All remaining 27 relationships are shown in the respective cells of Table 4. The results of the survey are shown in the form of histograms in each case. An alternative presentation of the results is shown in Figure 1 in the form of a stacked bar chart where the scores of *Low* (L) and *Medium* (M) together are juxtaposed with scores of *High* (H) and *Very High* (VH). In all cases, it can be seen that the sociocultural dimension is considered to be either of (i) high importance or (ii) very high importance in all cells (relationships). Taking these two responses (H and VH) as a group, it can be seen that the results of the survey show that the sociocultural dimension is considered important by 62% to 88% of the respondents in our sample.

Furthermore, in the case of Principle 9 (ensure all parties understand and agree on process), all three values are involved. For the people value, (as can be seen in Table 4) the sociocultural dimension's importance was considered *High* by 10 respondents, and *Very High* by five respondents. At the same time and regarding Principle 9 with respect to the value business, the reader can see that seven of the respondents considered the importance of the sociocultural dimension to be of high importance and another seven of very high importance. The (degree of the) importance of the sociocultural dimension with respect to Principle 9 and value change was considered by two respondents as *High* and by 10 respondents as *Very High*.

4.3 | Lessons learned from the pilot expert validation

Overall, the pilot validation was fruitful as during the process, the respondents who have been experts in their fields provided us with valuable feedback and further questions to ponder while designing the future professional validations. Further critical comments were raised and additional opinions prompted for reaction. For instance, one respondent presented the critical comment: 'I was unsure what exactly was asked of me', which means that a clearer formulation of the particular question for future use was/is necessary. Another respondent asked 'Why do you have more than one Dimension in each cell?', which indicates that it may not have been necessary to show all the possible dimensions in each cell because we were, at that particular time, only interested in collecting views about the sociocultural dimension. The cluttering of the table with all dimensions that we considered relevant somehow complicated matters.

There was an outlier response by one respondent who entered a value presumably relating to the sociocultural dimension although we had not identified it as an entry. This made us think that we should not predetermine possible answers nor bias the respondents by prompting them with the presence of particular dimensions, as it was demonstrated by that question in the questionnaire. The latter is true especially in cases where an open (or a carefully prepared with more available options) question could make the respondents ponder over and, thus, contemplate more relevant data to our study.

In the planned future validation of all eight STEEPLED dimensions, we will address these deficiencies that appeared from this first use of the designed questionnaire. We intend to consider field experts again and provide the potential sample of the respondents with eight separate pages—one for each of the eight STEEPLED dimensions. In order to avoid prejudicing the respondents, we intend to leave all cells blank so that the respondents (software engineers/practitioners) can enter their professional views and expert opinions about the importance of the dimension within the specific relationship (cell) upon reflecting on their professional knowledge and industrial experience. This research strategy may also result in the emergence of the dimension under scrutiny in other relationships (cells).

Regarding the pilot testing of our questionnaire we chose to conduct a field expert review first and not a cognitive/qualitative testing of the questionnaire. Both are valuable but different in pilot studies. Because expert review normally takes place first, we proceeded with that. An additional cognitive/qualitative testing of the questionnaire might be considered in the future based on the findings of Yan et al.,[54] which proposed ways of evaluating survey questions through a comparison of methods.

Naturally, it was not compulsory for all the respondents to answer all the questions. Notwithstanding, research data can/cannot be yielded/generated if there is no desire to answer nor sufficient understanding of the question, or further sufficient knowledge or experience in something. This is particularly true on pilot validation surveys. Leaving unanswered questions is something we might need to incorporate in the design of new (similar or different) questions for the actual future survey questionnaire. As researchers, we consider that such findings/observations accomplish the research purpose regarding data (and potential data) capturing and its validity.

Perhaps also cognitive testing of members of the expert population would then follow, after modifications of questions are made based on the experts' comments or their choice and right of not responding. In our pilot survey, this does not constitute a problem because we sampled an adequate and sufficient number of field experts. The issue of how many to test in a pilot survey is generally unsettled, depending on resources, complexity of the research instrument and the list can go on. In fact, it is almost common knowledge that a simple pretesting plan may involve no more than six to nine respondents in collecting experts opinions. In the future, an alternative approach could be iterative testing that involves both *Think-Aloud* and *Verbal Probing* techniques. We are now considering that after this first 'round' of testing the questionnaire, there is probably a need to modify the questionnaire based on what we have observed and found and then proceed to the next phase of the survey with the field experts. For instance, it is a general belief that two rounds of nine are better than one round of 18.

5 | CONCLUSIONS AND FURTHER WORK

This research study focused on a pilot validation with field experts in order to initialise an endeavour to review, reformulate and upgrade, where possible and necessary, the SPI Manifesto. Focusing on software professionals' views and experience in industrial and academic practice proved to be an eye-opening research venture. Utilising a questionnaire to collect professionals' and experts' views on the importance of the sociocultural dimension of the STEEPLED analysis was a decision that (i) had personal motivation after undertaking and leading a number of continuous software research and development projects throughout the years and (ii) became mature after investigating relevant studies of cross-cultural factors worldwide. The latter, as presented here, provided us with reflections on a number of systematic reviews over the last 10 (or earlier) years that identified success factors of and barriers to SPI initiatives.

Our focus centre has been on delving into the architecture of the SPI Manifesto, its principles, its values and their respective relationships. A manifesto is a public pledge, a promise, a programme for change and, thus, a binding relationship in practice. This is so because manifestos are based on the fundamental world views, values and principles of their issuer(s). The latter can be political parties, domain specialists, groups and even field experts or/and individuals within a specific historical and socio-economic context. A binding relationship holds its creators to account if they do not deliver the promises stated in their manifestos.[1,27]

Manifestos in software development (and elsewhere) appear and tend to have a narrow but evolutionary scope and are, sometimes, short-lived. Apparently, manifestos that have universal application and appeal stand the test of time. For instance, the enduring part of the AM seems to be positioned in its values, rather than its principles, which actually are more about *how* to work. Seemingly, the AM's principles are close enough to the SPI Manifesto principles.

The evolution of the EuroSPI conference as a forum for sharing experiences, innovations and research ideas produced collective knowledge that has been concretised in the SPI Manifesto, whose enduring characteristic is the ability to respond and adapt to change. As we reached a decade from the SPI Manifesto's inception, there is professional motivation and engagement in an ongoing debate and effort to review and revise the manifesto.

In the pilot research study with software field experts exposed in this paper, the authors and researchers carried out a pilot validation of the sociocultural dimension of the SPI Manifesto. This dimension is one of the eight dimensions that constitute the STEEPLED analysis. STEEPLED is a multidimensional and multifaceted analysis framework of thinking, which can be used as a thinking instrument in a number of cases in order to elucidate, model and formalise uncertain points of reference.

In the future, we aim to extend the matrix shown in Table 3 using the Haddon matrix,[55] which incorporates the stretching dimension of time (pre-event, event, postevent) as an appealing, brainstorming and planning tool. In 2005, Barnet et al.[56] expressed the research and developing need for 'including the dimension of time and contributing factors dissects the problem into its dimensions of time and contributing factors, applied as a practical, user-friendly interdisciplinary brainstorming and planning tool to help understand, prepare for, and respond to a broad range of public health emergencies and serve as a helpful model for disaster preparedness and response in a variety of contexts from public health readiness policy development'. The current COVID-19 pandemic demonstrates the need for readiness and response planning.

In the future, the authors, as continuous researchers of the other STEEPLED dimensions, aim to ask more details about, among other, the respondents' experiences in IT, knowledge of SPI implementation, reasons why their company and practice embarked on SPI and awareness of or experience of using the SPI Manifesto or other manifesto(s).

The STEEPLED analysis of the SPI manifesto aimed at understanding the software process as it is used within organisations and software industry. The initial study and analysis contributed towards a systemic (holistic) understanding of those factors that drive the realisation of changes and change management to the software process in order to achieve specific goals such as increasing development speed, achieving higher product quality or/and reducing costs.

Accordingly, SPI researchers must be equipped with suitable evaluation methodologies and measurement tools that can enable them to look through and within organisations and finally understand the state of practice with respect to the software development process and software process improvement initiatives. Additional investigation of relevant industrial research and practice can always provide insights from exemplary literature reviews and related case or field studies.

In so summarising, this research study extended the prior SPI research analysis by

i. focusing exclusively on sociocultural factors within SPI,
ii. exposing the opinions of software quality field experts and practitioners (Appendix A), and
iii. conducting a broad complementary literature review focusing on the sociocultural dimensions.

The latter addressed the sociocultural factors involved in the implementation of SPI programmes in software organisations worldwide and revealed how various sociocultural aspects of software development have gained increasing attention among the SPI research and software engineering community.

The growing demand for software-based products and services caused organisational changes in software industry; for example, the adoption of the SPI Manifesto's principles and values. Throughout this comparative study, it was observed that sociocultural and change management aspects depend on the practices adopted to promote interaction, exchange of knowledge and alignment of development activities. They also complement the expertise of the people involved.

It is rather a universally agreed view that, in the software production process, it is essential to implement development practices that consider sociocultural issues and cater for improving the performance of human resources. The latter is often neglected due to limited resources, which is a major influential factor in software process improvement practices.

Future research work for the SPI Manifesto will also be based on field experts' and software practitioners' knowledge and responses and will aim at reviewing and reflecting upon the usage of the SPI Manifesto and SPI awareness in general, in academia and industry. At a later stage, the authors aim to consolidate the findings of the overarching validation in clusters and incorporate possible new values and new principles related to them. A further target is to enrich the SPI Manifesto with the addition of a *comparative and practical philosophy* level proposing suitable modifications to the principles, for enhancing communication and collaboration channels between field experts—academics and practitioners—and other groups of software development stakeholders.

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APPENDIX A.: Questionnaire

A pilot validation of the proposed STEEPLED Analysis concentrating only on the sociocultural dimension. There is only one question applied to all relevant cells in the table.

How important is the *Sociocultural* Dimension in each case?

Please mark L for *Low*, M for *Medium*, H for *High*, VH for *Very High* in the box next to the sociocultural dimension.

	Values		
Principles	**People**	**Business**	**Change**
	Must involve people actively and affect their daily activities	Make business successful	Is inherently linked with change
1. Know the culture and focus on needs	***Sociocultural [S]*** Ethical [Et] Demographic D]	Political [P] Economic [E] ***Sociocultural [S]*** Demographic [D]	Ethical [Et]
2. Motivate all people involved	***Sociocultural [S]*** Ethical [Et] Environmental [En] Economic [E] Demographic [D]	Economic [E] Demographic [D]	***Sociocultural [S]*** Ethical [Et]
3. Base improvement on experience and measurements	Economic [E] Political [P] ***Sociocultural [S]*** Demographic D]	Economic [E] Demographic [D]	Technical [T] Economic [E]
4. Create a learning organisation	***Sociocultural [S]*** Ethical [Et] Economic [E] Technical [T] Demographic [D]	Economic [E] ***Sociocultural [S]*** Ethical [Et] Demographic [D] Demographic [D]	***Sociocultural [S]*** Demographic D] Technical [T]
5. Support the organisation's vision and objectives	Ethical [Et] ***Sociocultural [S]*** Demographic D]	Political [P] Economic [E] Demographic [D]	***Sociocultural [S]*** Political [P]
	Values		
Principles	**People**	**Business**	**Change**
	Must involve people actively and affect their daily activities	Make business successful	Is inherently linked with change
6. Use dynamic and adaptable models as needed	Technical [T] Economic [E]	Technical [T] Environmental [En]	Technical [T] Environmental [En]
7. 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]
8. 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]
9. Ensure all parties understand and agree on process	Demographic [D] ***Sociocultural [S]*** Political [P]Ethical [Et]	Demographic [D] Political [P] ***Sociocultural [S]*** Ethical [Et]	Political [P] ***Sociocultural [S]*** Ethical [Et] Environmental [En] Legal [L] Economic [E]
10. Do not lose focus	Demographic [D] Legal [L] Ethical [E]	Demographic [D] Legal [L] Ethical [Et]	Political [P] Ethical [E] ***Sociocultural [S]***

Comments

Please provide contact details such as an email if you would like a copy of the results and the associated research paper.

Your contact details: .....

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